SL=Zup SCANNED

PHASE II – COMPREHENSIVE SITE ASSESSMENT FOR AREAS NORTH OF THE RACEWAY

21 Canal ST

OXFORD PAPER MILL
LAWRENCE, MASSACHUSETTS

MADEP RTN 3-2691

VOLUME I of II – Report, Figures, and Tables

Prepared for:

Office of Planning & Development
City of Lawrence
147 Haverhill Street
Lawrence, Massachusetts 01840

RECEIVED
DEC 23 2004
DEP
NORTHEAST REGIONAL OFFICE

Prepared by:

Stone & Webster Massachusetts, Inc.
A Shaw Group Company
100 Technology Center Drive
Stoughton, MA 02072

December 2004

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC-102B

RELEASE LOG FORM ATTACHMENT

Release Tracking Number
3 - 2691

E. LOG/RELEASE LOCATION INFORMATION: (complete if using BWSC-102B only)

City/Town: Lawrence Date: 12/23/2004 Time: 5:00 ☐ AM ☑ PM

Release Address: 21 Canal Street

Use of Attachment (check one): ☐ Amendment to Release Log Form ☐ Attachment Page(s): ______ of: ______

F. INSPECTIONS OR SITE VISITS (also Follow-up Office Response): (check one)

☐ Initial Compliance Field Response - Announced
☐ Initial Compliance Field Response - Unannounced
☐ Compliance Field Response - Announced
☐ Compliance Field Response - Unannounced
☐ Short Notice Audit Inspection
☐ Field Response - Direct Oversight
☐ Follow-up or Other Field Response
☑ Follow-up Office Response

G. ADDITIONAL DESCRIPTION:

12/29/2004 The submitial is for an interim Phase II Report. There is no Phase I (although there is a TClass) or Phase II SOW in EPICS for this site. Jack Miano seems to think a Phase I was submitted at one time. I have requested the file from Salem. In the mean time I have given the recent submittal to John Zupkus.

1/10/05 after reviewing the files and checking with Jim I have decided to enter the Phase I for 12/01/99, the same date as the Tier IA for the site. This said the ~~[illegible]~~ TClass wouldn't have been entered for this site without a Phase I also being received.

Cr

1/11/05 The original Phase II SOW seems to have been submitted under an ESA Document with an obscure title, back on May 10, 2002. There was no Transmittal form for the SOW but I gave them the benefit of the doubt. See page 10 – the report accompanying this submittal for a history of submittals. ~~The~~ interim Phase II Report ~~[illegible]~~ has been entered as a status report.

H. DEP ASSIGNMENT: (complete if using BWSC-102A and 102B or BWSC-102B only)

Preparer of RLFA (please print): David Shakespeare

Staff Lead Assigned (If different from preparer): ______

☐ Check here if the Release or Threat of Release is unassigned.
☐ Check here if this RLFA records a change in staff lead.

STONE & WEBSTER MASSACHUSETTS, INC.
100 TECHNOLOGY CENTER DRIVE
STOUGHTON, MASSACHUSETTS 02072

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NORTHEAST REGIONAL OFFICE

DATE	December 22, 2004
J.O. No.	608134 05000000
P.O. No.	
LTR No.	COL - 336
REF.	Phase II – Areas North of the Raceway

TO

Massachusetts Department of Environmental Protection
Data Entry Unit
Northeast Region
One Winter Street
Boston, MA 02108

The following submittals are attached
__ copies __ prints __ reproducibles __ microfilm aperture cards
each of
☒ drawings ☐ specifications
☒ documents ☐ notes of conference

STATUS		PLEASE NOTE	SENT FOR YOUR
☒ final ☐ preliminary ☐ no comment ☐ suggestions as noted	☐ approved ☐ approved as revised ☐ unacceptable [as defined in specification]	☐ revisions ☐ omissions ☐ additions ☐ corrections ☐ comments	☐ approval ☐ comment ☒ use ☒ information ☐ files ☐ concurrence

YOUR ATTENTION IS DIRECTED TO THE FOLLOWING:

Released for: ☐ fabrication ☐ purchase of necessary materials.
☐ Please revise and submit ___ prints ___ reproducibles _____ microfilm aperture cards.
☐ Please submit ____ prints ___ reproducibles ____ microfilm aperture cards of:
☐ documents ☐ drawings ☐ shop detail.
☐ Please return one copy each of this material bearing your approval or comments.
☐ Please acknowledge receipt of this material by signing and returning the enclosed copy of this form.
☒ We trust that these notes are in accordance with your understanding: if not, please advise us.

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DEC 23 2004
DEP
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Phase II – Comprehensive Site Assessment for Areas North of the Raceway
FORMER OXFORD PAPER MILL - LAWRENCE, MA 01840

To Whom It May Concern:

We are transmitting the MADEP Phase II – Comprehensive Site Assessment for Areas North of the Raceway and transmittal forms with original signatures for investigative work conducted on the north side of the Former Oxford Paper Mill in Lawrence, Massachusetts (RTN 3-2691). This Phase II Comprehensive Site Assessment report does not cover investigative work conducted on the south side of the Oxford Paper Mill. The Phase II Comprehensive Site Assessment for Areas South of the Raceway will be submitted at a later date under a separate cover. Also, if significantly differing conditions are identified on the north side during removal of material from the wedge area, the enclosed report will be amended.

Sincerely, LM Tyrala

Les Tyrala, PG
Project Manager

Cc: T. Schiavone (City of Lawrence) – 1 copy
R. Devaney (GenCorp, Inc.) – 1 copy
K. Tisa (EPA Region 1) – 1 copy
A. Roche (MHD) – 1 copy
Job Book - 1 copy

[redacted] DDS

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC108

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

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

Release Tracking Number 3 - 2691

A. SITE LOCATION:

1. Site Name: Former Oxford Paper Mill - Areas North of the Raceway

2. Street Address: 21 Canal Street

3. City/Town: Lawrence 4. ZIP Code: 01840-1839

☐ 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 applicable, provide the Permit Number: W008661

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

☐ 1. Submit a **Phase I Completion Statement**, pursuant to 310 CMR 40.0484.

☐ 2. Submit a **Revised Phase I Completion Statement**, pursuant to 310 CMR 40.0484.

☐ 3. Submit a **Phase II Scope of Work**, pursuant to 310 CMR 40.0834.

☑ 4. Submit an **Interim Phase II Report.** This report does not satisfy the response action deadline requirements in 310 CMR 40.0500.

☐ 5. Submit a **final Phase II Report and Completion Statement**, pursuant to 310 CMR 40.0836.

☐ 6. Submit a **Revised Phase II Report and Completion Statement**, pursuant to 310 CMR 40.0836.

☐ 7. Submit a **Phase III Remedial Action Plan and Completion Statement**, pursuant to 310 CMR 40.0862.

☐ 8. Submit a **Revised Phase III Remedial Action Plan and Completion Statement**, pursuant to 310 CMR 40.0862.

☐ 9. Submit a **Phase IV Remedy Implementation Plan**, pursuant to 310 CMR 40.0874.

☐ 10. Submit a **Modified Phase IV Remedy Implementation Plan**, pursuant to 310 CMR 40.0874.

☐ 11. Submit an **As-Built Construction Report**, pursuant to 310 CMR 40.0875.

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NORTHEAST REGIONAL OFFICE

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

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

☐ 12. Submit a **Phase IV Final Inspection Report and Completion Statement**, pursuant to 310 CMR 40.0878 and 40.0879.

Specify the outcome of Phase IV activities: (check one)

- ☐ a. Phase V Operation, Maintenance or Monitoring of the Comprehensive Remedial Action is necessary to achieve a Response Action Outcome.
- ☐ b. The requirements of a Class A Response Action Outcome have been met. No additional Operation, Maintenance or Monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.
- ☐ c. The requirements of a Class C Response Action Outcome have been met. No additional Operation, Maintenance or Monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.
- ☐ d. The requirements of a Class C Response Action Outcome have been met. Further Operation, Maintenance or Monitoring of the remedial action is necessary to ensure that conditions are maintained and that further progress is made toward a Permanent Solution. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.

☐ 13. Submit a **Revised Phase IV Final Inspection Report and Completion Statement**, pursuant to 310 CMR 40.0878 and 40.0879.

☐ 14. Submit a **periodic Phase V Inspection & Monitoring Report**, pursuant to 310 CMR 40.0892.

☐ 15. Submit a **Remedy Operation Status**, pursuant to 310 CMR 40.0893.

☐ 16. Submit a **periodic Inspection & Monitoring Report to maintain a Remedy Operation Status**, pursuant to 310 CMR 40.0893(2).

☐ 17. Submit a **Termination of a Remedy Operation Status**, pursuant to 310 CMR 40.0893(5).

☐ 18. Submit a **final Phase V Inspection & Monitoring Report and Completion Statement**, pursuant to 310 CMR 40.0894.

Specify the outcome of Phase V activities: (check one)

- ☐ a. The requirements of a Class A Response Action Outcome have been met. No additional Operation, Maintenance or Monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement (BWSC104) will be submitted to DEP.
- ☐ b. The requirements of a Class C Response Action Outcome have been met. No additional Operation, Maintenance or Monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.
- ☐ c. The requirements of a Class C Response Action Outcome have been met. Further Operation, Maintenance or Monitoring of the remedial action is necessary to ensure that conditions are maintained and/or that further progress is made toward a Permanent Solution. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.

☐ 19. Submit a **Revised Phase V Inspection & Monitoring Report and Completion Statement**, pursuant to 310 CMR 40.0894.

☐ 20. Submit a **Post-Response Action Outcome Inspection & Monitoring Report**, pursuant to 310 CMR 40.0897.

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

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC108

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

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

Release Tracking Number
3 - 2691

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

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

> *if Section B indicates that an* ***As-Built Construction Report, Phase V Inspection and Monitoring Report,*** *or a* ***Remedy Operation Status*** *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.

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 #: 4488

2. First Name: Ronald   3. Last Name: Richards

4. Telephone: (617) 589-5499   5. Ext.: ______   6. FAX: (617) 589-2160

7. Signature: ______________________

8. Date: 12/16/04
(mm/dd/yyyy)

9. LSP Stamp:

RONALD B. RICHARDS No. 4488

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC108

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

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

Release Tracking Number 3 - 2691

D. PERSON UNDERTAKING RESPONSE ACTIONS:

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: City of Lawrence - Office of Planning & Development

3. Contact First Name: Thomas 4. Last Name: Schiavone

5. Street: 147 Haverhill Street 6. Title: Lawrence Gateway Project Director

7. City/Town: Lawrence 8. State: MA 9. ZIP Code: 01840-1515

10. Telephone: (978) 794-5891 11. Ext.: 12 12. FAX: (978) 683-4894

E. RELATIONSHIP TO SITE OF PERSON UNDERTAKING RESPONSE ACTIONS:

☑ 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 Response Actions Specify Relationship:

F. REQUIRED ATTACHMENT AND SUBMITTALS:

☐ 1. 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.

☑ 2. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the submittal of any Phase Reports to DEP.

☐ 3. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the availability of a Phase III Remedial Action Plan.

☐ 4. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the availability of a Phase IV Remedy Implementation Plan.

☐ 5. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of any field work involving the implementation of a Phase IV Remedial Action.

☐ 6. Check here if any non-updatable information provided on this form is incorrect, e.g. Site Name. Send corrections to the DEP Regional Office.

☑ 7. 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

BWSC108

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

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

Release Tracking Number 3 - 2691

G. CERTIFICATION OF PERSON UNDERTAKING RESPONSE ACTIONS:

1. I, Thomas Schiavone, 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: ______________________ Signature

3. Title: Lawrence Gateway Project I

4. For: City of Lawrence - Office of Planning & Development
(Name of person or entity recorded in Section D)

5. Date: 12/17/04
(mm/dd/yyyy)

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

7. Street: ______________________

8. City/Town: ______________________ 9. State: ________ 10. ZIP Code: ______________

11. Telephone: ______________ 12. Ext.: ________ 13. FAX: ______________

YOU ARE SUBJECT TO AN ANNUAL COMPLIANCE ASSURANCE FEE OF UP TO $10,000 PER BILLABLE YEAR FOR THIS DISPOSAL SITE. 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:)

PHASE II – COMPREHENSIVE SITE ASSESSMENT FOR AREAS NORTH OF THE RACEWAY

OXFORD PAPER MILL
LAWRENCE, MASSACHUSETTS

MADEP RTN 3-2691

VOLUME I of II – Report, Figures, and Tables

Prepared for:

Office of Planning & Development
City of Lawrence
147 Haverhill Street
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Prepared by:

Stone & Webster Massachusetts, Inc.
A Shaw Group Company
100 Technology Center Drive
Stoughton, MA 02072

December 2004

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List of Acronyms

ags	above ground surface
ACM	Asbestos Containing Material
AUL	Activity and Use Limitation
bgs	below ground surface
COPCs	Contaminants of Potential Concern
CSA	Comprehensive Site Assessment
EPA	Environmental Protection Agency
EPC	Exposure Point Concentrations
EPH	extractable petroleum hydrocarbons
EM	Electromagnetics
f/cc	fibers per cubic centimeter
FIRM	Flood Insurance Rate Map
GIS	Geographic Information System
GPR	Ground Penetrating Radar
ICV	Initial Calibration Verification
ICP	Inductively Coupled Plasma
IDW	Investigation-Derived Waste
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
µg/L	micrograms per liter

List of Acronyms (continued)

MADEP	Massachusetts Department of Environmental Protection
MCP	Massachusetts Contingency Plan
M&E	Metcalf & Eddy
MEK	methyl ethyl ketone
MHD	Massachusetts Highway Department
MIBK	methyl isobutyl ketone
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NFA	No Further Action
OHM	Oil and/or Hazardous Materials
OPM	Oxford Paper Mill
PAH	polycyclic aromatic hydrocarbons
PARCCS	Precision, Accuracy, Representativeness, Comparability, Completeness, and Sensitivity
PCB	polychlorinated biphenyls
PHC	petroleum hydrocarbons
PID	Photoionization Detector
PLM	Polarized Light Microscopy
PPE	Personal Protective Equipment
ppm	parts per million
PVC	polyvinyl chloride
QA / QC	Quality Assurance / Quality Control
RPD	Relative Percent Difference
RTN	Release Tracking Number
SAP	Sampling and Analysis Plan
SOW	Scope of Work
SVOCs	semi-volatile organic compounds
S&W	Stone & Webster Massachusetts, Inc.
TBA	Targeted Brownfields Assessment
TCLP	Toxicity Characteristic Leaching Procedure
THF	tetrahydrofuran
TPH	total petroleum hydrocarbon
UCL	Upper Concentration Limit
UST	Underground Storage Tank
VOC	volatile organic compounds
VPH	volatile petroleum hydrocarbons
XRF	X-ray Fluorescence

1.0 INTRODUCTION

The purpose of this report is to provide the Massachusetts Department of Environmental Protection (MADEP) with a Phase II - Comprehensive Site Assessment (CSA) report for areas north of the raceway at the Oxford Paper Mill (OPM) in Lawrence, Massachusetts. For this report, the area north of the raceway refers to both the wedge area and the North area (See Figure 3). The Oxford Paper Mill has been assigned release-tracking number (RTN) 3-2691 by the MADEP. Comprehensive Response Actions were conducted by Stone & Webster Massachusetts, Inc. (Stone & Webster or S&W), A Shaw Group Company, in accordance with the Massachusetts Contingency Plan (MCP), 310 CMR 40.0800, on behalf of the City of Lawrence, the owner of the Oxford Paper Mill property. The general site location is depicted on Figure 1 (Site Locus Map). Figure 2 shows the complete Oxford Paper Mill Site, including the areas north and south of the raceway. Figure 3 shows only the entire area north of the raceway, the area that this Phase II – CSA report is focused on.

This report provides a summary of known conditions on the north side of the Site and will be a bridge to use as required to address additional site activities.

2.0 BACKGROUND

2.1 General Information

The former Oxford Paper Mill (OPM) Site, Release Tracking Number 3-2691, is located on approximately three acres of land in Lawrence, Massachusetts, immediately northwest of the intersection of Canal Street and the Spicket River (refer to the Site Locus Map attached as Figure 1). A small portion of the OPM is also located north of Canal Street on the eastern bank of the Spicket River (an urban surface water body that abuts the OPM). The OPM is transected by a raceway, which discharges to the Spicket River. All nine buildings (Building Nos. 1, 2, 3, 4, 5, 6, 13, 1A, and 28) that once occupied the south side of the OPM have been demolished. Buildings north of the raceway were demolished in the 1970s. The OPM is surrounded by either a wooden stockade or chain-linked fence. Oxford Paper ceased operations at the Site in the mid-1970s. The City of Lawrence took ownership of the property in 1983.

Properties surrounding the OPM are used for commercial, institutional, and industrial purposes. GenCorp, Inc. (GenCorp), the Everett Mills property, and Union Street are west of the Site. Canal Street and the North Canal are south of the OPM beyond which are other historic mill buildings. The Spicket River is north and east of the Site. The Lawrence General Hospital is beyond the Spicket River to the north. The Everett Mills property is currently used for commercial purposes. The GenCorp facility, which was formerly occupied by Bolta Products and used for manufacturing rubber and plastic products, is currently vacant. The GenCorp facility was used most recently for manufacturing plastics and vinyl coated fabrics; polyvinyl chloride, resins; methyl isobutyl ketone (MIBK), methyl ethyl ketone (MEK), and tetrahydrofuran (THF) were used as part of these manufacturing operations.

Based on a review of the Massachusetts Geographic Information System (GIS) map (Lawrence) (refer to Figure 4), the OPM is not within an Interim Wellhead Protection Area (IWPA) or Zone II. Mr. Madden at the Lawrence Water Department indicated that the City of Lawrence obtains its water from the Merrimack River. Water is drawn from one well in the Merrimack River; this well is located in the river at the foot of Ames Street (i.e., at the intersection of Ames Street, Water Street, and Riverside Drive), approximately one and one-half miles west and cross gradient of the OPM. The city's reservoir is approximately one and one-half miles northeast of the OPM on Ames Hill. According to Mr. Madden, several car washes and only one residence have private water supply wells in the city. The closest private well is at a car wash approximately one mile from the OPM. Based on a review of Massachusetts Surface Water Quality Standards (314 CMR 4.00), the Spicket and Merrimack Rivers are Class B surface water bodies (i.e., designated as habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation).

According to the Federal Emergency Management Agency, Flood Insurance Rate Map (FIRM) for the City of Lawrence, Massachusetts (Community Panel Number 250087 0002B), the northwestern portion of the OPM is within Zone A17 (i.e., an area of 100-year flood) and portions of the north and southeastern areas of the Site are within Zone B (i.e., an area between the limits of the 100-year and 500-year flood).

Site Subject Area – North of Raceway (Wedge Area and North Area)

The area north of the raceway (the Site) is in an area of commercial development within downtown Lawrence, Massachusetts. The property does not contain any buildings or structures and is unpaved. The area north of the raceway contains vegetation that includes trees around the outer perimeter and tall grass throughout the interior portion. The Site is bounded to the north and east by the Spicket River, to the west by commercial property (the O'Gara Building), and to the south by the raceway. Access to the property is partially restricted by fencing along the western boundary. However, the Site can be accessed from the Spicket River or via an exit of the O'Gara Building. A Site Plan for the area north of the raceway is presented in Figure 3. The property will be used in the future as a passive park.

2.2 Ownership History and Historic Paper Mill Activities

HMM Associates conducted a preliminary site assessment in 1992, which summarized the history of the OPM. The following information is drawn from the HMM report (HMM, 1992). The HMM report states that paper making had been conducted on the Site for 135 years, first under the name Russell Paper Company, then Champion International, Oxford, Ethyl, and finally Pleasant Valley Paper Mills. Operations ceased completely in 1974. The City of Lawrence took ownership of the OPM in 1983.

Pulping of the wood chips was done by the "soda and sulphite" chemical process, which produced a foul odor (HMM, 1992) and typically used a base (lime or sodium hydroxide) plus sulfurous acid (HSO_3). Another pulping process, called the kraft chemical pulping process, uses sodium hydroxide (NaOH) and sodium sulfide (Na_2S), and may have also been used at the Oxford Site. The process was most likely conducted in steel digesters under steam pressure.

Some papers were coated with clay, which was stored in silos that were once present on the property. Buildings identified on the Sanborn maps include the "soda pulp mill", the "chemical mill" (No. 15), a machine building, (No. 3), and a building containing "beating engines" and a "rotary bleacher" (No. 6). Bleaching of pulp may have been done using chlorine or hypochlorite. An open coal bin, boiler room, and "black ash room" are also identified on some Sanborn maps. Note that building numbers, arrangements, and uses changed over the years according to the Sanborn maps.

Contaminants that may be present on the Site due to former paper mill operations include polycyclic aromatic hydrocarbons (PAHs) from coal, coal ash, and other combustion operations; chlorinated organic compounds that may have been formed during pulp bleaching operations; and sulfides from chemical pulp residues. The chlorinated organic compounds and sulfides would most likely have been released to surface water and air, as opposed to soil, because they are associated with mill operations that involved water discharges (to the raceway most likely) and air emissions (sulfur compounds and other volatile organic compounds (VOCs) from stacks and process tanks). In addition, underground storage tanks containing fuel oils and therefore, petroleum hydrocarbons (PHCs) may be present in soil and groundwater. Transformers containing polychlorinated biphenyls (PCBs) have historically been present on-site.

2.3 Environmental Compliance and Permit History

Since the Site is within the 100 year floodplain of the Spicket River (i.e., it is considered to be Bordering Land Subject to Flooding), a Notice of Intent (a written notice filed by any person intending to remove, fill, dredge, or alter an Area Subject to Protection under the Wetlands Protection Act) has been filed by MHD with the Lawrence Conservation Commission.

MHD has been given a National Pollutant Discharge Elimination System (NPDES) permit for dewatering activities that are being conducted as part of the demolition activities associated with the area south of the raceway. However, since groundwater exists at 15 to 20 feet below grade for areas north of the raceway, its not expected to be collected or treated.

2.4 Regulatory History

A Notice of Responsibility (NOR) was issued to the City of Lawrence on May 15, 1989; the NOR indicated that contaminant conditions at the former OPM render the Site a "Location To Be Investigated" (LTBI). According to an October 23, 1989 letter from DEP to the City of Lawrence, the Emergency Response Branch concluded that no further emergency response actions at the Site were necessary at the time and the case was referred to the Site Management Branch. The Site was first listed as an LTBI on DEP's "List of Confirmed Disposal Sites and Locations to be Investigated" on January 15, 1990. As a Transition Site under the Massachusetts Contingency Plan (MCP), the August 2, 1996 deadline for submittal of a Licensed Site Professional (LSP) Evaluation Opinion, as specified in the MCP (310 CMR 40.0610(3)(b)), applied to the Site. Neither one of the submittals listed in 310 CMR 40.0610(5)(a) through (c) (i.e., an LSP Evaluation Opinion, statement pursuant to 310 CMR 40.0610(4)(b), or Response Action Outcome Statement) nor a Tier Classification Submittal was submitted to DEP by this deadline. As such, the Site was categorically classified as a Tier IB disposal Site on August 2, 1996.

On November 23, 1999, the Site was Tier Classified by Mr. Kevin Scully, LSP of Stone & Webster. The numerical ranking for the Site was 558, and a Tier 1A Permit Application Submittal was sent to DEP on November 29, 1999 for administrative and technical review. A Site visit was conducted by MADEP on February 3, 2000. During this meeting and subsequence discussions with Mr. Kevin Scully and Ms. Ann Roche of MHD, Mr. Larry Mach of MADEP indicated that the Site would be classified Tier 1B. On March 3, 2000, MADEP classified the Site as a Tier 1B (Permit # W008661).

2.5 Soil and Groundwater Categories

For screening purposes only, the analytical results have been compared to applicable MCP Standards throughout this report. A Method 3 Risk Characterization for this portion of the Site has been performed and is discussed in Section 8.0. Soil and groundwater categories have been developed by MADEP to facilitate the characterization of site risk where releases have occurred. Appropriate categories for this site have been identified in accordance with 310 CMR 40.0990.

2.5.1 Soil Categorization

Soil categorization is described in Section 40.0933 of the MCP. Three criteria are assessed to identify the soil category: accessibility, frequency of use, and intensity of use. Accessibility is determined by identifying how close to the surface oil and hazardous material (OHM) is located and whether there are physical barriers such as pavement preventing access to it. At this site, surface soils are considered "accessible" and subsurface soils are considered "potentially accessible". Frequency of use describes how often a receptor has access to or use of the disposal site. Intensity of site use is an indication of the likelihood of contacting or disturbing the soil in a manner, which will increase exposures to OHM.

Soil contamination is present at depths less than three feet below the surface and access to the Site by children is currently not restricted. However, children would not be found at the Site with high frequency. Based on these considerations, and in accordance with the MCP soil category selection matrix. Under the MCP (310 CMR 40.0933) soil is categorized as S-1, S-2, or S-3, based on the current and reasonably foreseeable site activities and uses as identified in the MCP. For the purpose of soil categorization, the potential for exposure is described by a qualitative analysis of the accessibility of the soil in combination with information about the Site activities and uses. The criteria contained in the MCP (310 CMR 40.0933) were used to describe exposure potential at the Site. Site soils can be classified as S-2, unpaved soil within the property, 0 to 15 feet deep.

Since the Site may undergo future development as a park, the S-1 category is applicable to soils on the Site in the future. It is anticipated that the Site will be used for a passive park area, and hence have a low intensity of use. The frequency of use is also expected to be low, which could potentially allow for classification as S-2. However, because the City of Lawrence does not plan to regulate the frequency of use, the more protective classification of S-1 has been selected as more appropriate for evaluating future risk.

2.5.2 Groundwater Categorization

As described in 310 CMR 40.0932, MADEP has identified three groundwater quality categories under the MCP, each reflective of a type of risk that may be posed by OHM in groundwater. Different combinations of these criteria are applicable at sites depending upon the groundwater resource characteristics.

The GW-1 category is applicable to locations where groundwater is, or may in the future be, a drinking water source. Based on a review of the MADEP Bureau of Waste Site Cleanup Site Scoring Map (refer to Figure 4), the Site is not located within a designated Zone II, Interim Wellhead Protection Area, a Potentially Productive Aquifer, or the Zone A of a Class A Surface Water Body. In addition, the Site and surrounding areas are serviced by municipal water and is not indicated to be within 500 feet of any private wells. Therefore, a MCP GW-1 Groundwater Category classification is not considered applicable to the Site.

The GW-2 category applies to locations where OHM may volatilize from the groundwater and migrate into an occupied structure. Since no currently occupied buildings exist on-site and an AUL will prevent future building construction, the current and future classification of Site groundwater in the GW-2 (as defined in 310 CMR 40.0932(2) is not considered applicable.

The GW-3 category is intended to protect environmental receptors in surface water, which may be exposed to OHM when groundwater discharges to surface water. As is the case at all sites, the GW-3 groundwater category is applicable. The Spicket River, which abuts the Site, is a potential surface water receiving body for site related groundwater. Therefore, completion of an exposure pathway between contaminants in groundwater and this nearby surface water body is considered possible. Consequently, consistent with the requirements of 310 CMR 40.0932(2), where all groundwater is assumed to eventually discharge to surface waters, the groundwater at the Site is classified as a GW-3 Groundwater Category.

In summary, based on the above soil and groundwater categorizations, applicable MCP Categories are S-1 and S-2 for soil and GW-3 for groundwater.

2.6 Results of Previous Investigations

The following are the results of previous investigations for the areas north and south of the raceway:

Briggs Associates, Inc., 1984

In December 1984, Briggs Associates, Inc. (Briggs) completed an Environmental Site Investigation of the former OPM property in accordance with Massachusetts General Laws (M.G.L.) Chapter 21E. The study consisted of a Site reconnaissance, a review of information at the Lawrence Fire Department regarding storage tanks on the property, excavation of five shallow (to a maximum depth of 7 feet below ground surface) test pits (TP-1B thorough TP-5B), and collection and analysis of soil samples for volatile organic compounds (VOCs), RCRA-8 metals, and oil and grease. Briggs concluded that, "RCRA metals, oil and grease, and volatile organics concentration were all within limits not to represent an issue," and "all factors indicate that the area is environmentally acceptable."

Eckenfelder, Inc. 1984 through 1992

Eckenfelder, Inc. conducted investigations of the GenCorp, Inc. Site between 1984 and 1992. These studies were conducted in phases (i.e., Phase I-A, Phase I-B, Phase II, Phase III-A, Phase III-B, Phase IV-A, Phase IV-B, and Phase IV-C). Eckenfelder's Phase IV investigations, which were completed between September 1990 and December 1992, included sampling and analysis of soil and groundwater on the former OPM Site. The scope and results of their work on the former OPM Site are presented below.

Eckenfelder's Phase IV groundwater investigation program included: installation of monitoring wells on both the GenCorp, Inc. and former OPM property; collection of two rounds of groundwater samples from existing wells; collection of a third round of groundwater samples from a limited number of wells; and collection of surface and subsurface soil samples. The following paragraphs summarize soil and groundwater analytical results for the Oxford Paper property. Figures 2 and 3 show the locations of monitoring wells installed by GenCorp on the north side of the OPM property. These monitoring wells were decommissioned in 1997.

Soil

With the exception of 0.12 mg/kg of methylene chloride in surface soil sample G-19 (south side), no VOCs were detected in soil. Low levels of SVOCs (i.e., benzo(a)anthracene, benzo(b)fluoranthene, bis-(2-ethylhexyl) phthalate, di-n-butyl phthalate, chrysene, fluoranthene, and pyrene) were detected in soil at various depths. PHCs were detected in three subsurface soil samples (B-16XD (north side), B-22 (north side), and B-18 (south side)) at concentrations ranging from 13 to 1720 mg/kg. PCBs (Aroclor 1254) were detected in two surface soil samples, G-19 (south side) and G-22 (north side) at 0.165 and 0.34 µg/kg, respectively. Mercury was detected in surface soil at one location (i.e., B-19 (south side)) at a concentration of 43 mg/kg. Lead and zinc were detected in surface soil sample G-18 (south side) at 230 and 200 µg/kg, respectively. Phenols were also detected in soil sample G-18 at 59.5 mg/kg.

Groundwater

VOCs (i.e., benzene, chloroform, ethylbenzene, toluene, 2-chloro-ethyl vinyl ether, MIBK, MEK, acetone, THF) were detected at low concentrations in groundwater during Eckenfelder's Phase IV investigation.

Analytical results indicated the presence of low levels of PCBs in three wells (B-18D (south side), B-20D (north side), and B-22D (north side)) on the former OPM Site at concentrations close to the detection limit (concentrations ranged from 0.5 to 2.9 µg/L). Data validation concluded that the PCBs values for these wells were false positives. No PCBs were detected in deep bedrock wells or in wells along the downgradient perimeter of the former OPM Site.

Elevated levels of several metals (arsenic, chromium, mercury, lead) were detected in groundwater. Arsenic was detected in wells B-16D (north side) and B-22D (north side) at 212 and 370 µg/L, respectively. Analytical results indicated the presence of mercury in monitoring well B-19 (south side) at 440 µg/L and lead in monitoring well B-16D (north side) at 16 µg/L.

Phenanthrene was detected in groundwater collected from monitoring well B-22S (north side) at a concentration of 70 µg/L. Pesticides (beta BHC) were detected in B-22D (north side) at a concentration of 0.09 µg/L.

Based on the results of this study, Eckenfelder, Inc. concluded that the shallow VOC plume emanating from the GenCorp, Inc. property has decreased in size and no longer extends onto the former OPM property.

Eckenfelder, Inc., 1994

In October 1994, Eckenfelder, Inc. collected groundwater samples from 20 existing monitoring wells located on and around the Oxford Site (both north and south sides). The samples were analyzed for VOCs, PCBs, arsenic, chromium, mercury, and zinc. Low to non-detectable levels of VOCs were present in groundwater. PCBs were not detected in any of the groundwater samples. Concentrations of arsenic, chromium, mercury, and zinc were consistent with previous sampling results.

Eckenfelder, Inc., 1995

In May 1995, Eckenfelder, Inc. collected surface water samples from locations within the Spicket River, North Canal, and raceway. The samples were analyzed for VOCs via U.S. EPA Method 8240 and tetrahydrofuran (THF). With the exception of 1.1 µg/L of 1,2-dichloroethene (1,2-DCE) in the Spicket River at General Street (SW-1) and 2.7 µg/L of carbon disulfide in the raceway (SW-11), no VOCs were detected in the surface water samples collected.

Eckenfelder, Inc. 1997

Groundwater

Prior to March of 2003, groundwater at the Oxford Site was last sampled in November of 1996, during a sampling event done by Eckenfelder for GenCorp (Eckenfelder, Inc. – Oxford Paper Site Supplemental Groundwater Quality Report, 1997). The wells were sampled just prior to being decommissioned in 1997. During the November 1996 sampling event, wells north of the raceway were sampled and analyzed for VOCs, SVOCs, PCBs, priority pollutant metals, cyanide, and diesel range organics or petroleum hydrocarbons. Low levels of toluene (between 3.5 µg/L in B-21S and 17 µg/L in B-16S) were detected the groundwater samples. Methylene chloride was sporadically detected at levels below 2 µg/L (in B-21S, B-22S, and B-22D), and was also detected in field and trip blanks at similar levels. No data validation was conducted and it is not known whether the methylene chloride detections would have been eliminated due to blank contamination; however, it is considered likely.

B-21S contained PAH contamination, acenaphthene, fluorene, and 2-methylnaphthalene, at concentrations of 3.1, 4.8, and 2.8 µg/L, respectively. Diethyl phthalate was detected in B-22XD at a level of 1.0 µg/L. B-16D and B-21S contained diesel range organics or petroleum hydrocarbons in concentrations of 0.28 and 0.73 mg/L. No PCBs were detected in any of the samples. All well locations are depicted in Figures 2 and 3.

The concentrations of organic contaminants detected in the November 1996 sampling event are very low and sporadic, and are not suggestive of a significant groundwater impact at the Site.

2.7 Previous Assessment of Storage Tanks, Drums, and Containers

Information on the status of storage tanks, drums and containers is provided in various letters and reports regarding the area north of the raceway and is summarized below.

According to a review of City of Lawrence Fire Department records by Briggs Associates, Inc. in the 1984 study, no aboveground storage tanks were present at the OPM. However, the records indicated that one 20,000-gallon and three 30,000-gallon underground storage tanks (USTs) were present at the Site. The license for these tanks was issued on July 6, 1953. Fire Department records also indicated that gasoline was stored in two 300-gallon USTs. One tank was installed in 1921 and the other one was installed in 1928; both were removed on July 23, 1968.

A March 19, 1992 letter from Mr. Robert J. Devaney, Jr., Director of Environmental Engineering at GenCorp to the City of Lawrence Community Development Department summarizes the results of CDM's December 1985 report titled "Final Technical Memo Report #3 - Oxford Paper Site." The letter indicates that the presence of three 30,000-gallon tanks at the Site was confirmed in April 1989.

The May 15, 1989 NOR letter from MADEP to the City of Lawrence indicates that based on MADEP's review of a July 25, 1967 plan of the Site, seven fuel oil storage tanks were located on the property (three 30,000-gallon, one 20,000-gallon, one 10,000-gallon, and two 1,000-gallon tanks). The letter indicates that these tanks were abandoned in 1976. According to the letter, two of the tanks (one 20,000-gallon and one 1,000-gallon) were located on April 19, 1989 and were scheduled to be removed; no leakage was observed from the 20,000-gallon tank.

A Commonwealth of Massachusetts, Department of Public Safety, Division of Fire Prevention, Permit for Removal and Transportation to Approved Tank Yard was obtained for the 20,000-gallon tank on April 18, 1989. The tank was removed on April 19, 1989 and transported off-Site to John C. Tombarello & Sons of Lawrence, Massachusetts. The permit indicates that the tank was accepted at this location on June 9, 1989.

The 1,000-gallon tank was excavated on April 20, 1989. This 1,000-gallon tank was removed from the location of a supposed 10,000-gallon fuel oil tank shown on a historical map of the Site. According to a Commonwealth of Massachusetts, Department of Public Safety, Division of Fire Prevention, Permit for Removal and Transportation to Approved Tank Yard, the tank was transported off-Site to John C. Tombarello & Sons of Lawrence, Massachusetts. The permit indicates that the tank was accepted at this location on June 9, 1989.

An April 23, 1991 letter from Eckenfelder, Inc. to Mr. Robert J. Devaney, Jr., Director of Environmental Engineering at GenCorp indicates that GenCorp responded to the 1988 oil release to the Spicket River by assisting with UST location, identification, and removal on the former OPM property. The letter also indicates that subsequent excavations conducted by the City of Lawrence confirmed the presence of several large diameter USTs, which contained petroleum residuals of unknown composition.

According to information gathered, as part of HMM's Preliminary Site Assessment in 1992, five underground storage tanks were identified on the Site to the north of the raceway. Two of these tanks (one 500-gallon and one 1,000-gallon) were removed by Clean Harbors in 1988. Records maintained by the City of Lawrence Fire Department indicate that one 1,000-gallon tank was removed in 1989. The remaining USTs were each 30,000-gallons. The contents of the tanks were sampled by Clean Harbors in 1988; analytical results indicated that petroleum was stored in the tanks. Clean Harbors reportedly removed the contents of two of the USTs. According to records at the City of Lawrence Fire Department, the contents of the third tank had solidified.

Enpro, Inc. removed the three 30,000-gallon fuel oil USTs in November 2000. Analytical data showed no exceedances at MCP reportable levels. Based on the above information, it appears that there are no remaining underground storage tanks in the North area of the former OPM Site. Figure 3 shows areas north of the raceway where former USTs were once located.

2.8 Geophysical Investigation

A geophysical survey was conducted on March 7, 8, and 11, 2002 by Hager GeoScience, focusing on the area north of the raceway and up to the Spicket River. The report produced by Hager GeoScience is reproduced in Appendix A. Two techniques, electromagnetics (EM) conductivity and Ground Penetrating Radar (GPR), were used. The purpose of the survey was to identify and locate subsurface voids and obstructions that could pose hazards for environmental sampling with a drill rig or test pits. Due to the nature of the Site, there were many obstructions that interfered with the data collection, consequently leaving gaps in the data. Among the subsurface obstructions were heavy gauge steel plates, I-beams, a large roll of chain link fence, bricks, rebar, and vegetation.

EM is commonly used to delineate boundaries between native/natural ground material and anthropogenic material (fill, construction materials, disturbed native/natural material, and tanks).

The method relies on the ability of the EM to detect significant differences in conductivity between these media, using either in-phase or quadrature-phase conductivity responses to an induced electromagnetic field. In-phase responses are useful in discerning metallic objects, while quadrature-phase responses are useful in determining variations in ground conductivity.

At the Oxford Paper Mill site north of the raceway, the in- and quadrature-phase EM surveys indicated that there were no large buried metal objects (this indication was also confirmed by GPR results). Metal objects detected during the EM survey were all correlated to surficial debris such as steel plates and chain link fence that were annotated during the data collection. The survey was able to discern many rectilinear features, which seemed to correlate with historic buildings. In general, these buildings tend to run parallel to the raceway, within 30 feet of the raceway north wall. One building, however, ran north towards the Spicket River, across the center of the Site. These EM responses are suggestive of remnant foundation walls and debris filled foundations. Because of vegetation, the southern extent of these remnant foundation walls was not determined due to the inability to access this area with the EM equipment.

The EM method of investigation did not detect any voids large enough to be resolved by the 5-foot traverse spacing. At the Oxford Paper Mill, this was an issue in several areas because of the amount of metal on the ground, and in particular the steel/concrete slab overlying the foundation of the western end of the former chemical mill (Building No. 15).

The GPR method measures the time it takes for a radar wave pulse to travel to and from a discontinuity (such as a foundation wall) that has reflected the wave. The travel times are then converted to depths based on the composition of the material through which the waves travel. This conversion factor is based on site soils. In the case of the Oxford Paper Mill, borehole data (former wells B-16 and B-22, from former site assessments), handbook tables and experience were used. The transverse spacing of the GPR unit was also smaller (2 feet) than the EM traverses, thereby giving better definition and three-dimensional imaging.

The results of the GPR survey were very similar to the EM survey in that they revealed remnant building structures, which predominantly paralleled the raceway and one structure, which was oriented north to south across the Site. In addition, the GPR survey was also able to discern the presence of a linear feature between the engine room and the center of Building No. 19 (boiler room), a couple of locations where floors have collapsed or partially collapsed into basements, and one area where voids (buried rooms) were possible. This buried room area is roughly the area of the west end of the chemical mill, which was not discernable using EM method because of the I-beam and concrete floor structure at grade.

2.9 Asbestos Air Monitoring

Due to the presence of asbestos in surface soils, real-time air monitoring for asbestos was conducted during test pit excavation and soil boring activities. Real time asbestos-containing material (ACM) air monitoring results from the March of 2003 site investigation did not exceed action levels. Appendix B presents the real-time ACM air monitoring data. An asbestos air-monitoring plan and action levels were established for the project through consultation with the EPA and MADEP and the following table depicts this information:

Location	Frequency of Sample	Exposure Limit	Action Level	Response Action
Personal	Daily	0.1 f/cc	≥0.1 f/cc	- Upgrade to Level C - Initiate / modify engineering controls - Determine source of elevated fiber - Continue to monitor work area
Work Area	Background and Clearance	0.1 f/cc	≥0.1 f/cc	- Same as above
Work Area Perimeter	Daily, 2 downwind and 1 upwind (GenCorp and O'Gara)	0.1 f/cc	≥0.1 f/cc	- Stop work and notify MADEP

Note: f/cc = fibers per cc

In addition, equipment operators were required to wash equipment parts that contacted soil before leaving the Site. Wash water was discharged into a small, shallow test pit lined with geotextile fabric, to trap any ACM fibers present. Upon demobilization from the Site, the geotextile fabric was drummed and was disposed off-site as ACM waste.

2.10 Tier Classification

The Oxford Paper Mill property has undergone a succession of environmental investigations beginning in 1984. The site is a listed MCP disposal site, Release Tracking Number 3-2691. The Site first came to MADEP's attention in 1989, after a release of petroleum product to the Spicket River. The site was a transition site that was classified as a default Tier 1B site in 1996, because required MCP submittals were not filed with the MADEP. The Site was classified as Tier 1A by Stone & Webster (S&W) for the City of Lawrence in November 1999. After a site visit and subsequent discussions, MADEP re-classified the Site as Tier 1B, which is the current site status.

3.0 PHASE II-COMPREHENSIVE SITE ASSESSMENT ACTIVITIES

The purpose of the Phase II CSA field program was to fill data gaps necessary to characterize the source, extent, and migration pathways of OHM, and the risk or harm posed to health, safety, public welfare, or the environment. In accordance with 310 CMR 40.0800 of the MCP, Comprehensive Response Actions, Metcalf & Eddy prepared a Scope of Work (SOW) for the May 2002 site Targeted Brownfields Assessment (TBA), which covered the wedge area. The Scope of Work was issued after all the components of the work plan were agreed upon by the EPA, City of Lawrence, and the MADEP. After Metcalf & Eddy received all comments, the final Scope of Work was submitted to all parties in May 2002. Upon completion of the May 2002 Scope of Work, it was further agreed that data from this investigation would be supplied to Stone & Webster for use in preparing MCP submittals for the Site. The SOW prepared for the May 2002 TBA was completed by Metcalf & Eddy. Metcalf & Eddy worked as a subcontractor to Stone & Webster Massachusetts to conduct site work in March 2003 for the North Area.

The field activities for the May 2002 and March 2003 site investigations are summarized below and detailed in the following sections.

May 2002 – Wedge Area (Metcalf & Eddy)

- Advancement of test pits at twelve locations within the area north of the raceway (specifically the wedge area) that will be graded for park and bridge construction. Sixteen test pits were planned (refer to Figure 5), but not all were advanced due to accessibility and/or health and safety concerns;
- Collection of soil samples from 0 to 1 foot, and at approximate two-foot intervals thereafter to the bottom of each test pit, for PCB analysis in the mobile laboratory. Samples were collected to an approximate depth of fifteen feet or until the test pit was terminated based on physical or health and safety issues;
- Collection of soil samples from the surface (0 to approximately 1 foot) interval from each test pit for analysis in the mobile laboratory for arsenic, chromium, and lead;
- Selection of a portion of the mobile laboratory soil samples for confirmatory analysis for PCBs and metals by the fixed laboratory;
- Collection of composite soil samples from selected test pits for analysis in an off-site laboratory for the following: Extractable Petroleum Hydrocarbons (EPH), TCLP metals, sulfide reactivity, and priority pollutant metals (plus barium and vanadium). Composites samples were created by combining soils at different depths within the selected test pits, selected to represent surface soils (typically the first two intervals, i.e., 0 to 1 foot plus 1 to 3 feet) and subsurface soils (typically three feet to bottom of test pit). The test pits were selected to provide a representative spacing along the area north of the raceway that was under investigation;
- Collection of selected samples for asbestos analysis, and one water sample from a test pit for EPH and PCB analysis, based on field observations;
- Conducted geophysical investigations for subsurface anomalies; and
- Investigation-Derived Waste (IDW) management

March 2003 – North of Wedge Area (North Area) – Metcalf & Eddy / Stone & Webster

- Obtain surface and subsurface soil data sufficient for use in a Method 3 Risk Characterization through ten soil borings (refer to Figure 3);
- Evaluate groundwater to confirm the current understanding of the Site, based on sampling conducted by GenCorp that indicates groundwater contamination is not

present. Installation of five new monitoring wells at the new soil boring locations throughout areas north of the raceway;

- Further investigate subsurface geophysical anomalies found during the May 2002 site investigation that could represent pathways for migration or sources of contamination;
- Investigate areas where USTs were formerly located to rule out the possibility of subsurface petroleum releases;
- Characterize the subsurface to a depth of approximately fifteen feet (where possible) to allow development of a plan for remediating the Site consistent with its intended future use;
- Land surveying of all new sample and monitoring well locations, groundwater elevation survey; and
- Investigation-Derived Waste (IDW) management

The major site contaminants, and recommended analyses for the field investigation of the area north of the raceway, are summarized below:

PCBs. PCBs are the primary site contaminants, due to transformer spills and leaks and other possible sources, such as leaks from pulp and paper processing equipment. Analysis for PCBs is recommended for TSCA compliance, MCP risk characterization, and off-site disposal characterization.

The types of Aroclors most likely to be encountered at the Site based on historical data and the TBA data are Aroclor 1242 and Aroclor 1248. Aroclors 1254 and 1260 may also be encountered. The Aroclors lighter than 1242 are not considered as likely to be present.

Asbestos. Suspected ACM was visually observed during the TBA, and the observations were confirmed by laboratory analysis of soil samples. The November 2002 surface soil sampling event supplemented and confirmed the TBA results.

Petroleum Hydrocarbons. While UST leaks have not been documented, soils were sampled and analyzed for EPH by the MADEP method. The EPH soil data is needed for off-site disposal characterization, and the target PAH analytes from the EPH analysis (see below) also serve to characterize soil for disposal and MCP risk characterization. TPH concentrations in soil were elevated at one subsurface soil location north of the raceway (former Boring B-16, see Figure 2), and a sheen was observed in TP-7 during the TBA investigation, suggesting there may have been an on-site petroleum release.

It is not considered necessary to analyze soils for VPH and VOCs because there are no documented releases of volatile constituents on the Site. However, groundwater samples were analyzed for VPH, due to the proximity of potential upgradient sources.

PAHs. PAHs are likely to be present in soils, most likely due to coal and coal ash, and possibly petroleum releases. PAHs were widely detected at levels above reportable concentrations during the TBA. Phenanthrene was detected in groundwater at one location, according to the tier classification. PAH compounds were quantified via the EPH analysis. If related solely to coal and coal ash, the soil PAH concentrations may be determined to be "background" as defined in the MCP. It is understood that GenCorp is performing an assessment of area-wide background levels of PAHs for its property and the OPM property. PAH soil results were evaluated in light of the background assessment and for disposal purposes.

Metals. Heavy metals may be associated with coal ash, but the high level of mercury at one location is suggestive of a more concentrated source, possibly a release from mercury-containing manometers, gauges, or switches that may have been used at the former paper mill. Analysis for metals (priority pollutant list plus barium and vanadium at a minimum) was recommended. The addition of barium is recommended because it is a RCRA metal, and because it has MCP Method 1 Standards. Vanadium also has MCP Method 1 Standards.

Sulfide Reactivity. As noted previously, sulfides were used at the paper mill and there is a possibility that sulfide-reactive materials are present on Site. However, soil samples were analyzed for sulfide reactivity during the TBA and sulfide reactivity was not detected. For the March 2003 site investigation, soil samples were not analyzed for sulfide reactivity.

Other Analytes. VOCs and SVOCs other then PAHs in soil were detected in some samples at low levels, according to the data presented in the tier classification, and are not judged to be significant site contaminants. There was one detection of a pesticide in groundwater, beta BHC, at a low level (0.09 µg/L) during one previous groundwater sampling event. Pesticides are not known to have been used or stored at the property. Further analysis for pesticides is not considered to be necessary.

A description of the field investigation processes performed are summarized as follows:

3.1 Health and Safety

S&W developed and implemented a worker Health and Safety Plan for the work performed on the north side of the raceway (wedge and North Area) at the Oxford Paper Mill in Lawrence, MA (S&W, updated 2002). Also, Metcalf & Eddy's Health and Safety Plan was followed by on-site workers. On-site personnel read and signed the Health and Safety Plan before performing work on the north side of the Oxford Paper Mill. Due to the asbestos found throughout the areas north of the raceway, all work was conducted in Level C personal protective equipment (PPE) and no action levels were reached. Asbestos air monitoring was conducted during all investigative activities north of the raceway. Refer to Section 2.9 for a summary and Appendix B for real-time data.

3.2 Test Pit Excavations and Sampling

In May of 2002, Metcalf & Eddy completed a test pit investigation of an area north of the raceway known as the wedge area, which was conducted as part of a Targeted Brownfields Assessment (TBA). The test pit investigation concluded that soils were primarily contaminated with PCBs, asbestos, PAHs and certain metals.

Samples were collected to an approximate depth of fifteen feet below ground surface (bgs) or until the test pit was terminated based on physical or health and safety issues. PCB analysis was conducted by both mobile and fixed laboratory procedures. PCB analysis was conducted by the mobile laboratory for one to two foot samples collected from each of the twelve test pits. The mobile laboratory results indicated the presence of low levels of PCBs (1 to 15 mg/kg) throughout the wedge area soils. The fixed laboratory sample results did not confirm the mobile laboratory results in all cases. It was determined that the mobile laboratory sample results provided a conservative measurement of the PCBs present, because the mobile laboratory sample results were nearly always greater than the fixed laboratory sample results. Since the PCB concentrations do not show a pattern with either depth or test pit location, segregation of PCB-contaminated wedge material from uncontaminated material is not believed to be feasible. The concentrations do not differ over a wide range, and are uniformly less than 50 mg/kg.

Based on the site knowledge of the Region 1 PCB coordinator and GenCorp representatives, initial releases of PCBs at the Oxford Site are believed to have occurred before 1978. Disposal of pre-1978 wastes that have PCB concentrations less than 50 mg/kg is not regulated under TSCA. However, the PCB concentrations in the wedge area soils are greater than what can be accepted by Massachusetts landfills and/or recycling facilities (2 mg/kg or less). PCB contamination of wedge area soils is believed to have originated from demolition activities that occurred north of the raceway before and after 1978.

Soil samples and bulk waste samples were collected for asbestos analysis, based on field team observations of suspect ACM and asbestos warning tape. The presence of asbestos in soils was confirmed by laboratory analysis at nine of twelve test pit locations. Soil asbestos concentrations ranged from less than one percent (detectable) to several percent, and bulk ACM was also discovered at several locations. ACM was not visually observed at all locations, and it is considered likely that it is present throughout soils of the wedge area, even though some soils contained concentrations less than one percent. Wedge area test pit logs are presented in Appendix C. Figure 5 represents the locations of all wedge area test pit excavations.

Surface soil samples at each test pit location were screened for arsenic, lead, and chromium in a mobile laboratory using an XRF (X-ray Fluorescence) instrument. The samples were initially screened for these metals due to their presence in the groundwater from investigations conducted by Eckenfelder between 1984 and 1992. Samples from each of the test pit locations were also sent to a fixed laboratory for a wider range of metal analysis. For wedge area soils from test pits located furthest east, arsenic concentrations are elevated relative to samples from other areas. The elevated arsenic concentrations (>60 mg/kg) may be partially due to the presence of coal ash in that area. A "black ash room" and "boiler room" were formerly located in this area. Metals detected in the soil are believed to primarily originate from ash. TCLP extraction and analysis did not reveal concentrations of leachable metals in excess of toxicity characteristic regulatory levels (See Table 5-4).

The primary petroleum hydrocarbon fraction present in wedge area soils is the aromatic fraction with target PAH compounds. The presence of PAHs is consistent with field observations of coal and wood ash, coal chips, asphalt, and partially burned timbers. The PAHs found in wedge area soils are likely to be predominantly from asphalt, coal, coal ash, and wood ash, but petroleum and/or creosote releases cannot be definitely excluded as contributors to the PAH contamination. The highest total PAH concentrations (>100 mg/kg) were detected around the vicinity of the former "black ash" room.

As defined by the Massachusetts hazardous waste regulations (310 CMR 30.000), a waste exhibits hazardous characteristics if it is ignitable, corrosive, reactive, or toxic. Based on visual and laboratory evidence, it was confirmed that the wedge area soils that were sampled were non-corrosive and non-reactive. No soil borings or monitoring well installations occurred during this wedge area investigation.

In March of 2003, Metcalf & Eddy/S&W conducted an investigation of the North Area (north of raceway and wedge area) to determine the nature and extent of contamination for the area. Test pits (TP-A through TP-J) were advanced to evaluate and characterize the type of fill and obstructions present. A total of ten test pits were excavated and advanced to approximately fifteen feet bgs throughout the North Area. The objectives of the test pits were divided into four general categories; 1) evaluate geophysical anomalies that were discovered during the TBA investigation in 2002 (Metcalf & Eddy), 2) determine the extent and depth of fill (excavting to fifteen feet deep), 3) characterize the type of fill across the site with particular attention to the amount of asbestos, and 4) investigate former UST graves. North area test pit logs are presented in Appendix D. Figure 3 represents the locations of all the north of wedge area test pit excavations. Soil samples for chemical analysis were not collected, because the purpose of the test pits was to visually characterize the subsurface and to help identify locations for the soil borings. Only asbestos bulk samples were sent to a certified laboratory for analysis.

The reason for the geophysical anomaly (pipeline that appears to run from the engine room to a stack) identified in the EM survey and GPR survey during the TBA investigation in 2002 (Metcalf & Eddy) was not discovered during the March 2003 Metcalf & Eddy/S&W investigation. This anomaly was not reached due to the brick and concrete obstructions that were two feet thick. The lateral extent of fill was undetermined due to the inability to access the slopes to the Spicket River. All ten test pits contained fill and building debris. Most of the test pits contained large quantities of debris and building walls, foundations, and floors. No native soil was found in any test pit, since the test pits cover a significant portion of the site (test pits from March 2003 and May 2002), it is reasonable to estimate that the entire Site has been filled to a depth of fifteen feet or more. During test pits activities in the former UST graves, field observations did not indicate the presence of petroleum contamination in any of the soils. Also during test pit investigations, bulk samples of asbestos looking material were taken and later confirmed to be positive.

3.3 Soil Boring Advancement and Soil Sampling

As part of the Phase II CSA, ten soil borings were advanced utilizing a truck-mounted drill rig during Metcalf & Eddy/S&W March of 2003 investigation. Ten locations were chosen for soil borings based on the test pit results, previous investigations, and historical information. The locations of the soil borings are depicted on Figure 3. The soil borings were divided into five groupings: upgradient of the former Site buildings (SB-1), downgradient of the former Site buildings (SB-10), in the area of the former USTs (SBs 2, 3, 8, and 9), in the vicinity of the former soda pulp mill (SB-4), and in the vicinity of wedge area TP-7 (SBs 5, 6, and 7) where a sheen had been observed on the water in TP-7 during Metcalf & Eddy's 2002 investigation. Due to the difficult nature of drilling at the Site (because of subsurface obstructions), attempts to reach the target depth were generally limited to no more than three attempts at each location, although a fourth attempt was made for SB-6. Soil borings MW-1 (SB-1), SB-2, MW-3 (SB-3), SB-4, MW-5 (SB-5), MW-6 (SB-6), SB-7, SB-8, SB-9, and MW-10 (SB-10) were advanced from March 10 through March 14, 2003 and March 17, 2003. A truck-mounted drill rig equipped with 4¼ inch inside diameter hollow stem augers was used to advance the borings. The ten soil borings were advanced to depths ranging from 9.5 to 20 feet bgs. The ten soil borings were performed according to the protocols outlined in MADEP Publication #WSC-310-91. A soil description and boring log for each boring is provided in Appendix E.

The soil borings were designed to collect data for a Method 3 Risk Characterization and, in particular, to determine the extent of PCB contamination. One sample set was collected from each depth at each boring location: shallow (0 to 1 foot bgs), intermediate (1 to 9 feet bgs), and deep (9 to 15 feet bgs). Each sample set was collected from a two-foot split-spoon within the sample interval and analyzed for MA-EPH, MCP-regulated metals (the thirteen priority pollutant metals plus barium and vanadium), and PCBs. Additionally, PCB samples were collected, and frozen, from the remaining two-foot split-spoon sections that were not part of the sample set for that interval. If the samples sent to the laboratory tested positive for PCBs, then the samples that were frozen would be analyzed for PCBs as well to determine the vertical extent of contamination. For soil borings completed as monitoring wells, the deep-zone sample was collected at the water table.

Due to the nature of the Site (buried foundations filled with debris from the demolition of the former buildings), more than half of the borings required two or more attempts to reach target depth; however, only two of the ten borings hit shallow refusals after 3 tries. Native soils were encountered in borings SB-1, SB-3, SB-5, and SB-6 at approximately 15 to 20 feet bgs. The other borings were not advanced completely through the fill, and were completed at depths ranging from 9.5 to 17 feet bgs. The thickness of the fill appears to be a minimum of fifteen feet throughout the area north of the raceway.

The borings encountered predominantly the same materials found during the test-pitting phase of the March of 2003 investigation with the exception of SB-10/MW-10, the downgradient monitoring well. While advancing SB-10, a thick petroleum oil was found in the soil at a depth of approximately 9.5 to 16.5 feet. The petroleum appeared to be a heavy weight fuel oil, which after installation of a monitoring well screened from 5.5 to 17.5 feet, did not penetrate the sand pack of the well even 48 hours after the well had been constructed. Ten days later, during which the Spicket River had risen nearly 8 feet, water was detected in MW-10 at a depth of 12.6 feet bgs, though no NAPL was measured.

3.4 Monitoring Well Construction

Groundwater monitoring wells were installed in five soil borings, SB-1 (MW-1), SB-3 (MW-3), SB-5 (MW-5), SB-6 (MW-6), and SB-10 (MW-10). The monitoring wells were constructed using two-inch schedule-40 flush jointed PVC. Each well was screened across the water table with a ten-foot (12.5 feet in the case of MW-10) section of 20-slot PVC well screen and brought to two to three feet above grade surface (ags) with a solid PVC riser that was capped with a locking expansion cap and housed in a four-inch padlocked steel stand-pipe.

The well construction consisted of a sand pack in the annular space around the PVC completed to approximately two feet above the top of the well screen, approximately one to two feet of hydrated bentonite, and an additional six-inches of sand. Cuttings from the boring, and additional sand, were used to backfill the remaining annulus. Monitoring wells MW-1 and MW-3, and MW-10 were typical overburden monitoring well installations. MW-5 and MW-6, constructed by the same method as the other wells, were both situated so that the bentonite plug straddled a 12-inch concrete/brick floor that was penetrated during drilling, effectively isolating the groundwater from the water running off the former foundation floors of the buildings. Monitoring Well Construction Logs are presented in Appendix F.

3.5 Monitoring Well Development

Following well construction, Metcalf & Eddy/S&W developed the five installed monitoring wells MW-1, MW-3, MW-5, MW-6, and MW-10 using the procedures outlined in the EPA's Low Flow Groundwater Sampling Procedure (EPA, 1996a). The monitoring wells were developed with the use of a peristaltic pump powered by a 12-volt battery. The purpose of the development process was to remove the fine sediments that may have entered the well screen and to bring the well into hydraulic connection with the aquifer. At a minimum, three well volumes were removed from the well casing prior to considering well development activities complete. A well volume was determined to contain approximately 0.16 gallons of water per linear foot of well casing. After the wells were purged to remove the majority of sediments, low flow development was used. Temperature, pH, conductivity, turbidity, and salinity were recorded and development was continued until parameters had stabilized. All development water was containerized within 55-gallon drums for off-site disposal. Monitoring well development records are presented in Table 3-1. Depth to water on March 18, 2003 ranged from 15.7 to 17.1 feet bgs. Eight (8) days later, on March 26, 2003, the water level of the Spicket River had risen 8 feet, causing the water levels in the wells to rise to 12.6 from 15.8 feet bgs.

3.6 Groundwater Purging and Sampling

Groundwater sampling was conducted two weeks after monitoring well installation and development were completed. Groundwater samples were collected from the five installed monitoring wells (MW-1, MW-3, MW-5, MW-6, and MW-10) using the EPA's low flow protocol. The purge water was monitored for pH, temperature, specific conductivity, dissolved oxygen, ORP, and turbidity throughout the purge cycle. Upon stabilization of these in-situ parameters, a groundwater sample was collected from the monitoring well. Groundwater parameters collected during low flow sampling are included in Table 3-2. The groundwater samples were collected on March 26 and March 27, 2003. Groundwater samples were sent to a certified laboratory and analyzed for MA-EPH, MA-VPH, metals, and PCBs. Analytical results are discussed in Section 5.2. During sampling, MW-1 exhibited a sulfur odor after approximately a ½ hour of purging, and MW-10 a slight petroleum odor. While no NAPL was noted in MW-10, PID readings at the well cap registered a sustained 60 ppm after removing the expansion plug from the PVC riser.

3.7 Wellhead Surveying and Water Level Gauging

As part of Phase II CSA activities, Metcalf & Eddy / Stone & Webster surveyed the new monitoring well locations. The top of the PVC casing was surveyed to within ± 0.01 foot vertically using a surveyor's level and rod. The relative elevations of the top of the PVC casing and depth to groundwater measured in the separate gauging rounds are provided in Table 3-3. Depth to groundwater measurements were taken on two separate occasions, March 18 and March 26, 2003 (refer to Section 4.5).

3.8 Laboratory Analytical Methods & QA / QC

As part of Phase II CSA activities, soil samples were analyzed for EPH, priority pollutant metals (plus barium and vanadium), PCBs, and asbestos. Soil samples were analyzed using MADEP Method for EPH, EPA SW-846 Methods 6010B and 7471A for metals, EPA SW-846 Method 8082 for PCBs, and polarized light microscopy (PLM) for asbestos. Groundwater samples were analyzed for EPH, priority pollutant metals (plus barium and vanadium), PCBs, and VPH. Groundwater samples were analyzed using MADEP Method for EPH, EPA SW-846 Methods 6010B and 7471A for metals, EPA SW-846 Method 8082 for PCBs, and MADEP Method for VPH. MCP analytical methods were not used (with the exception of VPH and EPH) because the MCP methods were not fully promulgated during the time of the investigations. SW-846 methods were used for PCBs and total metal analyses.

Quality control (QC) samples were collected and submitted for laboratory analysis to monitor and evaluate laboratory and sampling performance. The field QC samples collected included trip blanks, field duplicates, and matrix spike/matrix spike duplicate samples. Generally, field QC samples (field duplicates and MS/MSD) were submitted at a frequency of one per 20 field samples. Trip blanks were also submitted with VPH aqueous samples. The types and numbers of field QC samples collected exceed the MCP requirements for Presumptive Certainty as presented in *Quality Assurance and Quality Control Guidelines for the Acquisition and*

Reporting of Analytical Data in Support of Response Actions Conducted Under the Massachusetts Contingency Plan (MCP), Final, 22 May 2003.

3.9 Sample Handling / Preservation

Following sample collection, all samples were placed in coolers containing ice and maintained at a temperature of 4^0C (±2^0C). Water samples collected for metals analysis were placed in plastic bottles preserved with nitric acid. Samples were not filtered in the field. All samples were delivered to the lab with a Chain of Custody form.

3.10 Decontamination Procedures

Sampling equipment that required decontamination included the split-spoon sampler, auger flights including the cutting head, peristaltic pumps used for well development/purging activities, and the water level indicators. Due to the asbestos concerns, vehicle decontamination was conducted on all vehicles prior to leaving the Site. Disposable plastic spoons and Ziploc® bags were used for composite sample collection. The disposable equipment was discarded after each use, and therefore no decontamination was necessary.

The split spoon samplers were decontaminated as follows:

1. Alconox bath to remove soils adhering to equipment;
2. Potable water rinse;
3. Methanol rinse; and
4. Distilled water rinse.

Auger flights including the cutting head were decontaminated using a high-pressure water spray. The peristaltic pumps used to develop the wells were decontaminated by pumping liquid alconox (detergent) through the pump and then subsequently recirculating the pump in a bucket of potable water for approximately 3 to 5 minutes. The tubing used in the development of the monitoring wells was dedicated to the well and was left in the wells following development activities. Subsequently, the tubing was used to purge the monitoring wells prior to sampling.

The water level indicator was decontaminated following gauging of the individual wells by using a paper towel and spraying with distilled water.

The excavator used for digging the test pits and the drill rigs used for the soil borings and monitoring well installations were decontaminated using a high-pressure water spray. A decontamination pad was placed under each vehicle, which captured all of the decontamination water prior to being drummed.

3.11 Investigative Derived Wastes

Soil cuttings, development water, purge water, decontamination water, and geotextile fabric were drummed during Phase II assessment activities. The geotextile fabric was used to collect ACM contaminated water/debris during vehicle and equipment washings. A total of five 55-gallon drums, two drums containing purge and development water from MW-1, MW-3, MW-5, and MW-6, one drum containing soil cuttings, and purge and development water from MW-10 (oil product encountered in MW-10), and two drums containing decontamination water and asbestos padding were transported off-site on November 25, 2003. The hazardous waste manifest records are presented in Appendix G. The drums were disposed of in accordance with state and federal regulations under hazardous waste manifests.

4.0 GEOLOGY AND HYDROGEOLOGY

4.1 Regional Geology

Based on the soil survey for the northern part of Essex County, Massachusetts, the overlying surficial deposits consist primarily of loamy soils formed in compact glacial till. Two drumlins are located nearby the Site, including Prospect Hill to the northeast and a smaller hill located to the northwest. The thickness of glacial till is often on the order of 15 to 20 feet, although thicknesses of up 175 feet have been observed in the drumlin area (Eckenfelder, Inc., 1998).

According to the GenCorp Phase II Groundwater Model Report conducted by Eckenfelder, Inc. in 1998, bedrock underlying the Oxford Paper Mill site lies within the Merrimack Belt lithotectonic zone. Major faults further subdivide the Merrimack belt into individual tectonic zones – each of which has a different and distinct lithology. Furthermore, the OPM site is located north of the Clinton-Newbury fault, which is accompanied by a series of many smaller faults and associated disrupted geologic strata. The bedrock lithology consists of a series of meta-sedimentary rock types of the Berwick formation. The encountered bedrock lithology of the OPM site is composed of phyllite, argillite, and quartzite with minor amounts of calcareous metagraywacke and schist (Eckenfelder, Inc., 1998).

4.2 Site Specific Geology

The area north of the raceway is relatively flat with the eastern portion of the Site sloping downward to the Spicket River. The average elevation of the Site is approximately 100 feet above mean sea level (msl).

The soils onsite are part of Urban Land, which consists of nearly level to moderately steep areas where the soils have been altered or obscured by urban works and structures. The soils onsite are part of the Paxton-Woodbridge-Monatauk association where the area is nearly level to steep, well drained and moderately well drained, loamy soils formed in compact glacial till (Soil Survey of Essex County, Massachusetts Northern Part, 1981).

The geology on the north side of the OPM was assessed through a subsurface boring program and test pits excavations as described in Sections 3.2 and 3.3. Based on observations of the test pits and split spoon samples, the general geologic profile was found to consist primarily of an assemblage of loamy and sandy soils. The mixture of varying sediment sizes indicates that the materials are not well sorted, and are consistent with glacial till deposits. The soil borings also revealed similar conditions of varying amounts of loam, sand and gravel with coal ash, bricks, and debris encountered throughout the area north of the raceway. Refer to Appendices C, D, and E for test pit and soil boring logs.

Bedrock was not encountered on the north side of the OPM. Bedrock coring was not conducted as part of the Phase II CSA. Soil borings were advanced from 0 to 24 feet bgs and test pits were advanced from 0 to 15 bgs. Refer to Sections 3.2 and 3.3, as well as Appendices C, D, and E, for drilling and excavation refusals encountered during the May 2002 and March 2003 site investigations.

4.3 Regional Hydrologic Setting

The property lies between the Spicket River and the raceway that transects the OPM property. Surface water run-off flows overland into these respective water bodies. The raceway flows into the Spicket River and both flow to the east/southeast, and eventually into the Merrimack River.

No streams, rivers, drainage basins or ponds exist on the Site. The area north of the raceway contains vegetation that includes trees around the outer perimeter and tall grass throughout the interior portion. Wetland vegetation does not exist along the property boundaries or on the Site.

4.4 Regional Hydrogeology

Water bodies surround the Site to the east, north, and south. Regional groundwater flow is to the south/southeast towards the Spicket and Merrimack River's and localized groundwater flow is discussed further in Section 4.5.

4.5 Site Specific Hydrogeology

This section describes the hydraulic properties of the North Area of the OPM, specifically the groundwater flow, horizontal hydraulic gradient, hydraulic conductivity, and the river's influence on groundwater.

On March 18th and March 26th 2003 synoptic water level gauging was conducted on the Site. Table 3-3 presents the depth to groundwater and relative elevation of the water table as measured during the March 18 and March 26, 2003 sampling events. Figures 6 and 7 depict groundwater flow from contour maps from the March 18 and 26, 2003 gauging rounds respectively. The hydraulic conductivity for the overburden zone for the region surrounding the Site ranges from 6.2 x 10^{-7} cm/sec to 1.7 x 10^{-2} cm/sec, with a geometric mean of 9.2 x 10^{-4} cm/sec (Camp Dresser & McKee Inc., 2003).

According to the data obtained from water level gauging on March 18 and March 26, 2003, it is apparent that groundwater flow is variable depending on the height of water in the Spicket River. Groundwater flow across the Site, like groundwater elevation, appears to be affected by the change of water level in the Spicket River. Measurements taken on March 18, prior to the warming temperatures and snowmelt, indicate that the groundwater flow was to the north-

northeast. Water levels measurements taken on March 26, 2003, after the eight-foot rise in the Spicket River water level, indicate a total reversal of groundwater flow to the south-southwest. Water table gradients between these two dates switched from 0.0096 NE to 0.0036 SW. These dynamic water levels, along with a shallow to moderate gradient, suggest that groundwater flow is somewhat variable, particularly during wet periods of the year.

5.0 ANALYTICAL RESULTS

Surface soil, subsurface soil, and groundwater samples, which have been collected from areas north of the raceway (wedge area and North Area) at the Oxford Paper Mill in Lawrence, MA between 2002 and 2003, are included in this Phase II Report. The results of previous investigations conducted in areas north of the raceway are discussed in Section 2.6. Phase II assessment activities were discussed in Section 3.0. The data collected from areas north of the raceway since 2002 is summarized in the following sections. A summary of the nature and extent of contamination of all the data included in this Phase II is discussed in Section 6.0 and Human Health and Environmental Risk Characterizations have been performed and a summary of these is included in Section 8.0.

5.1 Soil Laboratory Analytical Results

5.1.1 Surface Soil - Asbestos

In November 2002, S&W collected surface soil samples (0-1') in the area north of the wedge (North Area) and the samples were analyzed for ACM. Twenty-three (23) samples were collected using a grid-sampling plan within the North Area (refer to Figure 8). The primary purpose of this effort was to provide supporting data for use in determining the engineering controls, air monitoring requirements, and action levels that would be used during the March 2003 site investigation in order to limit the potential for exposure to ACM during test pit and soil boring advancement. It was not known whether surface soils throughout the North Area would contain detectable levels of ACM, although it was considered to be a possibility, given the results of the wedge test pit investigations conducted by M&E in May 2002. Table 5-1 summarizes the analytical results obtain by S&W through their sampling effort to determine potential exposures to ACM in the North Area. These data are also presented with data obtained by S&W in August of 2003. All samples were tested for the presence of asbestos (PLM Qualitative) and, subsequently, each sample that was found positive from the qualitative analyses was then tested quantitatively using EPA Region 1 protocol. The laboratory analytical reports from the November 2002 asbestos sampling event are included in Appendix H.

In August of 2003, S&W collected twelve surface soil samples (0-1') along the perimeter boundaries of the North Area and analyzed the twelve samples for ACM. The majority of the samples were collected along the banks of the Spicket River (refer to Figure 8). The primary purpose of this sampling effort was to provide supporting data for use in determining the placement of a geotextile cap extending from the wedge area to the boundaries of the North Area. Table 5-1 summarizes the analytical results obtain by S&W through their sampling efforts to determine potential exposures to ACM in the North Area. These data are presented with data obtained by S&W in November of 2002. All samples were tested for the presence of asbestos (PLM Qualitative) and, subsequently, each sample that was found positive from the qualitative analyses was then tested quantitatively using EPA Region 1 protocol. The laboratory analytical reports from the August 2003 asbestos sampling event are included in Appendix H.

5.1.2 Surface and Subsurface Soil

May 2002 – Metcalf & Eddy (Wedge Area)

Soils that were sampled and analyzed as part of the May 2002 test pit investigation (wedge area) were found to be primarily contaminated with PCBs and asbestos, although certain metals and PAHs were also detected. The types of Aroclors most likely to be encountered throughout the OPM (both north and south of the raceway) are Aroclor 1242 and Aroclor 1248. Aroclor 1254 was detected in wedge area soils. Aroclor 1260 may also be encountered. PCB analytical results from mobile and fixed laboratories for wedge area soils are presented in Table 5-2.

Suspected asbestos-containing material (ACM) was visually observed during the May 2002 test pit investigation, and the observations were confirmed by laboratory analysis of soil samples. The S&W November 2002 surface soil sampling event supplemented and confirmed these results. ACM results from wedge area soils are presented in Table 5-3.

While underground storage tank (UST) leaks have not been documented, soils were sampled and analyzed for Extractable Petroleum Hydrocarbons (EPH) by the MADEP method. The EPH soil data is needed for off-site disposal characterization, and the target PAH analytes from the EPH analysis also serve to characterize soil for disposal and MCP risk characterization. During the May 2002 site investigation, elevated total petroleum hydrocarbons (TPH) concentrations were identified in one subsurface soil location north of the raceway (former Boring B-16, refer to Figure 2), and a sheen was observed in water that accumulated in TP-7. The elevated concentration of TPH and the sheen suggested that there may have been an on-site petroleum release. EPH results from wedge area soils from composite samples are presented in Table 5-4. The laboratory analytical reports for EPH from the May 2002 sampling event are included in Appendix I.

PAHs are present in wedge area soils, most likely due to coal and coal ash, and possibly petroleum releases. PAHs were widely detected at levels above reportable concentrations during the May 2002 site investigation. Phenanthrene was detected in groundwater at one location, according to historical data presented in the tier classification. New PAH results from wedge area soils are presented in Table 5-4. The laboratory analytical reports for PAHs from the May 2002 sampling event are included in Appendix I.

Heavy metals may be associated with coal ash, but other sources, such as solid residuals from former paper mill operations that may have remained on site when the mill was abandoned, are also possible. Analysis for metals (priority pollutant list plus barium and vanadium) was performed. Metal analytical results of composite samples from wedge area soils are presented in Table 5-4. Metal analytical results from mobile and fixed laboratories for wedge area soils are presented in Table 5-5. The laboratory analytical reports for metals from the May 2002 sampling event are included in Appendix I.

March 2003 – Metcalf & Eddy / Stone & Webster (North Area)

Ten soil borings were advanced as part of the March 2003 site investigation. Surface and subsurface soil samples collected from the soil borings were analyzed for EPH, PCBs, and priority pollutant metals (plus barium and vanadium). Results are presented in Table 5-6 and are compared to S-1 reportable concentrations (RCS-1), MADEP background concentrations for natural soil, and MADEP background concentrations for soil containing fill material. The S-1 reportable concentrations were used because the Site is "at or within 500 feet of a residential dwelling, a residentially-zoned property, school, playground, recreational area or park" (310 CMR 40.0361(1)(a)1)).

The PAH compounds benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were detected in surface and subsurface soils at concentrations exceeding the MCP reportable concentrations. PAHs were also widely detected at levels above reportable concentrations during the May 2002 and March 2003 site investigations (refer to Section 5.5 "Discussion of PAHs as Background). The laboratory analytical reports for PAHs from the March 2003 sampling event are included in Appendix J.

Aroclor-1254 was detected at concentrations well below the MCP reportable concentration in surface and subsurface soils collected from soil borings during the March 2003 site investigation. PCBs are the primary Oxford site contaminants south of the raceway, due to transformer spills and leaks and other possible sources, such as leaks from pulp and paper processing equipment. The reported concentrations of Aroclor-1254 are consistent with the findings in the wedge area from the May of 2002 site investigation. PCBs may have become located in wedge area soils via minor releases or movement by human activities from areas south of the raceway, where the major transformer leaks are known to have taken place. The laboratory analytical reports for PCBs from the March 2003 sampling event are included in Appendix J.

The following metals were detected at concentrations exceeding MCP reportable concentrations during the March 2003 site investigation: arsenic, beryllium, lead, and vanadium.

Reported arsenic concentrations for the March 2003 site investigation were elevated above background at some locations, consistent with the May 2002 site investigation. The maximum concentration of 49.1 mg/kg was reported at location SB-6 (0-1 foot bgs sample), compared to the MADEP background concentration of 20 mg/kg and the RCS-1 value of 30 mg/kg. The arsenic may be associated with the coal ash found on-site. However, for reasons similar to those discussed above for PAHs, arsenic has been retained as a COPC in the risk characterization. Beryllium concentrations were fairly uniform, ranging from 0.33 to 1.1 mg/kg in samples collected in the March 2003 site investigation. These beryllium concentrations are consistent with MADEP background values for natural soil and soil containing fill material (0.4 and 0.9 mg/kg respectively). Lead was listed as a contaminant of concern in the tier classification submittal (S&W, November 1999) and S&W RAM Plan (S&W, October 2001) for the south side of the OPM and references a soil sample that exceeded the TCLP limit for lead (12 mg/L). Results from May 2002 site investigation did not indicate that lead was present above the reportable concentrations. For one soil sample from the March 2003 site investigation (surface soil location SB-1, 0 to 1 foot bgs sample), lead was detected at 1,970 mg/kg. No lead TCLP for this sample was performed. The RCS-1 value for lead is 300 mg/kg. Lead concentrations were consistent with MADEP background concentrations in the other soil samples collected during the March 2003 site investigation.

Vanadium concentrations in soil samples exceeded the RCS-1 value at locations SB-7 (7 to 9 feet) and SB-9 (5 to 7 feet) during the March 2003 site investigation, and also at Test Pit TP-6 (shallow sample) during the May 2002 site investigation. The source of vanadium is not known. However, it is known that vanadium becomes concentrated in ash from oil-fired boilers, and it is reported that workers who clean oil-fired boilers may be exposed to dust containing 6.1 to 12.7% of vanadium (http://toxnet.nlm.nih.gov, Vanadium Compounds). The history of the Site indicates that the boilers were likely switched from coal to oil at some point, as indicated by the former presence of oil-containing USTs at various site locations (refer to Figure 3). In addition to coal ash, it is possible that vanadium-containing oil ash has also become mixed with Site soils. The laboratory analytical reports for metals from the March 2003 sampling event are included in Appendix J.

5.2 Groundwater Laboratory Analytical Results

Groundwater samples were collected from monitoring wells MW-1, MW-3, MW-5, MW-6, and MW-10. Groundwater samples were analyzed for VPH, EPH, priority pollutant metals (plus barium and vanadium), and PCBs. Results are presented in Table 5-7 and are compared to the GW-2 reportable concentrations (RCGW-2). The RCGW-2 values apply because the Site is not located within a Current Drinking Water Source Area or Potential Drinking Water Source Area (refer to Figure 4). The Site is not located within an Interim Wellhead Protection Area or Zone II, and the closest private well is at a car wash approximately one mile from the Site. The Lawrence Water Department has stated that the City of Lawrence obtains its water from the Merrimack River.

No VPH compounds or PCBs were detected in groundwater samples collected during the March of 2003 site investigation. However, the PCB laboratory quantitation limit (1.0 μg/L for each Aroclor) was greater than the 0.3 μg/L MCP reportable concentration (RCGW-2). Hence, the possibility that PCBs are present in groundwater at concentrations above the RCGW-2, but below 1.0 μg/L, cannot be ruled out. However, PCB concentrations in soils north of the raceway have been found to be beneath the clean-up goals, and it is considered unlikely that Site groundwater contains dissolved PCBs at concentrations approaching the RCGW-2 value. GenCorp investigative data confirms the absence of elevated levels of PCBs on the north side of the OPM.

No individual EPH target analytes, which are PAHs were detected in groundwater samples. Total concentrations of EPH in the C_9-C_{18} aliphatic and C_{19}-C_{36} aliphatic fractions were well below the MCP reportable concentrations (all were below 50 μg/L).

Metals were detected at concentrations below MCP reportable concentrations with the exception of selenium in the sample collected from MW-3, and vanadium in the sample collected from MW-6. Selenium was detected at 188 µg/L, exceeding the GW-2 reportable concentration of 80 µg/L. A possible source of the selenium in groundwater may be leaching from coal ash noted at MW-3 (refer to boring log). The groundwater sample from MW-6 revealed the highest concentration of vanadium at 3,710 µg/L. Other detections were more than an order of magnitude lower. The vanadium may be related to the soil vanadium concentrations discussed in the previous section. The groundwater laboratory analytical reports from the March 2003 sampling event are included in Appendix J.

Groundwater monitoring wells were not installed during the May 2002 site investigation and, therefore, the groundwater was not sampled. Prior to the March 2003 site investigation, groundwater at the Site was most recently sampled in November 1996, during a sampling event conducted by Eckenfelder for GenCorp (Eckenfelder, 1997). These wells were decommissioned in 1997. The groundwater samples were analyzed for VOCs, SVOCs, PCBs, priority pollutant metals, cyanide, and diesel range organics or petroleum hydrocarbons. Low levels of toluene were detected in groundwater from B-16S (17 µg/L), B-21S (3.5 µg/L), and B-22S (11 µg/L). Methylene chloride was sporadically detected at levels below 2 µg/L, and was also detected in field and trip blanks at similar levels. It is not known whether the methylene chloride detections would have been blank-qualified as non-detect during more rigorous data validation; however, it is considered likely.

The PAHs acenaphthene, fluorene, and 2-methylnaphthalene were detected in B-21S at concentrations of 3.1, 4.8, and 2.8 µg/L, respectively. Diethyl phthalate was detected in B-22XD (a deep bedrock well) at a level of 1.0 µg/L. Diesel range organics or petroleum hydrocarbons were detected in B-16D at 0.28 mg/L and in B-21S at 0.73 mg/L. No PCBs were detected in the samples from the B-16 and B-22 clusters or B-21S. The decommissioned GenCorp monitoring wells are presented in Figures 2 and 3. Results obtained during the March 2003 site investigation are generally consistent with the Eckenfelder results.

5.3 Data Assessment

5.3.1 Introduction

The data collected from the areas north of the raceway in 2002 and 2003 (as described in Section 3.0) was intended for a Phase II Comprehensive Site Assessment including a Method 3 Human Health and Environmental Risk Characterization. Data collected during previous site investigations were not used as part of the risk characterization. M&E / S&W used the PARCCS Parameters to assess the usability of the 2002 and 2003 data. PARCCS stands for precision, accuracy, representativeness, comparability, completeness, and sensitivity. In order to evaluate these parameters, field duplicates, and matrix spikes and matrix spike duplicates (MS/MSD) were collected and analyzed, and analytical reports, including laboratory QA / QC documentation, were reviewed.

5.3.2 Soil Data Usability Assessment, Oxford Paper, Lawrence, MA – Samples Collected May 2002 – Wedge Area

See Table 5-8.

5.3.3 Soil Data Usability Assessment, Laboratory Project Number B0417, Oxford Paper, Lawrence, MA – Samples Collected March 2003 – North Area

See Table 5-9.

5.3.4 Soil Data Usability Assessment, Laboratory Project Number B0428, Oxford Paper, Lawrence, MA – Samples Collected March 2003 – North Area

See Table 5-10.

5.3.5 Groundwater Data Usability Assessment, Laboratory Project Number B0502, Oxford Paper, Lawrence, MA – Samples Collected March 2003 – North Area

See Table 5-11.

5.3.6 Data Analysis

May 2002 Site Investigation (Wedge Area) – Metcalf & Eddy

No fixed laboratory data were rejected during the data validation process, and all data were judged usable for use in the risk a characterization. Metcalf & Eddy conducted a limited validation for the fixed laboratory data. On-site mobile laboratory results (PCBs, XRF metals analyses) were used to help identify samples for fixed laboratory analysis and to help define the extent of contamination, but they were not used in the risk characterization because they were not subject to data validation. Some fixed laboratory results were qualified as estimated (flagged with a J) to indicate that the reported concentration is estimated due to limitations identified in the quality control review. Estimated values are usable for risk characterization. Some values were estimated due to the field duplicate relative percent differences (RPDs) in excess of 50%. Field duplicate RPDs outside of criteria are often due to highly inhomogeneous soil matrices, which makes sample collection and homogenization very difficult. Some metals results were qualified as a result of detection in laboratory blank samples. Laboratory reporting limits were low enough to allow comparison to RCS-1 concentrations.

March 2003 Site Investigation (North of Wedge Area) – Metcalf & Eddy / Stone & Webster

Non-detect results for antimony were rejected in several soil samples due to very low matrix spike recovery. Positive and non-detected mercury results were rejected in three soil samples due to low percent recovery in Initial Calibration Verification (ICV) analysis. Sufficient acceptable results are available from other soil samples collected during the March 2003 site investigation, and from the May 2002 site investigation, such that these rejections do not represent a serious impact on project data quality. Rejected data are not usable for any purpose and are noted on the data tables with the letter R, with no value associated with the R.

Other data qualifications were less severe and involved either estimating data (J flag) or qualifications of results due to presence in laboratory blanks. All soil samples results, except for rejected results, were judged usable for the risk characterization. Reporting limits were low enough to allow comparison to RCS-1 concentrations. All data qualifications and validation was performed by Metcalf & Eddy.

For groundwater samples, no results were rejected. The reporting limit attained by the laboratory for the individual Aroclors in the groundwater samples (1.0 µg/L) was above the RCGW-2 value of 0.3 µg/L. Hence, it is not possible to determine from the results whether the RCGW-2 value for PCBs is exceeded in the groundwater samples collected. It is considered unlikely that PCBs are present in the groundwater at concentrations approaching the RCGW-2 value, due to their low solubility and the low levels of PCBs encountered in the soil north of the raceway.

Some reported values for VPH and certain metals in groundwater samples were qualified as not detected, due to trip or laboratory blank contamination. No blank contamination was detected in the PCB or EPH analyses for groundwater. Reported results for metals that were below the laboratory's reporting limit, but above the instrument detection limit, were qualified as estimated due to uncertainty in quantitation near the instrument detection limit. Some EPH fractions in certain groundwater samples were qualified as estimated due to low surrogate or MS / MSD recoveries. Estimated values are usable for risk characterization.

5.3.7 LSP Opinion

Quality control samples were collected at the frequency required for presumptive certainty and PARCCS criteria were met. There were no deviations from MCP methods. Therefore, the data set may be used in support of MCP opinions.

5.4 Contaminants of Potential Concern (COPCs)

Based on the data collected during this Phase II Site Assessment and used in the Method 3 Human Health Risk Characterization, as well as data collected previously from areas north of the raceway, the COPCs have been determined for each media for the north side of the Oxford Paper Mill. The following table summarizes the COPCs in each media for the north side of the Oxford Paper Mill.

Surface Soils	Subsurface Soils	Groundwater
EPH by MADEP		
C_9-C_{18} Aliphatics	C_9-C_{18} Aliphatics	C_9-C_{18} Aliphatics
C_{19}-C_{36} Aliphatics	C_{19}-C_{36} Aliphatics	C_{19}-C_{36} Aliphatics
C_{11}-C_{22} Aromatics	C_{11}-C_{22} Aromatics	
PAHs		

2-Methylnaphthalene	2-Methylnaphthalene	None
Acenaphthene	Acenaphthene	
Acenphthylene	Acenphthylene	
Anthracene	Anthracene	
Benzo(a)anthracene	Benzo(a)anthracene	
Benzo(a)pyrene	Benzo(a)pyrene	
Benzo(b)fluoranthene	Benzo(b)fluoranthene	
Benzo(g,h,i)perylene	Benzo(g,h,i)perylene	
Benzo(k)fluoranthene	Benzo(k)fluoranthene	
Chrysene	Chrysene	
Dibenzo(a,h)anthracene	Dibenzo(a,h)anthracene	
Fluoranthene	Fluoranthene	
Fluorene	Fluorene	
Indeno(1,2,3-cd)pyrene	Indeno(1,2,3-cd)pyrene	
Naphthalene	Naphthalene	
Phenanthrene	Phenanthrene	
Pyrene	Pyrene	
VPH by MADEP		
Not Tested	Not Tested	None
PCBs		
Aroclor - 1248	Aroclor - 1248	None
Aroclor - 1254	Aroclor - 1254	
Priority Pollutant Metals (Plus Barium and Vanadium)		
Antimony	Antimony	Arsenic
Arsenic	Arsenic	Barium
Barium	Barium	Beryllium
Beryllium	Beryllium	Chromium
Cadmium	Cadmium	Nickel
Chromium	Chromium	Selenium
Copper	Copper	Vanadium
Lead	Lead	Zinc
Mercury	Mercury	
Nickel	Nickel	
Selenium	Selenium	
Silver	Silver	
Thallium	Thallium	
Vanadium	Vanadium	
Zinc	Zinc	
Asbestos		
Present	Present	Not Tested

5.5 Discussion of PAHs as Background

Concentrations of oil and or hazardous materials (OHM) that are attributable to coal, coal ash, or wood ash are exempt from reporting under the MCP (CMR 40.0317). In addition, fill material containing coal ash/wood ash may be defined as "background" for the purposes of risk assessment as described in 310 CMR 40.0006. PAHs were widely detected at levels above reportable concentrations during the May 2002 site investigation. If related solely to coal ash or wood ash associated with fill material, the soil PAH concentrations would meet the definition of "background" as defined in the MCP. However, it is noted during the March 2003 site investigation that some locations (SB-10, 0 to 1 foot; SB-6, 0 to 1 foot and 5 to 7 feet), the concentrations of some PAHs detected in soil samples are higher than the corresponding MADEP background levels for soil containing fill material. In addition, at location SB-10 petroleum odors were noted and viscous oil was visually observed at depth. Other sources of PAHs, such as creosote-preserved timbers and ash from combustion of materials other than coal and wood, are also present on site. Because PAH contamination in Site soils north of the raceway is not likely to be due solely to coal ash and wood ash, and because the contribution of background materials to the elevated concentrations of PAHs cannot readily be determined, the PAHs are not treated as meeting the MCP definition of "background". The risk characterization (Appendix K) includes those PAHs that were detected above MADEP background levels for natural soils, and does not screen contaminants of potential concern (COPCs) on the basis of MADEP background concentrations for soil associated with fill material, or any other source of background concentrations. GenCorp has conducted extensive studies on the area and has shown elevated levels of PAHs are considered a background condition.

6.0 NATURE AND EXTENT OF CONTAMINATION

6.1 Soil

Metcalf & Eddy and Stone & Webster collected numerous samples for areas north of the raceway during the May 2002 and March 2003 site investigations. Soil samples collected during these investigations were from test pits and soil boring activities. Soil samples during the May 2002 site investigation were taken from test pits located along the entire wedge area (Figure 5). Soil samples collected during the March 2003 site investigation were taken from soil borings located north of the wedge area (Figure 3) and test pits. Asbestos bulk samples were taken from the March 2003 test pit excavations for laboratory analysis. The following sections discuss the nature and extent of the soil contamination for areas north of the raceway at the Oxford Paper Mill. For discussion purposes, areas north of the raceway have been divided up into two separate sections: the wedge area and north of the wedge area (North Area). For comparison purposes only, the analytical results have been compared to applicable MCP Standards. Surface and subsurface soil samples were compared RCS-1. Sample locations, which have concentrations greater than applicable MCP Standards, are provided in Tables 5-1 through 5-7. This section is not a risk assessment and the applicable MCP Standards are presented only for discussion purposes. Method 3 Human Health and Environmental Risk Characterization are summarized in Section 8.0.

6.1.1 Wedge Area

The wedge area extends along the entire length of the north side of the raceway within the Oxford Paper Mill boundary, and ends approximately 30 feet from the north raceway wall. The wedge area encompasses the southern portion of the area north of the raceway. Refer to Figure 3 for the location of the entire wedge area. Surface and subsurface soil samples were collected from 12 different test pit locations along the entire wedge area and analyzed for PCBs, EPH, priority pollutant metals (plus barium and vanadium), and asbestos. Test pits (sample locations) in the wedge area are depicted on Figure 5. Laboratory analytical results for the wedge area samples compared to applicable MCP Standards are summarized on Tables 5-2 through 5-5 (surface and subsurface soil analytical).

6.1.1.1 Surface Soil (0 to 3 feet bgs)

EPH carbon fraction ranges, PAHs, metals (namely arsenic), PCBs, and asbestos were detected in some surface samples in the wedge area at concentrations above applicable MCP Standards. The PAHs detected at concentrations greater than applicable MCP Standards were the following seven analytes; benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. The PAHs detected above applicable MCP Standards were identified in five of the six surface soil samples collected in the wedge area (refer to Table 5-4). PAH impacted surface soils are considered to be located throughout the entire wedge area.

According to the laboratory results for composite samples, the concentrations of arsenic were above applicable MCP Standards in two surface soil (0-3 feet bgs) samples (SS-4S and SS-6S) located in the eastern portion of the wedge area (refer to Table 5-4). The concentrations of arsenic from the mobile and fixed laboratory analyses indicate that arsenic is present above applicable MCP Standards (30 mg/kg) throughout surface soils in the wedge area (refer to Table 5-5). Arsenic concentrations in wedge area soils detected above 30 mg/kg should be considered a possible imminent hazard. Arsenic imminent hazard areas (0-1' bgs) exist in surface soils in the eastern portion of the wedge area. Arsenic impacted surface soils are considered to be located throughout the entire wedge area.

The concentrations of PCBs (Aroclor-1242, 1248, 1254, and 1260) from the mobile and fixed laboratory analyses (refer to Table 5-2) indicate that PCBs are present above applicable MCP Standards (2 mg/kg) throughout surface soils of the wedge area in 8 of the 12 test pits excavated. Because the PCB concentrations do not show a pattern with either depth or test pit location, segregation of PCB contaminated wedge material from uncontaminated material is not believed to be feasible. Also, the concentrations do not vary over a large range, and are uniformly less than 50 mg/kg. However, there are no PCB concentrations in wedge are soils detected above 10 mg/kg (0-1' bgs) to consider an imminent hazard. PCB impacted surface soils are considered to be located throughout the entire wedge area.

The presence of asbestos in wedge area soils was confirmed in 9 of the 12 test pits (refer to Table 5-3). Soil asbestos ranged from less than 1 percent (but detectable) to 8 percent, and bulk ACM was encountered. The samples collected for asbestos analysis were generally composite samples over several depth intervals within each test pit. Suspect ACM was not visually observed at all locations, it is considered likely that it is present in soils throughout the entire wedge area. Suspect ACM was observed in test pits 3, 4, 5, 6, 7, 11, 12, 14, and 16.

6.1.1.2 Subsurface Soil (> 3 feet bgs)

EPH carbon fraction ranges, PAHs, metals (namely arsenic), PCBs, and asbestos were detected in some subsurface samples in the wedge area at concentrations above applicable MCP Standards. The PAHs detected at concentrations greater than applicable MCP Standards were the following seven analytes; benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. The PAHs detected above applicable MCP Standards were identified in seven samples collected in subsurface soils throughout the entire wedge area. PAH impacted subsurface soils are considered to be located throughout the entire wedge area.

According to the laboratory results for composite samples, the concentrations of arsenic were above applicable MCP Standards in two subsurface soil (3-9 feet bgs) samples (SS-4D and SS-6D) located in the eastern portion of the wedge area (refer to Table 5-4). Arsenic subsurface samples (> 3 feet) were not analyzed by mobile or fixed laboratories. Arsenic impacted subsurface soils are not considered to be located throughout the entire wedge area only in two isolated areas along the eastern portion.

Subsurface samples analyzed for PCBs and asbestos reveal the same information for surface soils as mentioned above under Section 6.1.1.1 – Surface Soils. PCBs and asbestos are believed to be throughout this area.

6.1.2 North of Wedge Area

North of the wedge area (or North Area) encompasses the northern portion of the area north of the raceway. Refer to Figure 3 for the location of the North Area. Surface and subsurface soil samples were collected from ten different soil boring locations that covered areas of contaminant concerns from the historical information for the entire North Area. Also, ten test pits were excavated as part of the North Area (March 2003) site investigation. The primary goal of the test pits was to provide subsurface information that was helpful in determining the location of the ten soil borings in the North Area. Positive bulk asbestos samples were collected from the certain test pits. Surface and subsurface samples were collected throughout the entire North Area and analyzed for PCBs, EPH, priority pollutant metals (plus barium and vanadium), and asbestos. North Area soil borings and test pit locations in the North Area are depicted on Figure 3. Laboratory analytical results for the North Area samples compared to applicable MCP Standards are summarized on Table 5-6 (surface and subsurface soil analytical).

6.1.2.1 Surface Soil (0 to 3 feet bgs)

EPH carbon fraction ranges, PAHs, metals (namely arsenic, beryllium, and lead), and asbestos were detected in all surface samples in the North Area at concentrations above applicable MCP Standards. The PAHs detected at concentrations greater than applicable MCP Standards were the following six analytes; benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. The PAHs detected above applicable MCP Standards were identified in all ten samples collected in surface soils throughout the North Area (refer to Table 5-6). Therefore, PAH impacted surface soils are considered to be located throughout the entire North Area. PAHs were also compared to MADEP background concentrations for "natural soils" and "soil containing fill material." PAHs above background were found throughout the Site.

Concentrations of metals were greater than applicable MCP Standards in surface soil samples in the North Area. Arsenic was detected at concentrations above applicable MCP Standards (30 mg/kg) in 1 of 10 surface soil samples. The arsenic concentration above applicable MCP

Standards in surface soil samples was detected in one sample (SB-6/0-1) located near the center of the North Area. Arsenic was detected below applicable MCP Standards in the remaining surface samples in the North Area. Arsenic concentration in SB-6/0-1 was detected above 40 mg/kg (0-1' bgs) and was therefore considered a possible imminent hazard. Arsenic impacted surface soils are not considered to be located throughout the entire North Area.

Beryllium was detected at a concentration above applicable MCP Standards (0.7 mg/kg) in 8 of 10 surface soil samples. The concentration of beryllium above applicable MCP Standards was detected in samples collected throughout the North Area (refer to Table 5-6). Beryllium impacted surface soils are considered to be located throughout the entire North Area. Lead was detected at concentrations above applicable MCP Standards in 1 of 10 surface soil samples. The elevated concentrations of lead were detected in the northwest corner of the North Area (SB-1/0-1). Lead impacted surface soils are not considered to be located throughout the entire North Area. Other metals were not detected above applicable MCP Standards in surface soils.

PCBs were detected below applicable MCP Standards in all of the surface soil samples collected from the North Area (refer to Table 5-6). Therefore, PCBs are not believed to be located throughout this area. Asbestos is found throughout the Site. Additional information on asbestos contamination in surface soils is provided in Section 5.1.1 – Surface Soil – Asbestos.

6.1.2.2 Subsurface Soil (> 3 feet)

EPH carbon fraction ranges, PAHs, and metals (namely arsenic, beryllium, and vanadium) were detected in all subsurface samples in the North Area at concentrations above applicable MCP Standards. The PAHs detected at concentrations greater than applicable MCP Standards were the following six analytes; benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. The PAHs detected above applicable MCP Standards were identified in ten samples collected in subsurface soil throughout the entire North Area (refer to Table 5-6). PAH impacted surface soils are considered to be located throughout the entire North Area. PAHs were also compared to MADEP background concentrations for "natural soils" and "soil containing fill material." PAHs above background were found throughout the Site.

Concentrations of metals were greater than applicable MCP Standards in subsurface soil samples in the North Area. Arsenic was detected at concentrations above applicable MCP Standards (30 mg/kg) in 3 of 20 subsurface soil samples. The arsenic concentration above applicable MCP Standards in subsurface soil samples was detected in three samples (SB-4/5-7, SB-5/9-11, and SB-6/5-7) in the North Area. Subsurface sample SB-4/5-7 is located in the western portion of the North Area. SB-5/9-11 is located in the center of the North Area while SB-6/5-7 is located in the eastern portion. Arsenic was detected below applicable MCP Standards in the remaining subsurface samples in the North Area.

Beryllium was detected at a concentration above applicable MCP Standards (0.7 mg/kg) in 10 of 20 subsurface soil samples. The concentration of beryllium above applicable MCP Standards was detected in samples collected throughout the North Area (refer to Table 5-6). Beryllium impacted subsurface soils are considered to be located throughout the entire North Area. Vanadium was detected at concentrations above applicable MCP Standards in two of 20 subsurface soil samples. The vanadium concentration above MCP Standards in subsurface soil samples was detected in two samples (SB-7/7-9 and SB-9/5-7) in the North Area. The elevated concentrations of vanadium in subsurface soils were detected in the center to northern portions of the North Area. Other metals were not detected above applicable MCP Standards in subsurface soils.

PCBs were detected below MCP Standards in all of the subsurface soil samples collected from the North Area. Soil samples were not collected and analyzed for asbestos from the subsurface only from the surface.

6.2 Groundwater

Groundwater samples were collected in the North Area in an effort to determine if the groundwater had been impacted by the contaminants detected in site soils. A total of 24 groundwater samples from five sample locations were collected from the North Area in the March 2003 site investigation (Metcalf & Eddy / Stone & Webster). Groundwater samples were not collected during the May 2002 site investigation of the wedge area. The following sections discuss the nature and extent of groundwater contamination at the North Area.

For screening purposes, the analytical results have been compared to MCP reportable concentration GW-2 Standards. All groundwater samples collected from the North Area were analyzed for PCBs, MADEP-VPH, MADEP-EPH, and priority pollutant metals (plus barium and vanadium). Sample locations, which have concentrations greater than applicable MCP Standards, are boxed and provided in Table 5-7. All analytical results are summarized and compared to applicable MCP Standards in Table 5-7. Laboratory analytical reports from the March 2003 site investigation are included in Appendix J. Sample locations are depicted on Figure 3 (the entire area north of the raceway).

Selenium was detected at a concentration above applicable MCP Standards in one groundwater sample (MW-3). This monitoring well was located in the northern portion of the North Area where the former USTs were once located (refer to Figure 3).

Vanadium was also detected at a concentration above applicable MCP Standards in one groundwater sample in MW-6, which is south of MW-3 and located near the former black ash room (refer to Figure 3).

7.0 CONTAMINANT FATE AND TRANSPORT

7.1 Introduction

The previous section of this report discussed the nature & extent of contamination for the area north of the raceway. Based on these data, contaminants of concern (COPCs) were identified for the Site. This section discusses how the contaminant concentration may change with time and how the contaminants may move in the environment. The table in Section 5.4 presents a list of the COPCs qualitatively evaluated in the Method 3 Risk Characterization, as provided in Appendix K and discussed in Section 8.0. The principal contaminants detected in the area north of the raceway consist of PCBs, PAHs, EPH carbon fractions, asbestos, and the metals arsenic and beryllium. Other analytes were detected at concentrations above applicable MCP Standards. These two metals, PCBs, PAHs, EPH carbon fractions, and asbestos were detected most frequently in surface / subsurface soils and may have the potential to impact groundwater. As such, the focus of this Fate & Transport section will be PCBs, PAHs, EPH carbon fractions, asbestos and the metals, arsenic and beryllium.

7.2 Contaminant Transport Pathways

The contaminants identified in the area north of the raceway have the potential to migrate through groundwater, soil, air, and via surface water. The rate of groundwater flow, the direction of groundwater flow, the physical properties of the contaminant, and the subsurface soil conditions control the contaminant fate in groundwater. For contaminant migration in soil, the physical properties of the contaminant, subsurface soil conditions, and the amount of precipitation, control the transport characteristic of the contaminant. The volatility of the compounds, which is described by the contaminants interaction with the soil matrix controls vapor transport.

7.3 Fate and Transport Processes

The following sections provide a brief review of the major contaminant fate and transport properties and processes that influence the mobility of contaminants in the environment. When released into the environment, most organic chemicals undergo a variety of reactions or processes that affect their transport potential and final fate. For example, given a significant amount of time, all petroleum compounds will break down into carbon dioxide and water (mineralization). Whereas, metals have a more limited set of processes that they undergo and are typically controlled by the redox potential (Eh) and pH conditions of the soil/water. Processes that may be important to areas north of the raceway include the following:

Solution/Dissolution
Sorption
Physical Transport Mechanism

7.3.1 Solution/Dissolution

Solution is the partitioning of a chemical between the non-aqueous and dissolved phases. The degree to which a compound is soluble (i.e., solubility) is a function of various factors including salinity, temperature, dissolved organic carbon, oxidation state/redox potential, pH, polarity, and other factors. Solubility of organic compounds varies from sparingly soluble to infinitely soluble (Lyman et al. 1982). Compounds considered to be very water-soluble generally have water solubilities greater than 1,000 milligrams per liter (mg/L). Compounds are considered to have moderate water solubilities if their solubilities are between 100 and 1,000 mg/L. Low water solubilities are generally less than 100 mg/L. The solubility data for the COPCs evaluated in this section are presented in Table 7-1.

Based on the solubility data presented in Table 7-1, the PAHs present in soil/groundwater have very low water solubility's. However, of the PAHs, naphthalene, 2-methylnaphthalene and acenaphthene are slightly soluble. With respect to the metals, arsenic and beryllium similarly have low water solubility's.

Arsenic can occur in –3, +1, +3, and +5 valence states. However, the important state of arsenic is in the arsenate (+5), or the arsenite (+3) form. Dissolved arsenic species can be absorbed by ferric hydroxides. Arsenic (+5), is more strongly sorbed than arsenic (+3). Ferric hydroxides are stable over a wide Eh-pH range, thus limiting the mobility of arsenic (Fetter, 1999). Arsenic tends to be mobile over a limited pH/Eh range. Beryllium oxide or hydroxide occur in the +2 valence, and have a very low water solubility. Beryllium and other metals can be expected to undergo cation exchange with clays, thus the mobility of beryllium in groundwater is limited (Fetter, 1999).

Asbestos is not readily soluble. However, like metals, these layered silicates have been found in aquifers as colloids (Fetter, 1999).

With respect to the EPH carbon fractions the C_{11}-C_{22} aromatics are the most soluble of the three fractions. The other two fractions C_9-C_{18} Aliphatics and C_{19}-C_{36} Aliphatics are considered slightly soluble to immobile.

Based on the residual concentrations of COPCs in the soil and groundwater, the Solution/Dissolution process is a limited transport mechanism for the metals, PAHs, asbestos and EPH carbon fractions with the exception of naphthalene, 2-methylnaphthalene, and C_{11}-C_{22} aromatics.

7.3.2 Sorption/Retardation

Sorption is defined as the interaction of an organic or inorganic contaminant with a solid (Piwoni and Keeley, 1996). Sorption processes can be classified as adsorption (adhesion to the solid's surface) and absorption (penetration into the solid). The discussion below covers only the adsorption processes, since absorption can only occur when the aquifer particles are sufficiently porous so that the solute can diffuse into the particle and be absorbed with the interior structure of the mineral. The site geology consists principally of fill underlain by glacial till deposits and loamy sands and silt deposits. Due to the presence of fine-grained sediments encountered, the absorption process is likely to retain site COPCs, and as such these contaminants are not likely to migrate a significant distance.

Adsorption mechanisms are typically the dominant processes causing retention of large molecular weight organic molecules and inorganic compounds. Adsorption may be a significant process in the fate and transport of contaminants, because it can retard the transport of COPCs. Also, transformation reactions such as biodegradation are affected by the degree of adsorption.

Adsorption is defined as the interaction of a solute with sorption sites on a solid surface. Adsorption is a function of various properties of a given contaminant and the nature of the aqueous and solid media. Contaminant properties that influence sorption for the COPCs include the amount of organic carbon in decimal percent (fraction of organic carbon (f_{oc})) present in the soil/sediment, water solubility, and the soil-water partition coefficient (K_{oc}). Organic carbon data was not obtained as part of the investigation. However, as described in EPA (1997), the organic matter for loam varies between 0.52%-0.71%. The organic carbon is determined by dividing this value by 1.724. Using the lower range, the organic carbon for the loamy soils encountered would be approximately 0.3% or 0.003 in decimal percent.

The partitioning ability of the chemical to be sorbed to the host media (soil) or to be released to the pore water (groundwater) is directly related to the chemical's K_{oc} and the soil/sediment f_{oc}. The distribution coefficient, K_d, for organic chemicals is calculated using the following equation: $K_d = f_{oc} * K_{oc}$. The soil-water partitioning coefficient for inorganic compounds is more complex and is affected by numerous geochemical parameters and processes, including pH, sorption to clays, organic matter, iron oxides, and other soil constituents; oxidation-reduction conditions, major ion chemistry, and the chemical form (e.g., hydroxide, carbonate, or silicate) of the metal. The number of significant influencing parameters, and differences in experimental methods, results in as much as seven orders of magnitude variability in measured metal K_d values reported in the literature.

Table 7-2 includes the K_{oc} and the calculated K_d based on a TOC of 0.3% or in decimal percent, 0.003 for organic compounds. The source of the K_d data for inorganic compounds provided in Table 7-2 is for arsenic (+3) and beryllium (+2) with an aqueous pH of 6.8. The distribution coefficient for beryllium varies by 5 order from 2.8 L/kg at a pH of 4.9 to 466,000 L/kg at pH 8.0. The sorption for arsenic (+3) is based on the following Eh-pH dependent relationship:

Arsenic (+3) $\text{Log } K_d = 0.0322 * \text{pH} + 1.24$

Based on the K_{oc}, f_{oc} and K_d values presented in Table 7-2, the PAH compounds sorb readily to site soils as noted by their high distribution coefficient numbers and do not readily migrate in soil or groundwater. Exception to this are the PAHs, naphthalene, acenaphthene, fluorine, and 2-methylnaphthalene. Additionally, the C_{11}-C_{22} aromatic hydrocarbon is the most mobile of the three carbon fractions. As depicted in the table, arsenic may be mobile in site groundwater and may leach from site soils based on their K_d values. However, as previously noted, metals transport in the subsurface is dictated by many factors including soil Eh/pH conditions to name a few.

The retardation factor of a compound can be determined based on the distribution coefficient, K_d, of a compound, the net effective porosity of the soil, and the soil bulk density. Based on a dry bulk density of 1.47 g/mL for a loamy soil (EPA 1997) and an estimated net effective porosity for a silty-sand of 20 percent (Fetter, 1994), the retardation factor for each compound was determined. Retardation Factors are presented in Table 7-3 and were determined as follows:

$$\mathbf{Rf = 1 + (P_b/n) \times K_d}$$

Where:

Rf = retardation factor, unitless
P_b = dry bulk density, g/mL
n = net effective porosity, as void fraction
K_d = $K_{oc} * f_{oc}$ (for organic compounds solely), mL/g
f_{oc} = fraction of organic carbon, decimal percent
K_{oc} = partitioning coefficient, mL/g

As indicated by the calculated retardation values, the heavy weight PAHs and PCBs are highly retarded and bind to site soil as presented in Table 7-3. With the exception of naphthalene, the PAHs are not anticipated to migrate any substantial distance in groundwater. Similarly, the metals arsenic and especially beryllium would sorb to site soils. As noted previously, metals transport are highly dependent on soil-water interactions such as Eh/pH, amount of ferric iron present in the soil and the cation exchange capacity (CEC) of the soil.

As presented in Table 7-3, the COPCs solute velocity is presented. The relationship between retardation and solute velocity is as follows. Assume groundwater flows at a rate of 0.5 ft/day, see Section 7.3.3, then a dissolved naphthalene front with a retardation factor of 29.67 would migrate approximately 6 feet from the source in one year, whereas uncontaminated groundwater without naphthalene would migrate 182.5 feet. The PAHs are essentially immobile and many of the other COPCs migrated tenths of feet per year to several feet per year. Therefore, the Sorption/Retardation process is a significant Fate & Transport mechanism in prohibiting the migration of site contaminants.

7.3.3 Physical Transport Mechanisms

Other physical transport mechanisms that may be important to the site include the following:

molecular diffusion (diffusion),
advection,
dispersion,
physical transport

Diffusion is a physical process that occurs in subsurface environments. Diffusion will occur in any environment that has a concentration gradient and tends to be more significant in low permeable soils. The magnitude of the gradient determines the rate of the reaction. Under normal conditions, areas of higher concentration move to areas of lower concentration since the system wants to be in equilibrium. The difference between the high and low concentration is related to the concentration gradient. This process tends to spread the contamination outward in all directions from the source. Based on the residual concentration of COPCs in the subsurface soil and groundwater, diffusion is not likely to be a significant physical transport mechanism due to the permeable nature of the fill and loam deposits.

Advection is a process where dissolved contaminants are carried along with bulk groundwater flow. Many different advection transport models are used to describe the flow of groundwater and contaminants through subsurface media. Factors affecting the advective transport include contaminant concentration, hydraulic gradient, hydraulic conductivity, and effective porosity (Fetter, 1994). The one-dimensional mass flux due to advection can be calculated using the variables identified. The seepage velocity of the groundwater at the site-using maximum determined values is approximately 0.5 ft/day. This was determined from the following equation and estimated variables:

$V_{seep} = K*I/n_e$

Where:

V_{seep} = Seepage Velocity, ft/day
K= Hydraulic Conductivity of the subsurface soils, 3.8×10^{-3} cm/sec (Eckenfelder, Inc., 1998)
I = Hydraulic Gradient, Unitless, 0.0098 (maximum)
n_e= Net Effective Porosity, Unitless, 0.2 (typical)

Advection itself is a significant transport mechanism for this site, since groundwater migrates approximately 180 ft/year. However, when retardation and dilution (via precipitation and dispersion) are considered, the solute concentration would be considered negligible, and this pathway is not considered important.

The mixing of contaminants through soil pore spaces in the subsurface is called mechanical dispersion. There are three ideas associated with this type of fluid transport (Fetter, 1994). Fluid will move faster through the center of pores than along the edges. Some fluid molecules may travel along longer flow paths than others to go the same linear distance. Fluid will flow faster through larger pores than smaller ones.

Considering the situations discussed above, not all fluid is traveling at the same velocity, allowing mixing along the flow path, thereby causing some degree of dilution. Dispersion can occur in the longitudinal or transverse direction. Many equations have been developed to determine/represent dispersion coefficients.

Dispersion should not play a significant role since the K_{oc}'s and K_d values are fairly high, contaminants will preferentially sorb to site soils, thereby reducing dispersion effects in a transverse or vertical direction. As such, dispersion is not considered a significant fate & transport process.

7.3.4 Volatilization

Volatilization is a physical process that depends on the thermodynamic properties of a chemical and the effects of environmental factors. VOC analytes are principally the compounds that are subject to volatilization and are not COPCs at the site.

Volatilization may occur from groundwater into soil gas within the vadose "unsaturated" zone. The rate of volatilization depends upon temperature, vapor pressure, and the difference in concentration between the liquid and vapor phases. The emissions from a source can be estimated with the use of Henry's Law constants, equilibrium chemistry, and other site-specific factors. Henry's Law is used for dilute solutions and represents the ratio of the concentration in the gas to the liquid concentration. Table 7-4 lists the Henry's Law constants for the site COPCs, where available.

From the information presented in Table 7-4, the higher the Henry's Law constant the greater likelihood that the compound will be present in the gas phase surrounding the liquid. Temperature and the chemical composition of water significantly affect Henry's Law constant.

Henry's Law is proportionally related to the vapor pressure and molecular weight of the compound and inversely proportional to the compound solubility. As depicted in Table 7-4, PAHs and PCBs tend to have very low Henry's Law constants, and metals are considered to be non-volatile. With the possible exception of 2-methylnaphthalene and the EPH carbon fraction C9-C18 Aliphatics, all other COPCs are not considered volatile. Therefore, volatilization from site COPCs is not expected to be a major transport process.

7.4 Fate and Transport Conclusions

In summary, residual concentrations of the COPCs are expected to degrade or remain in the general area of the releases. The Fate and Transport evaluation has revealed that COPCs are not expected to significantly migrate from site soils, groundwater, or volatilize from site soils.

8.0 METHOD 3 RISK CHARACTERIZATION

8.1 Introduction

A Method 3 Risk Characterization and Stage I Environmental Screening has been prepared for the Site in order to establish whether a condition of No Significant Risk, as defined in the MCP, exists for current and foreseeable future site uses. In accordance with the MCP, characterization of the risk of harm to health, public safety, public welfare, and the environment associated with concentrations of OHM in environmental media were evaluated in the risk characterization. The complete Method 3 Risk Characterization and Stage I Environmental Screening are provided in Appendix K.

The Method 3 Human Health Risk Characterization and Stage I Environmental Screening was prepared by Metcalf & Eddy and are included as Appendix K.

8.2 Human Health Risk Characterization

In accordance with the Massachusetts Contingency Plan, 310 CMR 40.0990, a Method 3 Human Health Risk Characterization and Stage I Environmental Screening has been conducted for areas north of the raceway of the Oxford Paper Mill using applicable soil and groundwater analytical sampling data from the May 2002 and March 2003 site investigations. The raceway and the area south of the raceway are being characterized and remediated separately. It is anticipated that the wedge area soils will need to be removed from the northern portion of the property as part of a bridge construction project being performed by the Massachusetts Highway Department (MHD). However, since the design plans for the bridge have not been firmly established, all soils (including the wedge area soils) have been assumed to remain within areas north of the raceway for the purposes of this risk evaluation.

This risk characterization is intended to be an evaluation of baseline conditions at areas north of the raceway and has been conducted in a manner consistent with the requirements of 310 CMR 40.0900, guidelines laid out in MADEP's Guidance for Disposal Site Risk Characterization (MADEP, 1995 and 2002 technical updates), MADEP petroleum policies (MADEP, 2002) and current risk assessment practices. Risk of harm to human health, welfare, safety, and the environment from potential exposures to the detected contaminants has been characterized to provide information that will be used to select the appropriate Response Action Outcome (RAO) pursuant to 310 CMR 40.1000.

8.2.1 Uses, Receptors, and Exposure Pathways

The risk evaluation assumes that an Activity and Use Limitation (AUL) will be placed on the property to prevent future residential and/or commercial land use including the construction of occupied buildings. Therefore, the risk characterization has not included these receptors or the pathways by which these receptors may be exposed to site-related contaminants. In addition, asbestos-contaminated soils exist on-site that, if contacted, would present a potential risk to human receptors. It is assumed that contact with these soils will need to be prevented as part of the AUL at the Site.

8.2.2 Current Site Activities and Uses

Persons who may currently be present at the Site include the following:

1. Adolescents trespassing onto the Site; and
2. Adolescent users of the Spicket River.

Direct exposures of human receptors to contaminants detected in surface soil is considered a potentially complete exposure pathway under current Site conditions since contamination is present at depths less than three feet below ground surface in unpaved areas. Therefore, direct contact surface soil exposures (ingestion and dermal contact) and the inhalation of soil-derived dust are evaluated as current exposure pathways for adolescent trespassers.

The potential for indirect exposures of human receptors to volatile contaminants detected in soil and groundwater through inhalation of impacted outdoor air is considered negligible under current Site conditions due to dilution and dispersion of any released vapors in ambient air.

Based on the direction of groundwater flow across the Site, potential exposures of adolescent receptors to contaminants in the surface waters of the Spicket River via dermal contact and ingestion are possible. This assumption is consistent with MADEP's requirement that groundwater shall be considered a potential source of discharge to surface water (310 CMR 40.0932(3)). Therefore, this pathway was evaluated in terms of impact of surface water contaminants exposures on human health and the environment.

The Site is not located with a designated Zone II, Interim Wellhead Protection Area, a Potentially Productive Aquifer, or the Zone A of a Class A Surface Water Body (refer to Figure 4). Therefore, potential exposures of human receptors to contaminants in groundwater used directly as a potable water supply or for irrigation purposes are considered highly unlikely. Consequently, the use of Site groundwater as a source of potable water was not further evaluated.

8.2.3 Reasonably Foreseeable Site Activities and Uses

Under future foreseeable Site activities and uses, the most likely exposures to contaminants are expected to occur during subsurface excavations through contaminated soils. Principal receptors are expected to be workers involved in grading areas north of the raceway as part of MHD's bridge construction, or in trenching activities for the installation of utility connections. Excavation and construction activities for a proposed geotextile cap over areas north of the wedge area would most likely pose an exposure pathway for workers to on-site subsurface contaminants.

The most likely pathways and routes of exposure to contaminants for workers during these invasive activities are direct dermal contact, incidental ingestion and inhalation of fugitive dusts and volatiles from contaminated soils as a result of subsurface activities. It is also possible for these workers to come in contact with contaminants detected in shallow groundwater during excavations, resulting in exposure through incidental ingestion, and dermal contact.

Future excavation/construction work could result in the movement and mixing of subsurface contaminants with surficial contaminants and subsequent exposures to future receptors. Should the Site be developed as a park, young child and adult users could potentially be exposed to contaminants in soil (following movement of these soils to the surface during excavation activities) through dermal contact, incidental ingestion and inhalation of fugitive dusts entrained from friable soils. In addition, exposures to surface water in the Spicket River, via direct dermal contact and incidental ingestion, are possible under future Site use and have been evaluated as part of the exposure scenario. Since dilution and dispersion of the low levels of vapors migrating from soil and groundwater into ambient air are not expected to mitigate any significant exposures through inhalation, this pathway was not evaluated further. Should the Site not undergo development in the future as a park, future adolescent trespassers may be exposed by the same pathways as current adolescent trespassers except for ACM. The Site is fenced and excludes trespassers.

8.3 Method 3 Human Health Risk Characterization Conclusions

The Method 3 Human Health Risk Characterization concluded that under current site activities and uses, potential exposures to Contaminants of Potential Concern (COPCs) in soil and surface water (as estimated based on groundwater discharge to the Spicket River, and a dilution factor of 10) pose no significant risk of harm to current adolescent trespassers.

Under future foreseeable site activities and uses, potential direct contact exposures of COPCs in soil pose a significant risk of harm to human health. Significant risk of harm is posed to: (1) the future hypothetical young child user; and (2) the future hypothetical adult user. The risks are primarily attributable to the presence of carcinogenic PAHs and arsenic in soil. Future exposures to construction/utility workers or adolescent trespassers pose no significant risk to harm to health. Note that the assessment of future risk includes data for all soils currently present at the Site north of the raceway, including those in the wedge area. Removal of wedge area soils was not assumed in estimating future risk. Because wedge area soils and soils north of the wedge area are similar with respect to contaminant concentrations, the evaluation of future risk would not likely change, were the wedge area soils to be excluded from the evaluation.

The Method 3 Human Health Risk Characterization also concluded that risk of harm to safety and public welfare is not significant under both current and future foreseeable site conditions. Also since the water Exposure Point Concentrations, modeled from groundwater contaminant concentrations, do not exceed Ambient Water Quality Criteria for aquatic receptors, it is concluded that the Site does not pose a significant risk to the environment.

8.4 Stage I Environmental Screening

The following observations about the Site and its environs may be made:

- The Site is not located within a one-half mile radius of or adjacent to an inland Area of Critical Environmental Concern (MADEP Bureau of Waste Site Cleanup Site Scoring Map; Figure 4)

- The U.S. EPA Region 1 List of Priority Wetlands/Water Bodies in New England does not indicate the presence of specific priority wetlands/water bodies at or in the vicinity of the Site.

- The Massachusetts Natural Heritage Atlas does not show High Priority Sites of Rare Species Habitats and Exemplary Natural Communities or Estimated Habitats of Rare Wetlands Wildlife and Certified Vernal Pools within a one-half mile radius of the Site.

- The MADEP Bureau of Waste Site Cleanup Site Scoring Map (Figure 4) indicates that the closest surface water body (Spicket River) is located immediately adjacent to the Site.

Based on the review of available data and the aforementioned observations, the potential media of concern for ecological receptors were identified as on-site surface soils and surface water (as impacted by groundwater discharge).

8.4.1 Terrestrial Receptors

The principal exposure pathway for terrestrial receptors includes contact with COPCs in on-site surface soils. However, given the small size (<2.0 acres) of undeveloped impacted property on the Site and the limited vegetated cover (i.e., lack of suitable habitat), the Site appears to qualify for exclusion from assessment of risk of harm to terrestrial life under MCP guidance (MADEP, 1995).

8.4.2 Aquatic Receptors

For discharge of groundwater to surface water, the most likely environmental receptors are aquatic organisms living in the Spicket River. Terrestrial organisms may drink from the river; however, this is likely to occur from multiple locations along the river and other water bodies in the area. Potential exposure point concentrations (EPCs) for aquatic life in the Spicket River were modeled using average groundwater concentrations and conservative dispersion modeling (i.e., MADEP default 10-fold dilution factor).

8.5 Stage I Environmental Screening Conclusions

Risk of harm to the aquatic organisms was evaluated by comparison of the modeled surface water EPCs to Massachusetts Ambient Water Quality Criteria provided by MADEP (MADEP, 1994). COPC EPCs are below the corresponding AWQCs, and thus pose no significant risk of harm to aquatic receptors.

Based on the findings of the above Stage I Environmental Screening, current and future foreseeable site conditions pose no significant risk of harm to the environment, as defined in 310 CMR 40.09. In addition, a Stage II Environmental Risk Characterization (as defined in 310 CMR 40.0995(4)) is not indicated.

9.0 POTENTIAL SOURCES OF CONTAMINATION

Based on a review of the site history, site visits, field observations and analytical data, it appears that the possible sources of COPCs for areas north of the raceway are due mostly to the former paper mill operations. Contaminants include polycyclic aromatic hydrocarbons (PAHs) from coal, coal ash, and other combustion operations; chlorinated organic compounds that may have formed during pulp bleaching operations; and sulfides from chemical pulp residues. The chlorinated organic compounds and sulfides would most likely have been released to surface water and air, as opposed to soil, because they are associated with mill operations that involved water discharges (to the raceway most likely) and air emissions (sulfur compounds and other volatile organic compounds (VOCs) from stacks and process tanks). In addition, underground storage tanks containing fuel oils and transformers containing polychlorinated biphenyls (PCBs) have historically been present on-site.

10.0 SUMMARY/CONCLUSIONS

A Phase II - CSA has been performed by Stone & Webster for areas north of the raceway at the Oxford Paper Mill. The Oxford Paper Mill is located off of Canal Street in Lawrence, Massachusetts (refer to Figure 1).

Soil (surface and subsurface), and groundwater samples have been collected over a two-year span (2002 to 2003) by the Metcalf & Eddy and Stone & Webster. The majority of contamination found in areas north of the raceway at the Oxford Paper Mill is PAHs, PCBs, asbestos and metals in soil and metals in groundwater. PAHs are not considered background in areas north of the raceway due to the detection of some PAHs in soil samples at concentrations greater than the corresponding MADEP background levels for fill material (refer to Section 5.5). The sample results have been used to perform a Method 3 Risk Characterization.

The Risk Characterization (included in Section 8.0) concluded the following:

- A condition of no significant risk to human health does exist for current site activities and that a condition of no significant risk to human health does not exist for future activities.

- The Risk Characterization also concluded that a condition of no significant risk to safety and public welfare does exist for both the current and future foreseeable site conditions.

- In final, the Risk Characterization concluded that a condition of no significant risk to the environment does exist. A condition of no significant risk has not been achieved for future activities and therefore additional remediation must occur or an AUL must be placed on the property for restricted future use.

The human health risk characterization conclusions are based on limits to site use for current and future residential development through the implementation of an Activity and Use Limitation (AUL). Remedial actions and/or additional restrictions in the AUL are required to address potential risks to the users for areas north of the raceway at the Oxford Paper Mill to meet a condition of No Significant Risk. A Phase III – Identification, Evaluation, and Selection of Comprehensive Remedial Action Alternatives will be submitted in accordance with 310 CMR 40.0850 to address the potential risks to human health and the environment.

The Stage I Environmental Screening (included in Section 8.0) concluded the following:

- Since surface water EPCs, modeled from groundwater contaminant concentrations, do not exceed AWQCs for aquatic receptors, it is concluded that the Site does not pose a significant risk to the environment.

11.0 LIMITATIONS

This report was prepared for the use of the City of Lawrence. The observations made and results presented in this report are believed to be representative of current conditions at the time of Stone & Webster's assessment. Any additional information regarding Site conditions or past/current Site use should be brought to Stone & Webster's attention so it may be addressed and incorporated in the Site study. This information could potentially result in modification of Stone & Webster's conclusions and recommendations.

Stone & Webster is not responsible for the accuracy and veracity of information provided to us by outside parties with respect to areas north of the raceway at the Oxford Paper Mill and adjacent properties. This report presents the opinions of Stone & Webster Massachusetts, Inc., with the respect to the environmental conditions of areas north of the raceway at the Oxford Paper Mill. The actual determination of compliance of present or former operators of areas north of the raceway at the Oxford Paper Mill with federal or state regulations can only be made by the appropriate regulatory agencies. The opinions rendered herein are not intended to imply a warranty or a guarantee and are based solely upon areas north of the raceway at the Oxford Paper Mill conditions at the time of our investigation.

Chemical analyses were performed for certain parameters during this assessment. The parameters selected were based upon site knowledge and potential sources. However, chemical constituents not searched for during the studies may be present in soil and/or groundwater at areas north of the raceway at the Oxford Paper Mill. Chemical conditions reported reflect conditions only at the locations tested at the time of testing and within the limitations of the methods used. Such conditions can vary rapidly from area to area and from time to time. No warranty is expressed or implied that chemical conditions other than those reported do not exist within areas north of the raceway at the Oxford Paper Mill.

Negative findings at a test location do not guarantee that the soil or groundwater at a greater depth is free of contaminants because geologic and/or hydrologic conditions may be present that prevents upward diffusion of contaminants from deeper horizons. Additionally, positive findings at a sample location can arise from soil contamination only and do not confirm that the underlying groundwater has been impacted.

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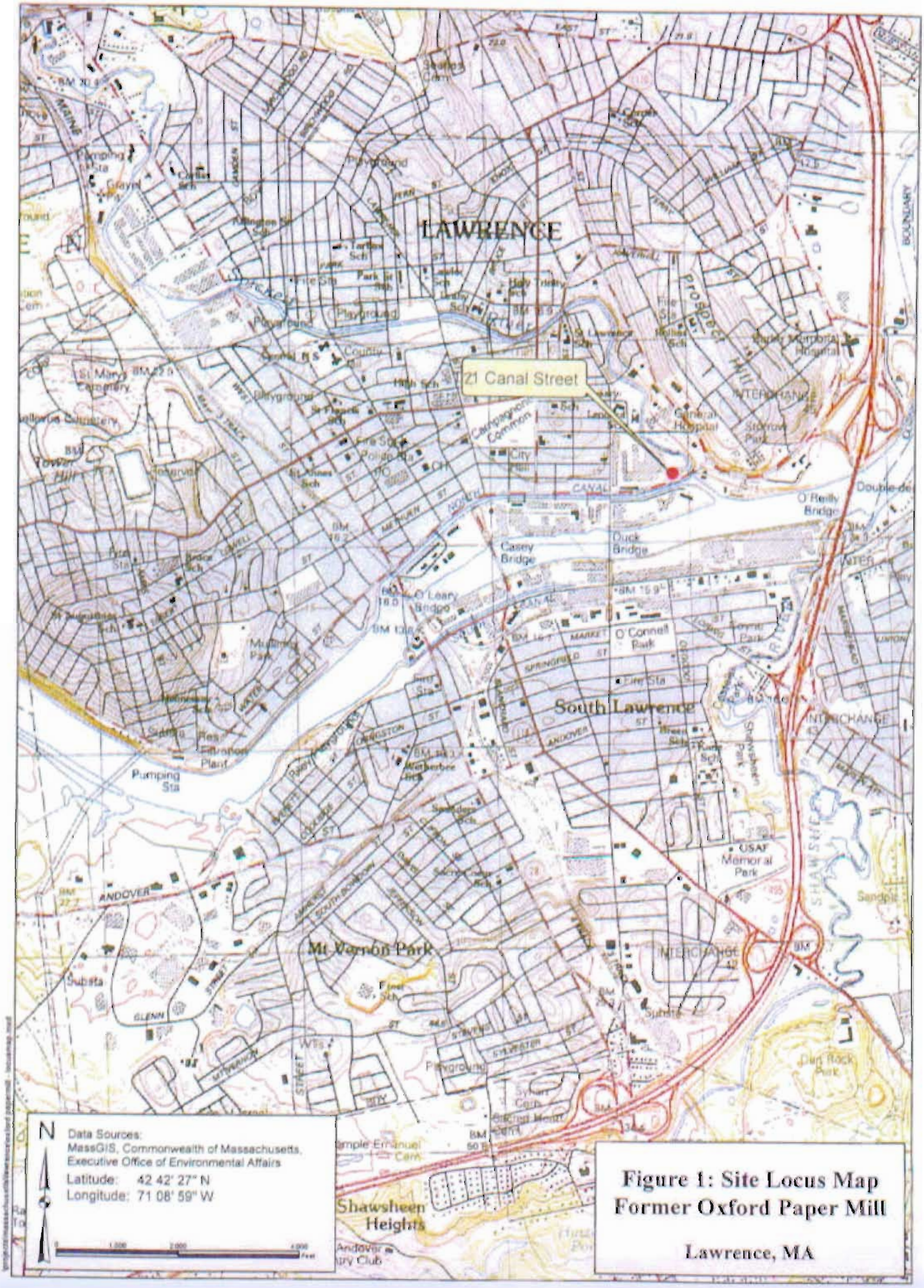
FIGURES

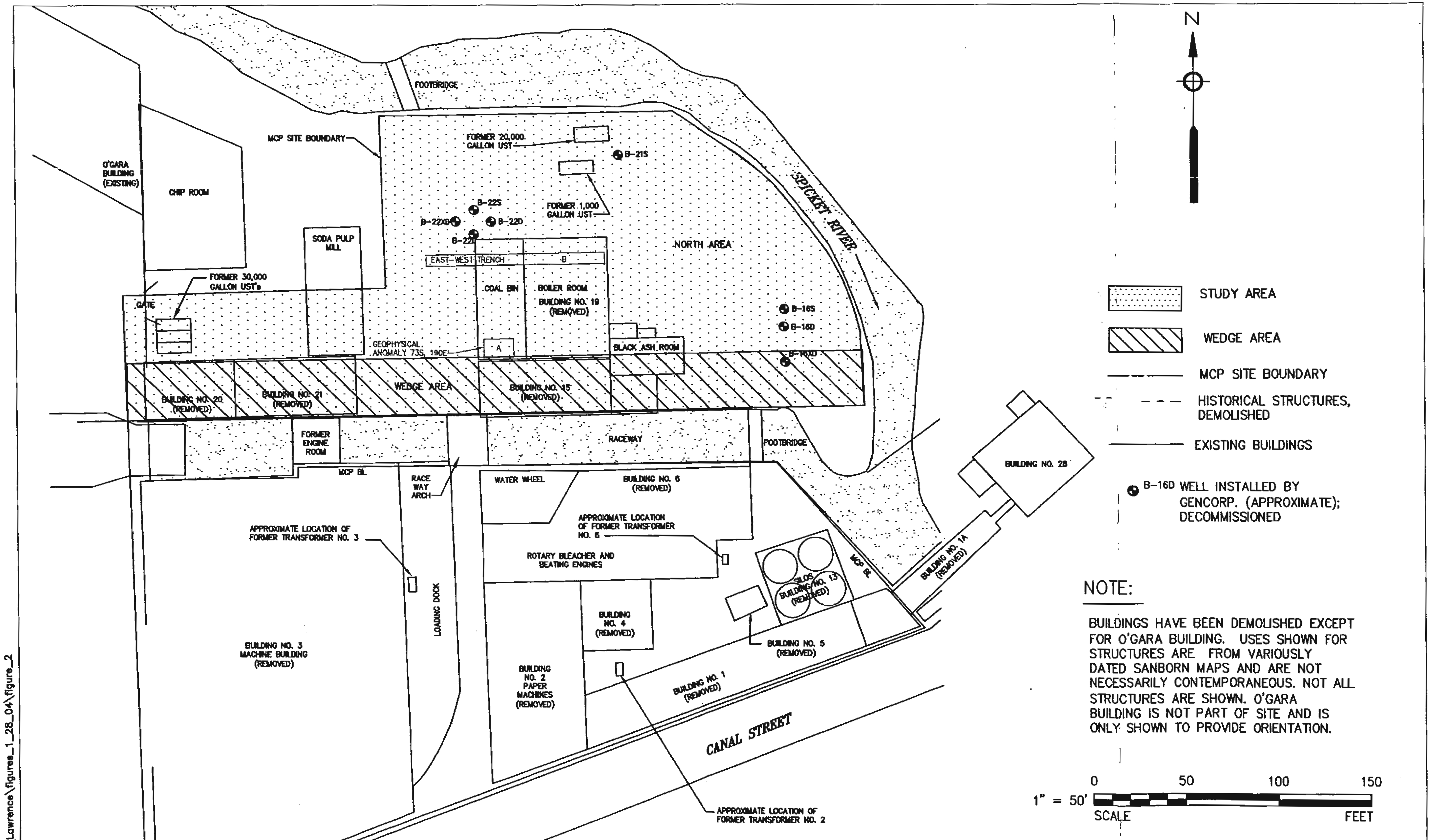


Data Sources:
MassGIS, Commonwealth of Massachusetts,
Executive Office of Environmental Affairs

Latitude: 42 42' 27" N
Longitude: 71 08' 59" W

Figure 1: Site Locus Map
Former Oxford Paper Mill

Lawrence, MA



NOTE:

BUILDINGS HAVE BEEN DEMOLISHED EXCEPT FOR O'GARA BUILDING. USES SHOWN FOR STRUCTURES ARE FROM VARIOUSLY DATED SANBORN MAPS AND ARE NOT NECESSARILY CONTEMPORANEOUS. NOT ALL STRUCTURES ARE SHOWN. O'GARA BUILDING IS NOT PART OF SITE AND IS ONLY SHOWN TO PROVIDE ORIENTATION.

Shaw® Shaw Environmental, Inc.

SHAW ENVIRONMENTAL OXFORD PAPER MILL SITE
SUBSURFACE INVESTIGATION – LAWRENCE, MASSACHUSETTS

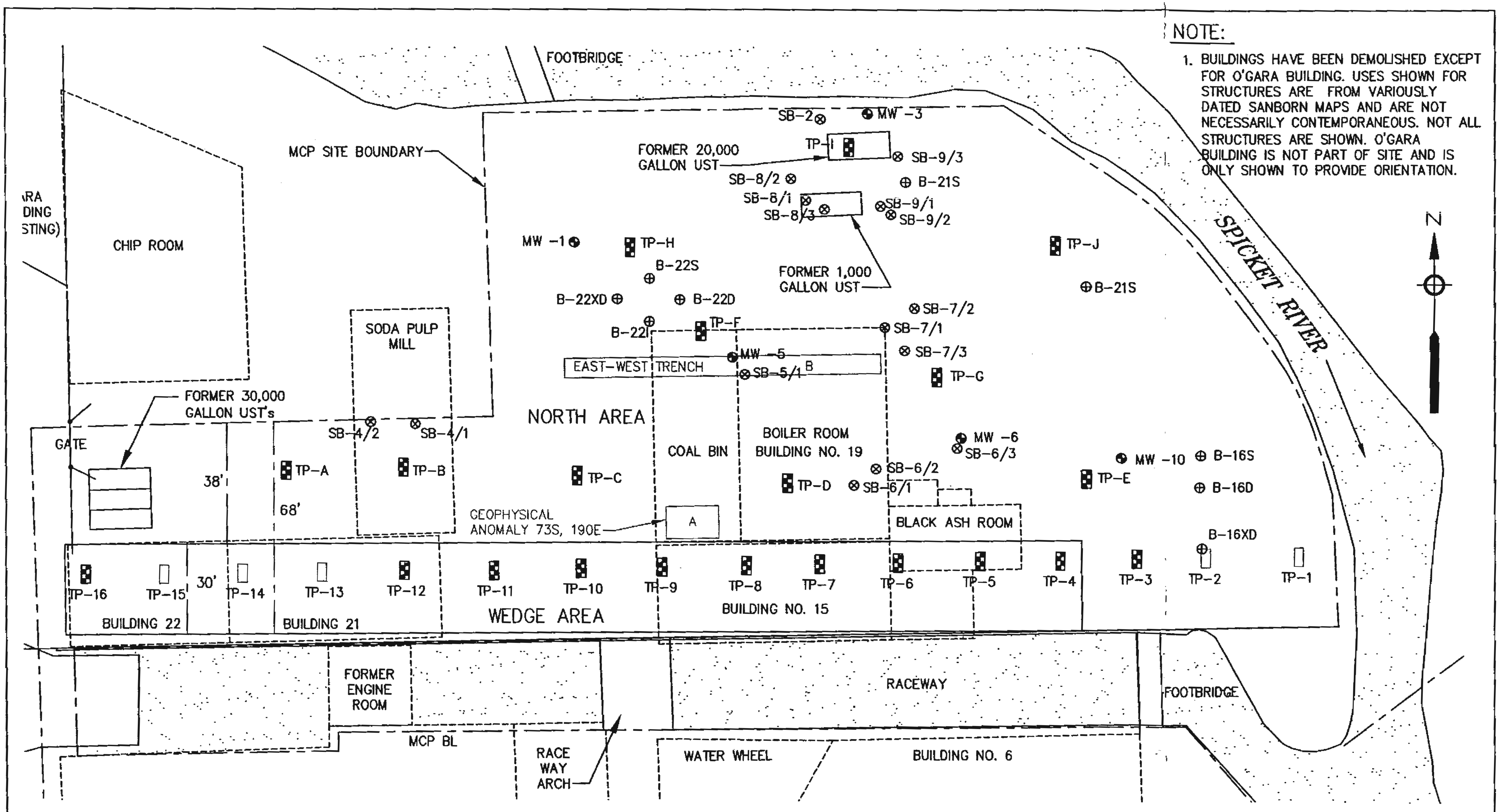
FIGURE 2 – SITE PLAN AND SELECTED HISTORICAL FEATURES

SCALE: AS NOTED	3/16/04	DEH

3/17/04 L:\Hazwaste\Lawrence\figures_1_28_04\figure_2

NOTE:

1. BUILDINGS HAVE BEEN DEMOLISHED EXCEPT FOR O'GARA BUILDING. USES SHOWN FOR STRUCTURES ARE FROM VARIOUSLY DATED SANBORN MAPS AND ARE NOT NECESSARILY CONTEMPORANEOUS. NOT ALL STRUCTURES ARE SHOWN. O'GARA BUILDING IS NOT PART OF SITE AND IS ONLY SHOWN TO PROVIDE ORIENTATION.



LEGEND

- – – – MCP SITE BOUNDARY
- - - - - HISTORICAL STRUCTURES, DEMOLISHED
- ——— EXISTING BUILDING
- ● MW-1 MONITORING WELL LOCATION
- ⊗ SB-7/1 SOIL BORING LOCATION (/ FIRST ATTEMPT, /2 SECOND ATTEMPT, /3 THIRD ATTEMPT
- ⊕ B-16D WELL INSTALLED BY GENCORP. (APPROXIMATE); DECOMMISSIONED
- ☐ WEDGE AREA TEST PITS NOT COMPLETED DUE TO ACM OR SLOPE
- ▨ WEDGE AREA TEST PITS COMPLETED (2002)
- ▨ NORTH OF WEDGE AREA TEST PITS (2003)

1" = 30'

0 30 60

SCALE FEET

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SHAW ENVIRONMENTAL OXFORD PAPER MILL SITE
SUBSURFACE INVESTIGATION – LAWRENCE, MASSACHUSETTS

FIGURE 3 –
MAY 2002 & MARCH 2003 SITE INVESTIGATION TEST PIT AND BORING LOCATIONS

SCALE: AS NOTED	3/16/04	DEH

3/17/04 L:\Hazwaste\Lawrence\figures_1_28_04\Figure3.dwg

FIGURE 4

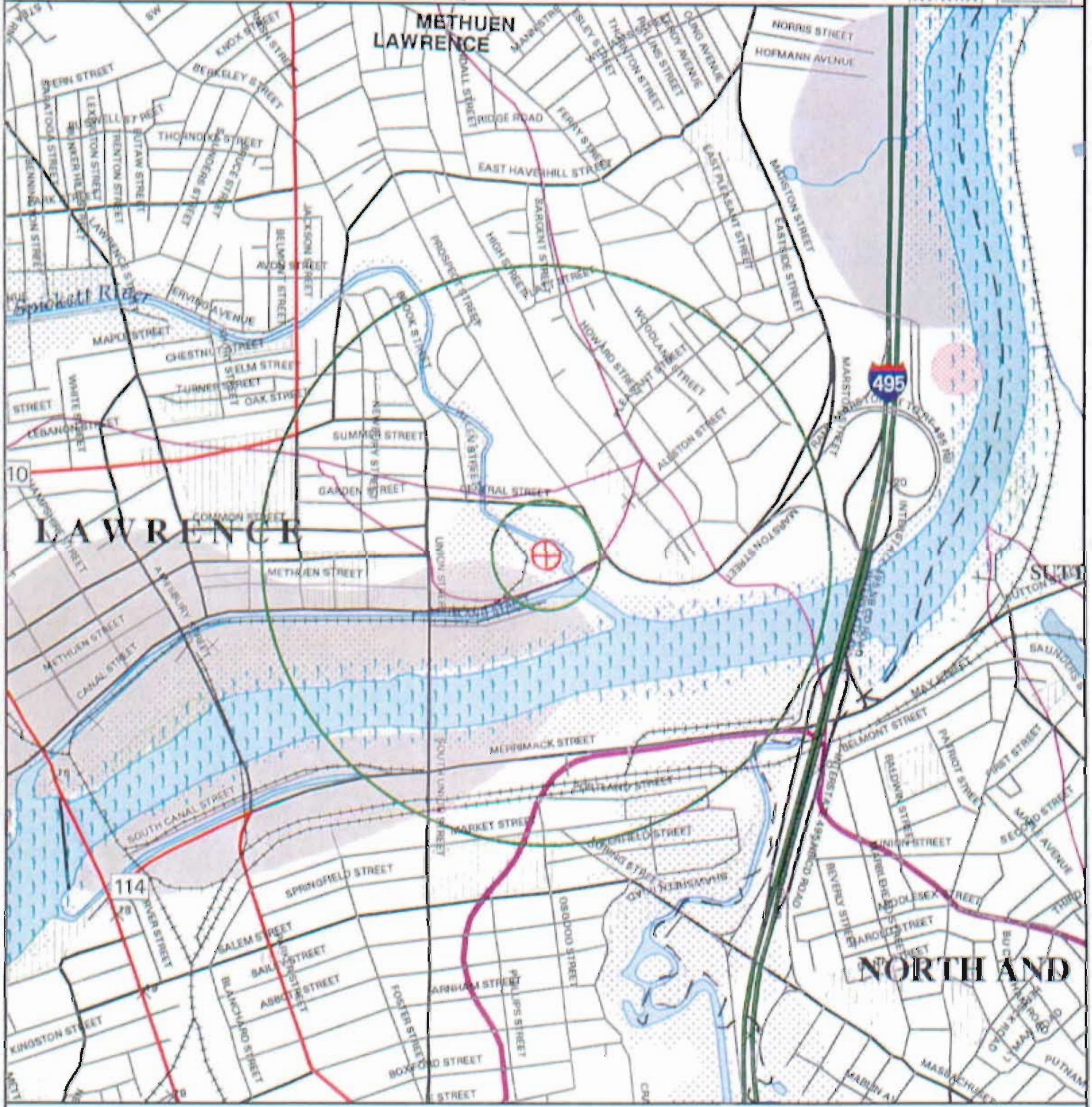
MA DEP - Bureau of Waste Site Cleanup

Site Scoring Map: 500 feet & 0.5 Mile Radii

SITE NAME:
Oxford Paper Mill
Canal Street
LAWRENCE, MA
939758n 228732ew

The information shown on this map is the best available at the date of printing. Please refer to the data source descriptions document.

MASS GIS
Massachusetts Geographic Information System
Massachusetts Executive Office of Environmental Affairs - 2003



SCALE 1:15000

May 30, 2003

NRS SCORING MAP DATA SOURCES

AQUIFERS: USGS-WRD/MassGIS, 1:48,000. Automated by MassGIS from the USGS Water Resources Div. Hydrologic Atlas series manuscripts. The definitions of high and medium yield vary among basins. Source dates 1977-1988.

SOLE SOURCE AQUIFERS: US EPA/MA DEP/MassGIS, various scales. They are defined by EPA as aquifers that are the 'sole or principal source' of drinking water for a given aquifer service area. Last updated May 1996.

NON POTENTIAL DRINKING WATER SOURCE AREAS: DEP-BWSC (Bureau of Waste Site Cleanup). Those portions of high and medium yield aquifers, which may not be considered as areas of groundwater conducive to the locations of public water supplies. Please refer to the MCP guidelines for the definitions of these areas.

DEP APPROVED ZONE II's: MA DEP, 1:25,000. As stated in 310 CMR 22.02 'that area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated.' Digitized from data provided to DEP in approved hydrologic engineering reports. Data is updated continuously.

INTERIM WELLHEAD PROTECTION AREAS: DEP-DWS (Division of Water Supply), 1:25,000. These polygons represent an interim Zone II for a groundwater source until an actual one is approved by the DEP Division of Water Supply. The radius of an IWPA varies according to the approved pumping rate. Updated in parallel with the Public Water Supplies data.

PUBLIC WATER SUPPLIES: DEP-DWS, 1:25,000. Community and non-community surface and withdrawal points were field collected using Global Positioning System receivers. The attributes were added from the DEP Division of Water Supply database. Continuously updated.

HYDROGRAPHY: USGS/MassGIS. 1:25,000 USGS Digital Line Graph (DLG) data modified by MassGIS. Approximately 40% of the data was provided by USGS and MassGIS created the remainder to USGS specifications. Source dates 1977-1997.

DRAINAGE BASINS: USGS-WRD/MassGIS, 1:24,000. Automated by MassGIS from USGS Water Resources Division manuscripts with approximately 2400 sub-basins as interpreted from 1:24,000 USGS quadrangle contour lines. 1987-1993.

WETLANDS: Umass Amherst RMP/MassGIS, 1:25,000. Includes nonforested wetlands extracted from the 1971-1991 Land Use datalayer, which was photointerpreted from summer CIR photography. Interpretation was not done in stereo. Also includes, in most areas, forested wetlands from USGS Digital Line Graph (DLG) data.

PROTECTED OPEN SPACE: EOEA (Executive Office of Environmental Affairs) MassGIS, 1:25,000. Includes federal, state, county, municipal, non-profit and protected private conservation and outdoor recreation lands. Ongoing updates.

ACECs: DEM, 1:25,000. Areas of Critical Environmental Concern are areas designated by the Secretary of EOEA as having a number of valuable environmental features coexisting. Projects in ACECs are subject to the highest standards of review and performance. Last updated October 1996.

ROADS: USGS/MassGIS/MHD, 1:100,000. MassGIS extracted roads from the USGS Transportation DLG files. MA Highway Dept. updated roads through 1999. MassGIS and MA DEP GIS group further edited this layer. Numbered routes are part of the state, U.S. or Interstate highway systems.

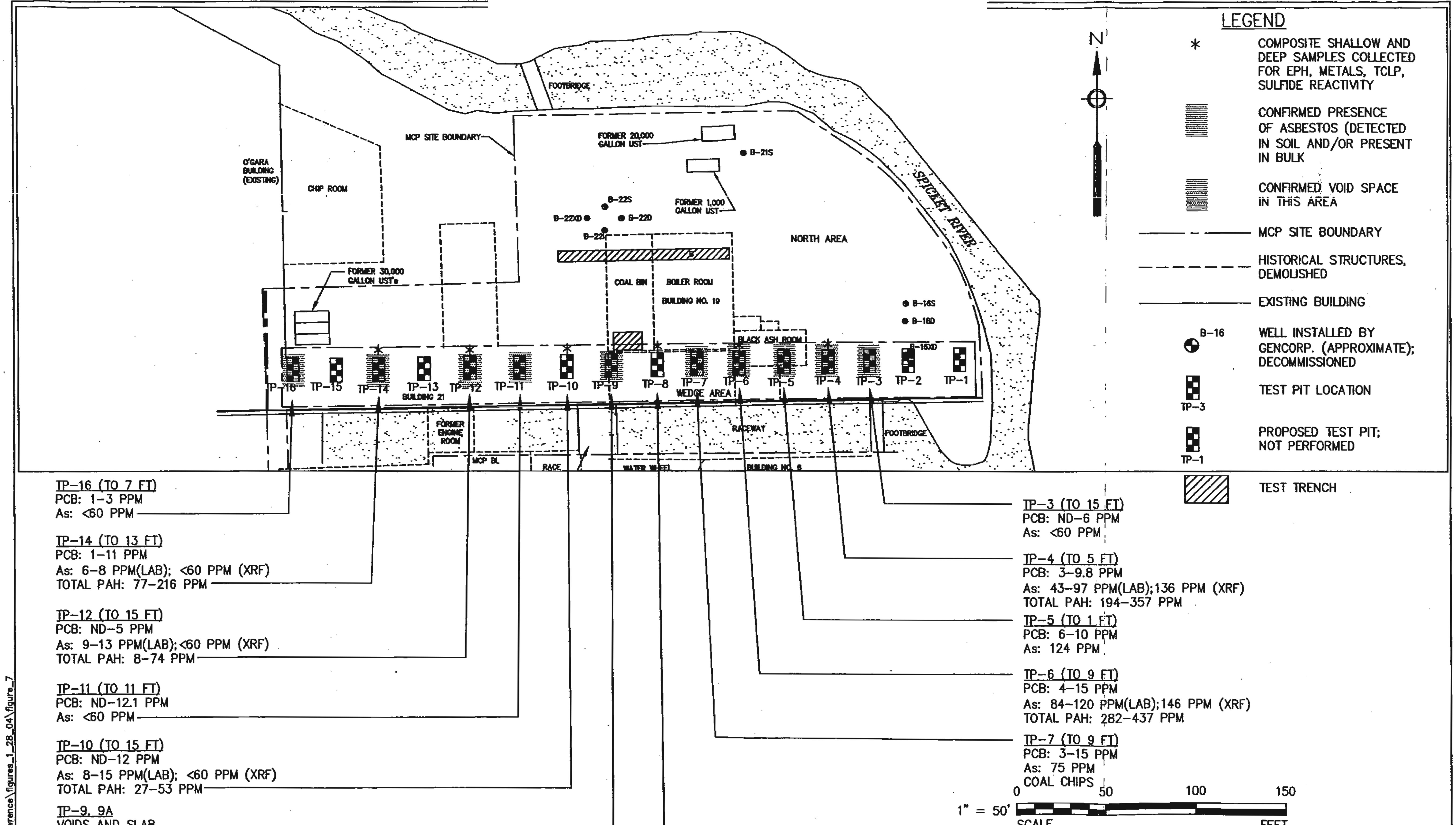
POLITICAL BOUNDARIES: MassGIS/USGS, 1:25,000. This datalayer was digitized by MassGIS from mylar USGS quads. Source date is approximately 1985.

DEP PERMITTED SOLID WASTE FACILITIES: DEP-DSW (Division of Solid Waste), 1:25,000. Includes only facilities regulated since 1971. Data includes sanitary landfills, transfer stations and recycling or composting facilities. Facility boundaries were compiled or approximate facility point locations drafted onto USGS quadrangles and automated by the DEP Division of Solid Waste. Last updated 1997.

NHESP ESTIMATED HABITATS OF RARE WETLANDS WILDLIFE: Polygons show estimated habitats for all processed occurrences of rare wetlands wildlife. Data collected by Natural Heritage & Endangered Species Program and compiled at 1:24,000 or 1:25,000 scale. For use with Wetlands Protection Act Only. Effective 1999 - 2001.

NHESP CERTIFIED VERNAL POOLS: Points show all vernal pools certified by NHESP/MADFW (Fisheries and Wildlife) as of June 30, 1999. Data compiled at 1:24,000 or 1:25,000 scale. Effective 1999 - 2001.

Last revised: 2000



TP-16 (TO 7 FT)
PCB: 1-3 PPM
As: <60 PPM

TP-14 (TO 13 FT)
PCB: 1-11 PPM
As: 6-8 PPM(LAB); <60 PPM (XRF)
TOTAL PAH: 77-216 PPM

TP-12 (TO 15 FT)
PCB: ND-5 PPM
As: 9-13 PPM(LAB); <60 PPM (XRF)
TOTAL PAH: 8-74 PPM

TP-11 (TO 11 FT)
PCB: ND-12.1 PPM
As: <60 PPM

TP-10 (TO 15 FT)
PCB: ND-12 PPM
As: 8-15 PPM(LAB); <60 PPM (XRF)
TOTAL PAH: 27-53 PPM

TP-9, 9A
VOIDS AND SLAB
NEAR SURFACE

TP-8 (TO 13 FT)
PCB: ND-10 PPM
As: 4-8 PPM(LAB); <60 PPM (XRF)
TOTAL PAH: 36-192 PPM
LIME
COAL CHIPS

TP-3 (TO 15 FT)
PCB: ND-6 PPM
As: <60 PPM

TP-4 (TO 5 FT)
PCB: 3-9.8 PPM
As: 43-97 PPM(LAB); 136 PPM (XRF)
TOTAL PAH: 194-357 PPM

TP-5 (TO 1 FT)
PCB: 6-10 PPM
As: 124 PPM

TP-6 (TO 9 FT)
PCB: 4-15 PPM
As: 84-120 PPM(LAB); 146 PPM (XRF)
TOTAL PAH: 282-437 PPM

TP-7 (TO 9 FT)
PCB: 3-15 PPM
As: 75 PPM
COAL CHIPS

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OXFORD PAPER MILL, - LAWRENCE, MA
FIGURE 5
MAY 2002 INVESTIGATION RESULTS (WEDGE AREA)

SCALE: 1"=50' | 3/17/04 | DEH

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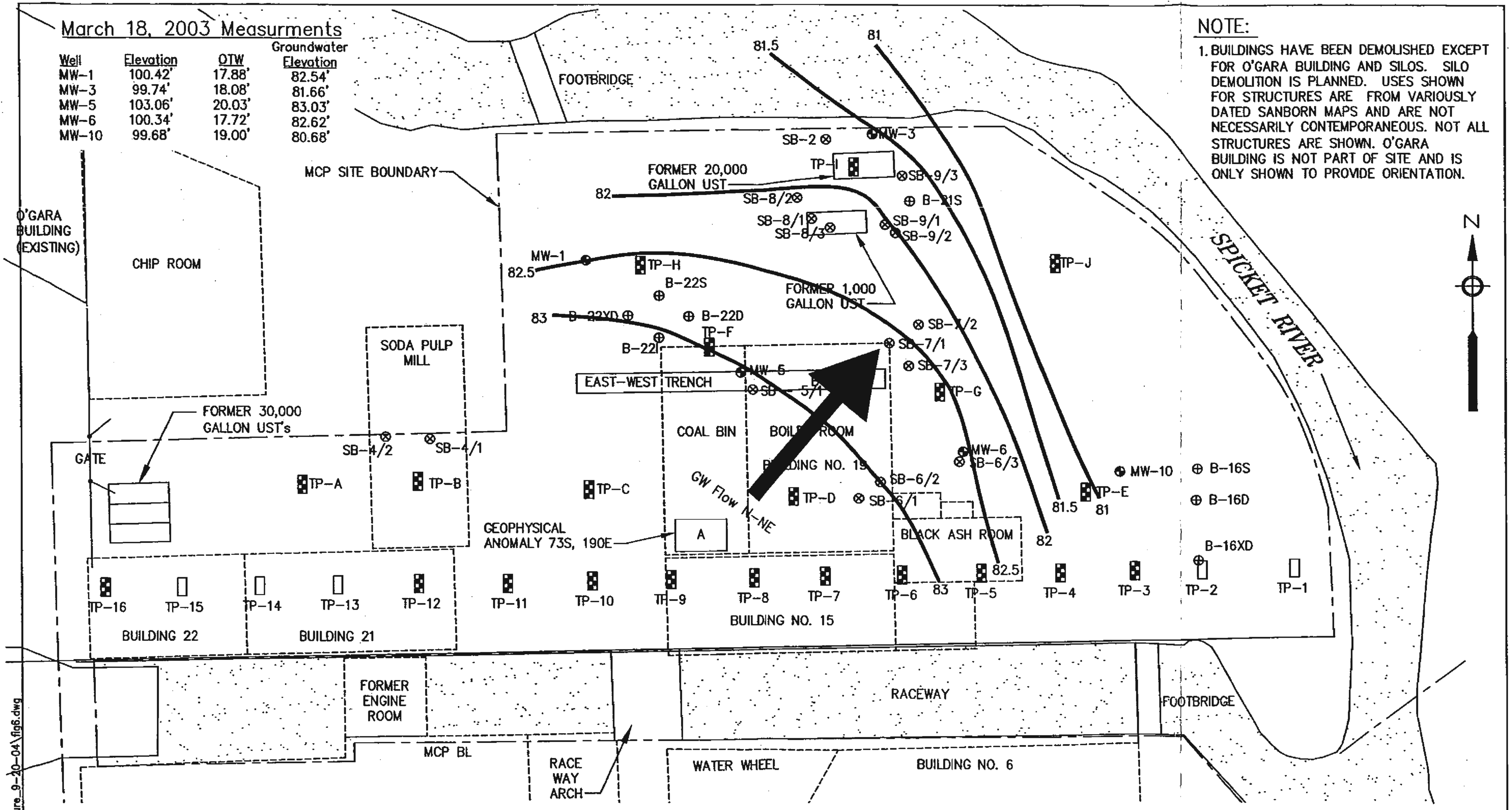


March 18, 2003 Measurments

Well	Elevation	OTW	Groundwater Elevation
MW-1	100.42'	17.88'	82.54'
MW-3	99.74'	18.08'	81.66'
MW-5	103.06'	20.03'	83.03'
MW-6	100.34'	17.72'	82.62'
MW-10	99.68'	19.00'	80.68'

NOTE:

1. BUILDINGS HAVE BEEN DEMOLISHED EXCEPT FOR O'GARA BUILDING AND SILOS. SILO DEMOLITION IS PLANNED. USES SHOWN FOR STRUCTURES ARE FROM VARIOUSLY DATED SANBORN MAPS AND ARE NOT NECESSARILY CONTEMPORANEOUS. NOT ALL STRUCTURES ARE SHOWN. O'GARA BUILDING IS NOT PART OF SITE AND IS ONLY SHOWN TO PROVIDE ORIENTATION.

LEGEND

— —	MCP SITE BOUNDARY
– – – –	HISTORICAL STRUCTURES, DEMOLISHED
——	EXISTING BUILDING
● MW-1	MONITORING WELL LOCATION
⊗ SB-7/1	SOIL BORING LOCATION (/1 FIRST ATTEMPT, /2 SECOND ATTEMPT, /3 THIRD ATTEMPT
⊕ B-16D	WELL INSTALLED BY GENCORP. (APPROXIMATE); DECOMMISSIONED
☐	WEDGE AREA TEST PITS NOT COMPLETED DUE TO ACM OR SLOPE
▩	WEDGE AREA TEST PITS COMPLETED (2002)
▩	NORTH OF WEDGE AREA TEST PITS (2003)

1" = 30'
0 30 60
SCALE FEET

Shaw® Shaw Environmental, Inc.

SHAW ENVIRONMENTAL OXFORD PAPER MILL SITE
SUBSURFACE INVESTIGATION – LAWRENCE, MASSACHUSETTS

FIGURE 6 – GROUNDWATER FLOW MAP – MARCH 18, 2003

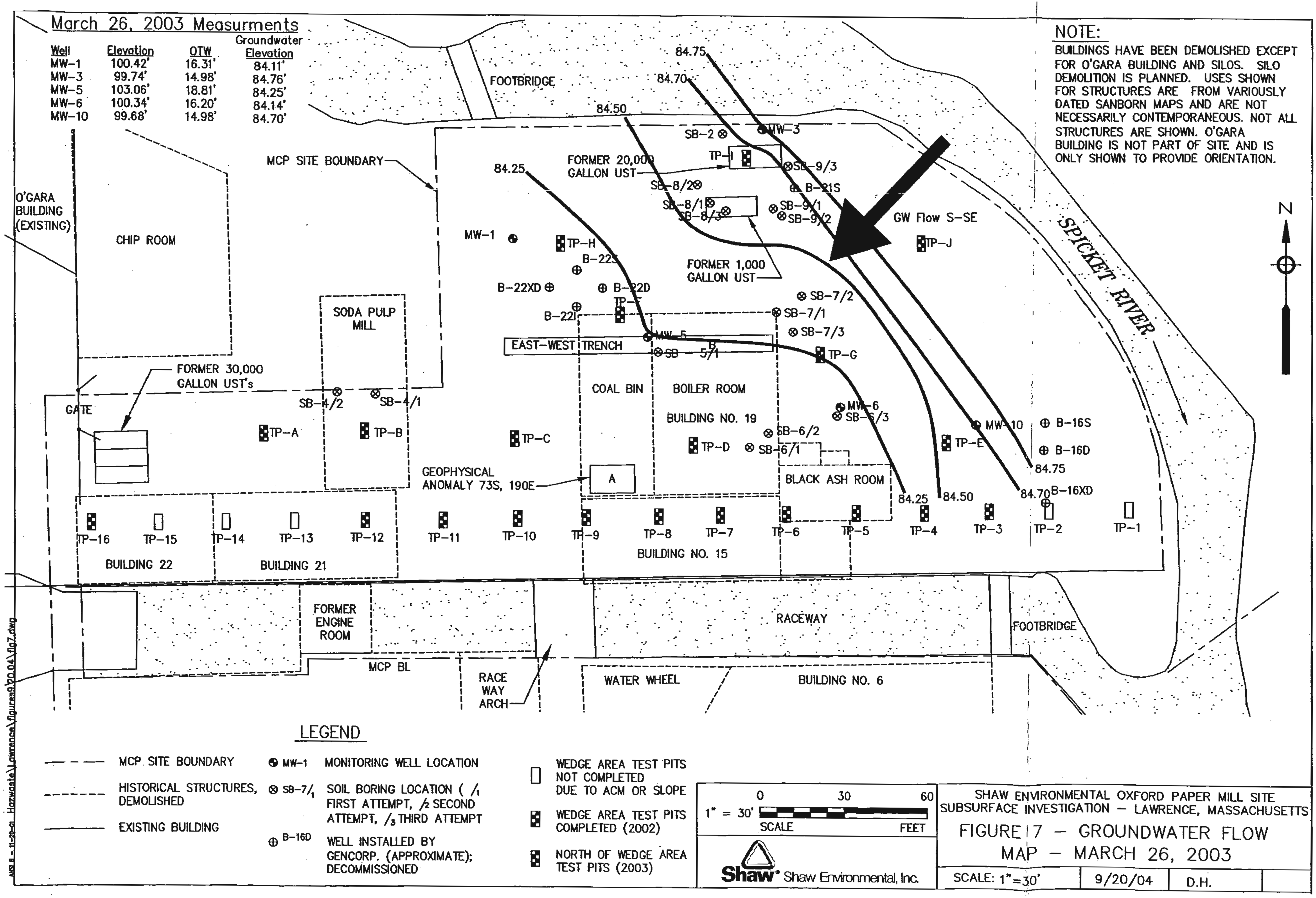
SCALE:	1"=30'	3/9/04	S.N.

AHS B - 11-20-01 Hazwaste\Lawrence\figure_9-20-04\fig6.dwg

March 26, 2003 Measurments

Well	Elevation	OTW	Groundwater Elevation
MW-1	100.42'	16.31'	84.11'
MW-3	99.74'	14.98'	84.76'
MW-5	103.06'	18.81'	84.25'
MW-6	100.34'	16.20'	84.14'
MW-10	99.68'	14.98'	84.70'

NOTE:
BUILDINGS HAVE BEEN DEMOLISHED EXCEPT FOR O'GARA BUILDING AND SILOS. SILO DEMOLITION IS PLANNED. USES SHOWN FOR STRUCTURES ARE FROM VARIOUSLY DATED SANBORN MAPS AND ARE NOT NECESSARILY CONTEMPORANEOUS. NOT ALL STRUCTURES ARE SHOWN. O'GARA BUILDING IS NOT PART OF SITE AND IS ONLY SHOWN TO PROVIDE ORIENTATION.

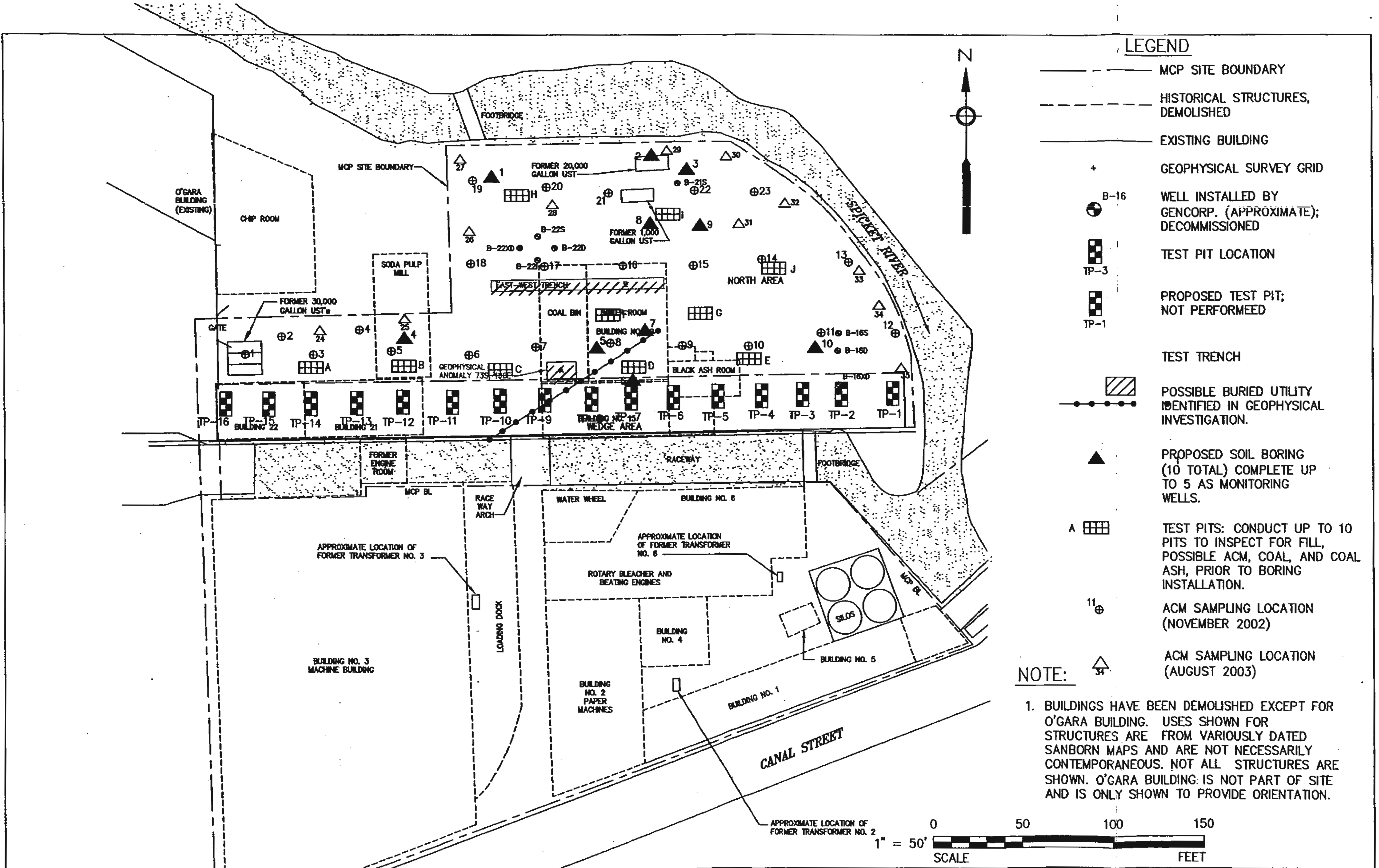


Shaw Environmental, Inc.

SHAW ENVIRONMENTAL OXFORD PAPER MILL SITE
SUBSURFACE INVESTIGATION – LAWRENCE, MASSACHUSETTS

FIGURE 7 – GROUNDWATER FLOW MAP – MARCH 26, 2003

SCALE: 1"=30'	9/20/04	D.H.



LEGEND

— - —	MCP SITE BOUNDARY
- - - -	HISTORICAL STRUCTURES, DEMOLISHED
——	EXISTING BUILDING
+	GEOPHYSICAL SURVEY GRID
B-16	WELL INSTALLED BY GENCORP. (APPROXIMATE); DECOMMISSIONED
TP-3	TEST PIT LOCATION
TP-1	PROPOSED TEST PIT; NOT PERFORMEED
▨	TEST TRENCH
—●—●—	POSSIBLE BURIED UTILITY IDENTIFIED IN GEOPHYSICAL INVESTIGATION.
▲	PROPOSED SOIL BORING (10 TOTAL) COMPLETE UP TO 5 AS MONITORING WELLS.
A ▦	TEST PITS: CONDUCT UP TO 10 PITS TO INSPECT FOR FILL, POSSIBLE ACM, COAL, AND COAL ASH, PRIOR TO BORING INSTALLATION.
11⊕	ACM SAMPLING LOCATION (NOVEMBER 2002)
△34	ACM SAMPLING LOCATION (AUGUST 2003)

NOTE:

1. BUILDINGS HAVE BEEN DEMOLISHED EXCEPT FOR O'GARA BUILDING. USES SHOWN FOR STRUCTURES ARE FROM VARIOUSLY DATED SANBORN MAPS AND ARE NOT NECESSARILY CONTEMPORANEOUS. NOT ALL STRUCTURES ARE SHOWN. O'GARA BUILDING IS NOT PART OF SITE AND IS ONLY SHOWN TO PROVIDE ORIENTATION.

Shaw® Shaw Environmental, Inc.

OXFORD PAPER MILLS, LAWRENCE, MA

FIGURE 8 –ASBESTOS SOIL SAMPLING LOCATIONS (NOV. 2002 / AUG. 2003)

SCALE: 1"=50' | 3/16/04 | DEH

3/17/04 L:\Hazwaste\Lawrence\figure_1_28_04\figure_8

TABLES

Table 3-1 - Monitoring Well Development Information for MW-1, MW-3, and MW-5 from March 2003 Site Investigation

			MW-1				
Time	Flow Rate (mL/min)	pH	Specific Conductivity (µs/cm)	Turbidity (NTU)	Temp (^{0}C)	Purge Volume (gallons)	Water Level (feet)
8:45	600	6.29	1156	>1000	9.0		18.10
8:58	600	6.31	1194	500	11.5		18.15
9:05	600	6.28	1230	11.0	11.7	9.0	18.20
9:10	600	6.28	1241	9.30	11.7	12.0	18.18

			MW-3				
Time	Flow Rate (mL/min)	pH	Specific Conductivity (µs/cm)	Turbidity (NTU)	Temp (^{0}C)	Purge Volume (gallons)	Water Level (feet)
9:25	700	6.42	1425	170	10.4		18.00
9:30	700	6.42	1479	33.0	10.7		19.98
9:40	700	6.41	1537	5.40	11.6		20.01
9:45	960	6.43	1542	13.0	13.8	6.0	20.45
10:00	960	6.45	1483	150	13.3	10.0	21.10

			MW-5				
Time	Flow Rate (mL/min)	pH	Specific Conductivity (µs/cm)	Turbidity (NTU)	Temp (^{0}C)	Purge Volume (gallons)	Water Level (feet)
10:15	Black dark silt						19.95
10:25	900	5.88	527	450	13.0		22.00
10:30	480	5.84	624	>1000	13.6	5.0	24.63
10:38	Out of Water - Letting Well Recharge						
10:50	600	5.63	588	>1000	15.4	7.0	22.25
11:00	600	5.67	600	500	15.7	8.0	23.92
11:05	600	5.67	600	170	15.8	9.0	24.22
11:10	Out of Water - Letting Well Recharge						
11:13	600	5.67	600	150	15.8	9.5	22.15
11:15	600	5.67	600	170	15.8		23.57
11:17	450	5.67	600	170	15.8	10.0	24.62

Table 3-1 Cont. - Monitoring Well Development Information for MW-6 and MW-10 from March 2003 Site Investigation

			MW-6				
Time	Flow Rate (mL/min)	pH	Specific Conductivity (µs/cm)	Turbidity (NTU)	Temp (⁰C)	Purge Volume (gallons)	Water Level (feet)
11:12	850	6.86	1433	85.0	14.8		17.93
11:30	850	6.86	1433	85.0	14.7		18.35
11:35	720	7.00	1462	11.0	14.0	3.0	18.63
11:40	600	7.05	1472	190	14.0	3.5	19.20
11:50	650	7.21	1491	750	13.0	3.8	23.30
11:52	Letting Well Recharge						
12:03	480	7.34	1523	75.0	13.0	4.0	20.78
12:08	Out of Water - Letting Well Recharge						
13:00	660	7.36	1539	11	22.0	4.2	18.52
13:08	Out of Water						

			MW-10				
Time	Flow Rate (mL/min)	pH	Specific Conductivity (µs/cm)	Turbidity (NTU)	Temp (⁰C)	Purge Volume (gallons)	Water Level (feet)
14:40	Black silt and oil mixture				13.0		14.90
14:50	300	7.0	1400	25.1	13.0		14.90
14:55	320	7.0	1350	20.2	13.0		14.90
15:02	320	7.0	1200	47.9	13.0		14.90
15:08	320	7.0	780	25.2	13.0	4.0	14.90

Table 3-2 - Monitoring Well Sampling Information for MW-1 and MW-3 from March 2003 Site Investigation (Low Flow Sampling)

MW-1

Time	Water Level (feet)	pH	ORP (mV)	Temp (^{0}C)	Specific Conductivity (µs/cm)	DO (mg/L)	Turbidity (NTU)	Flow Rate (mL/min)
10:33	16.31	6.80	-93.1	13.16	976	1.83	2.21	210
10:43	16.33	6.11	-75.7	13.23	870	0.61	1.71	210
10:51	16.33	6.06	-75.7	13.23	872	0.52	1.62	215
10:56	16.33	6.07	-77.4	13.31	875	0.49	1.04	220
11:01	16.33	6.04	-76.1	13.25	878	0.45	1.02	215
11:06	16.33	6.07	-77.9	13.32	878	0.42	1.02	220
11:12	16.33	6.03	-76.7	13.37	880	0.4	1.01	220
11:17	16.33	6.04	-78.2	13.44	883	0.38	1.02	220
11:27	16.33	6.04	-78.7	13.46	885	0.37	1.02	220

MW-3

Time	Water Level (feet)	pH	ORP (mV)	Temp (^{0}C)	Specific Conductivity (µs/cm)	DO (mg/L)	Turbidity (NTU)	Flow Rate (mL/min)
9:00	14.41	6.49	56.3	12.24	1814	7.48	11.80	120
9:10	14.41	6.71	0.10	12.13	1776	6.67	10.40	125
9:15	14.41	6.76	-18.1	11.74	1720	6.34	7.50	140
9:20	14.41	6.76	-25.8	11.51	1695	6.13	7.10	158
9:25	14.45	6.76	-35.7	11.08	1656	5.86	6.70	180
9:30	14.45	6.76	-39.8	10.89	1637	5.64	6.20	196
9:35	14.50	6.76	-40.8	10.77	1626	5.56	7.10	210
9:40	14.50	6.77	-39.0	10.71	1624	5.60	5.20	210
9:45	14.50	6.77	-36.4	10.66	1612	5.66	4.50	210
9:50	14.50	6.76	-33.9	10.71	1606	6.02	3.90	210

Table 3-2 Cont. - Monitoring Well Sampling Information for MW-5 and MW-6 from March 2003 Site Investigation (Low Flow Sampling)

MW-5

Time	Water Level (feet)	pH	ORP (mV)	Temp (°C)	Specific Conductivity (µs/cm)	DO (mg/L)	Turbidity (NTU)	Flow Rate (mL/min)
11:20	19.23	5.02	138.3	13.67	449	0.92	2.70	74
11:30	19.25	5.03	127.5	13.92	448	0.78	2.40	78
11:40	19.26	5.05	112.1	13.73	449	0.65	2.00	84
11:45	19.28	5.04	95.8	13.72	448	0.55	1.60	86
11:50	19.28	5.04	84.6	14.17	448	0.54	1.49	78
11:55	19.28	5.05	71.4	13.88	450	0.53	1.22	78
12:05	19.28	5.04	52.8	13.76	450	0.50	1.21	78
12:10	19.28	5.05	42.2	14.07	450	0.47	1.18	78
12:15	19.28	5.07	32.2	14.14	451	0.46	1.19	80
12:20	19.28	5.06	26.7	14.09	451	0.45	1.15	80
12:23	19.28	5.06	22.4	14.11	451	0.45	1.30	80

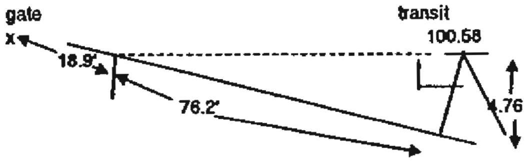
MW-6

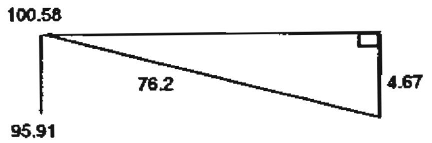
Time	Water Level (feet)	pH	ORP (mV)	Temp (°C)	Specific Conductivity (µs/cm)	DO (mg/L)	Turbidity (NTU)	Flow Rate (mL/min)
9:20	16.68	7.07	168.6	11.61	1491	15.4	9.24	86
9:25	16.71	7.09	147.4	11.60	1491	1.49	8.20	112
9:30	16.75	7.10	109.0	11.47	1489	1.35	7.22	110
9:40	16.82	7.11	34.3	11.34	1484	1.12	7.15	84
9:50	Peristaltic pump shoved surgical tubing out and disconnected teflon tubing - a lot of air introduced into the system							
10:00	16.82	7.12	-38.3	11.52	1481	1.26	5.89	94
10:05	16.83	7.11	-67.8	11.30	1483	1.08	6.32	94
10:10	16.84	7.11	-74.5	11.28	1482	1.02	4.98	96
10:20	16.86	7.09	-53.9	11.38	1474	0.99	4.36	100
10:25	16.88	7.08	-45.3	11.19	1465	0.94	3.46	100
10:30	16.88	7.07	-38.0	11.25	1459	0.92	3.13	88
10:33	16.88	7.06	-37.7	11.31	1459	0.91	3.06	88
10:36	16.88	7.06	-44.0	11.23	1456	0.90	3.23	90

Table 3-2 Cont. - Monitoring Well Sampling Information for MW-10 from March 2003 Site Investigation (Low Flow Sampling)

				MW-10				
Time	Water Level (feet)	pH	ORP (mV)	Temp (^{0}C)	Specific Conductivity (µs/cm)	DO (mg/L)	Turbidity (NTU)	Flow Rate (mL/min)
11:10	14.30	7.28	18.4	12.55	559	6.01	1.81	142
11:17	14.32	7.00	23.2	12.05	504	5.52	3.42	154
11:22	14.32	6.96	25.1	11.82	501	5.39	2.92	166
11:27	14.32	6.95	26.0	11.58	496	5.31	3.56	170
11:32	14.32	6.94	26.5	11.25	493	5.32	2.94	248
11:37	14.35	6.92	26.9	11.16	491	5.27	4.25	220
11:42	14.33	6.92	28.1	11.35	493	5.26	2.30	178
11:47	14.32	6.92	28.3	11.47	494	5.26	2.27	182
11:52	14.32	6.92	29.2	11.49	494	5.27	1.52	192

Table 3-3 - LAWRENCE, MA - OXFORD PAPER MILL 3/28/03 - FIELD SURVEY									Quantitative		Qualatative		
Shot #	Hor. Angle (Az. Angle)	Rod (ft.)	Stadia (Ft.)		Stadia Difference	Shot Dist. (x100) (ft.)	Comments	Elevation (ft.)	GW depth below top pvc (ft) 3/26/03	GW Elev. (ft) 3/26/2003	GW depth below top pvc (ft) 3/18/03	GW Elev. (ft) 3/18/2003	Difference between top of steel case and top pvc
			High	Low									
0	-	4.76	-	-	-	-	Transit Station 1	100.58					
1	0	5.34	5.83	4.85	0.98	98	SE crn O'Gara Bldg	100					
2	96	7.82	8.41	7.23	1.18	118	cl ft. bridge/Spicket	97.52					
3	118	4.92	5.35	4.51	0.84	84	mw-1 pvc (grade 7.08)	100.42	16.31	84.11	17.88	82.54	0.24
4	125	6.06	6.56	5.59	0.97	97	tp-h	99.28					
5	124	7.00	7.86	6.19	1.67	167	SB-2	98.34					
6	126	5.60	6.50	4.70	1.80	180	mw-3 pvc (grade 7.34)	99.74	14.98	84.76	18.08	81.66	0.26
7	128	6.41	7.24	6.54	1.70	170	tp-l	98.93					
8	131	4.88	5.67	4.16	1.51	151	SB-8/1	100.46					
9	128	5.66	6.40	4.90	1.50	150	SB-8/2	99.68					
10	132.5	4.64	5.42	3.87	1.55	155	SB-8/3	100.7					
11	134.5	5.26	6.14	4.43	1.71	171	SB-9/1	100.08					
12	136	5.23	6.11	4.38	1.73	173	sb-9/2	100.11					
13	131	6.66	7.60	5.78	1.82	182	sb-9/3	98.68					
14	145	5.28	5.11	4.42	0.69	69	sb-7/1	100.06					
15	145.5	5.00	5.85	4.13	1.72	172	sb-7/2	100.34					
16	150	5.30	6.14	4.47	1.67	167	sb-7/3	100.04					
17	153	6.20	7.04	5.28	1.76	176	tp-g	99.14					
18	148	2.28	2.88	1.73	1.15	115	mw-5 pvc (grade 4.38)	103.06	18.81	84.25	20.03	83.03	0.2
19	150.5	4.94	5.55	4.37	1.18	118	SB-5/1	100.4					
20	143	4.64	5.20	4.13	1.07	107	tp-f	100.7					
21	159	5.00	5.95	4.12	1.83	183	mw-6 pvc (grade 6.40)	100.34	16.2	84.14	17.72	82.62	0.5
22	165	6.36	7.15	5.63	1.52	152	sb-6/1	98.98					
23	162.5	6.66	7.44	5.86	1.58	158	sb-6/2	98.68					
24	160	6.86	7.82	6.00	1.82	182	sb-6/3	98.48					
25	160	5.66	6.84	4.52	2.32	232	mw-10 pvc (grade 8.0)	99.68	14.98	84.7	19	80.68	0.25
26	161.5	8.31	9.42	7.20	2.22	222	tp-e	97.03			+		
27	143	5.50	6.56	4.38	2.18	218	tp-j	99.84					
28	167	10.76	12.12	9.50	2.62	262	cl ft. bridge/raceway	94.58					
29	166	5.00	5.65	4.33	1.32	132	tp-d	100.34					
30	196	3.23	3.76	2.68	1.08	108	cl arch/raceway	102.11					
31	172.5	5.12	5.46	4.77	0.69	69	tp-c	100.22					
32	209	4.14	4.24	4.03	0.21	21	tp-b	101.2					
33	299	3.92	4.07	3.78	0.29	29	tp-a	101.42					
34	168	4.36	4.45	4.28	0.17	17	sb-4/1	100.98					
35	199	4.60	4.62	4.58	0.04	4	sb-4/2	100.74					
36	324	-2.00				89	well 24s	107.34					
37	357	1.54	1.92	1.16	0.76	76	well 12s	103.8					
38	99.5	7.82	8.38	7.20	1.18	118	tie round cl ft bridge/spi	97.52					
39	95	19.39	19.91	18.83	1.08	108	Spicket elev 1600 green rail	85.95	elev. Spicket River at 1600 here	85.95			
40	95	7.69	8.17	7.23	0.94	94	pl spicket ne crn	97.65					
41	107.5	7.51	7.89	7.17	0.72	72	pl east	97.83					
42	130	5.90	6.18	5.60	0.58	58	pl so. east Crn	99.44					
43	330				0.00	95	cl gate - see below	105.34					





4.67'/76.2'= 0.061286 slope
*18.9'

1.16' rise
elevation at gate = 100.58+1.16 = 101.74

Table 5-1 - November 2002/August 2003 ACM Soil Sampling Events Results

Sample Number*	Reported Value (%)
1	Not Detected
2	Not Detected
3	Less than 1.0
4	1.3
5	Not Detected
6	1.2
7	1.8
8	Less than 1.0
9	Not Detected
10	1.3
11	Not Detected
12	Not Detected
13	Not Detected
14	Less than 1.0
15	Less than 1.0
16	1.3
17	Less than 1.0
18	1.4
19	Not Detected
20	1.3
21	Not Detected
22	1.3
23	Not Detected
24	Less than 1.0
25	Not Detected
26	Less than 1.0
27	Less than 1.0
28	2.9
29	Less than 1.0
30	Less than 1.0
31	1.5
32	Less than 1.0
33	Not Detected
34	Not Detected
35	Less than 1.0

* Refer to Figure 8 for the corresponding asbestos sampling locations (November 2002/August 2003)

Pit	Horizon	Mobile Labo		ent Difference for Detections**		
		PCBs (mg/k		e and OEME Fixed Labs		
		Aroclor 1254	Aroclor 1242	Aroclor 1242	Aroclor 1260	Aroclor 1248
3	A	1 U	2 U	NC	NC	NC
	KA	1 U	2 U	NC	NC	NC
	B	1 U	2 U	NC	NC	NC
	C	1 U	1 U	NC	NC	NC
	D	1 U	1 U	NC	NC	NC
	E	0.6	1 U	NC	NC	NC
	F	1 U	1 U	NC	NC	NC
	G	1 U	1 U	NC	NC	NC
	H	1 U	1 U	NC	NC	NC
4	A	1 U	1 U	NC	NC	NC
	B	0.9	1 U	NC	NC	NC
	C	2.8	1 U	NC	NC	NC
	KC	--	--	NC	NC	NC
5	A	2 U	3 U	NC	NC	NC
	KA	2 U	3 U	NC	NC	NC
6	A	1.5 U	2 U	NC	NC	NC
	B	1.5 U	8 U	NC	NC	NC
	C	1.5 U	4 U	NC	NC	NC
	D	2 U	2 U	NC	NC	NC
	E	2 U	4 U	NC	NC	NC
7	A	1 U	2 U	NC	NC	NC
	B	2 U	5 U	NC	NC	NC
	C	2 U	2 U	NC	NC	NC
	D	2 U	3 U	NC	NC	NC
	E	2 U	3 U	NC	NC	NC
8	A	1 U	2 U	NC	NC	NC
	B	1 U	1 U	NC	NC	NC
	C	2 U	2 U	NC	NC	NC
	D	2 U	4 U	NC	NC	NC
	E	3 U	5 U	NC	NC	NC
	F	3 U	5 U	NC	NC	NC
	G	2 U	2 U	NC	NC	NC
10	A	1 U	1 U	NC	NC	NC
	B	2 U	2 U	NC	NC	NC
	C	1 U	1 U	NC	NC	NC
	KC	1 U	1 U	NC	NC	NC
	D	3 U	5 U	NC	NC	NC
	E	1 U	1 U	NC	NC	NC
	F	1 U	1 U	NC	NC	NC
	G	1 U	1 U	NC	NC	NC
	H	10 U	10 U	NC	NC	NC
11	A	1 U	1 U	NC	NC	NC
	B	2.1	4 U	NC	NC	NC
	C	2 U	2 U	NC	NC	NC
	D	3 U	4 U	NC	NC	NC
	E	2 U	2 U	NC	NC	NC
	F	1 U	1 U	NC	NC	NC
12	A	1 U	1 U	NC	NC	NC
	B	1 U	1 U	NC	NC	NC
	C	1 U	1 U	NC	NC	NC

Table 5-2. Oxford Paper Mill Site: Mobile Lab and Fixed Lab Analytical Results: PCBs

Pit	Horizon	Mobile Laboratory Results				OEME Fixed Laboratory Results					Mobile Laboratory Results				Relative Percent Difference for Detections**			
		PCBs (mg/kg wet weight)				PCBs (mg/kg dry weight)					PCBs (mg/kg dry weight)*				Mobile and OEME Fixed Labs			
		Aroclor 1254	Aroclor 1242	Aroclor 1260	Aroclor 1248	Aroclor 1254	Aroclor 1242	Aroclor 1260	Aroclor 1248	Percent Solids	Aroclor 1254	Aroclor 1242	Aroclor 1260	Aroclor 1248	Aroclor 1254	Aroclor 1242	Aroclor 1260	Aroclor 1248
	D	1 U	1 U	0.5 U	2 U	0.13	0.1 U	0.1 U	0.12	87	1 U	1 U	0.6 U	2 U	NC	NC	NC	NC
	E	1 U	1 U	0.5 U	2 U	--	--	--	--	--	--	--	--	--	NC	NC	NC	NC
	F	1 U	1 U	0.5 U	2 U	--	--	--	--	--	--	--	--	--	NC	NC	NC	NC
	G	1 U	1 U	0.5 U	4-5 PD	--	--	--	--	--	--	--	--	--	NC	NC	NC	NC
	H	3.1	5 U	0.5 U	10 U	**16**	2.3 U	2.3 U	2.3 U	81	**3.8**	6 U	0.6 U	12 U	**-123**	NC	NC	NC
14	A	1 U	1 U	0.5 U	4-5 PD	--	--	--	--	--	--	--	--	--	NC	NC	NC	NC
	B	1 U	2 U	0.5 U	2-3 PD	--	--	--	--	--	--	--	--	--	NC	NC	NC	NC
	C	2 U	6 J	0.5 U	4-5 PD	0.5 U	0.5 U	0.5 U	**6.0**	86	2 U	7 J	0.6 U	**5-6 PD**	NC	NC	NC	**0 to 18**
	D	1 U	1 U	0.5 U	1-2 PD	--	--	--	--	--	--	--	--	--	NC	NC	NC	NC
	E	1 U	1 U	0.5 U	1-2 PD	--	--	--	--	--	--	--	--	--	NC	NC	NC	NC
	F	1 U	1 U	0.5 U	2-3 PD	--	--	--	--	--	--	--	--	--	NC	NC	NC	NC
	G	1 U	2 U	0.5 U	2-3 PD	0.37	0.2 U	0.2 U	**0.44**	83	1 U	2 U	0.6 U	**2-4 PD**	NC	NC	NC	**130 to 160**
16	A	1 U	1 U	0.5 U	1-2 PD	--	--	--	--	--	--	--	--	--	NC	NC	NC	NC
	B	1 U	2 U	0.5 U	2-3 PD	0.58	0.2 U	0.2 U	**1.2**	86	1 U	2 U	0.6 U	**2-3 PD**	NC	NC	NC	**50 to 86**
	C	1 U	2 U	0.5 U	2-3 PD	--	--	--	--	--	--	--	--	--	NC	NC	NC	NC
	D	1 U	2 U	0.5 U	2-3 PD	--	--	--	--	--	--	--	--	--	NC	NC	NC	NC

NOTES:

*	Mobile laboratory results were converted to dry weight basis using the corresponding percent solids for that sample reported by the fixed laboratory. The calculated dry weight value was rounded to the same number of significant figures as the wet weight mobile laboratory result.
**	Relative percent difference between mobile laboratory result (after conversion to dry weight basis) and fixed laboratory result. RPD only calculated when both mobile laboratory and fixed laboratory reported a detection for a particular Aroclor. When the mobile laboratory reported a range, a range of RPDs was calculated.
NC	Relative percent difference not calculated, either due to non-detects, or no corresponding fixed laboratory sample analysis.
--	Sample not submitted for this analysis, or conversion to dry weight not possible due to no corresponding fixed laboratory analysis.
U	Not detected; value is the reporting limit
PD	Partially degraded
BOLD	Value is used to calculate RPD, or is an RPD value.

Table 5-3. Oxford Paper Mill Site: Asbestos Analytical Results

Pit	Horizon	Asbestos			
		Estimated Volume Percent			
		Chrysotile	Amosite	Crocidolite	Total Asbestos
3	A	--	--	--	--
	KA	--	--	--	--
	B	--	--	--	--
	C	--	--	--	--
	D	--	--	--	--
	E	--	--	--	--
	F	--	--	--	--
	G	--	--	--	--
	H	--	--	--	--
	AB Composite	1	<1	2	3
4	A	--	--	--	--
	B	--	--	--	--
	C	--	--	--	--
	AC Composite	4	<1	2	6
5	A	2	1	2	5
	KA	--	--	--	--
6	A	--	--	--	--
	B	--	--	--	--
	C	5	1	2	8
	D	4	1	3	8
	E	2	3	2	7
	AB Composite	3	1	3	7
7	A	--	--	--	--
	B	--	--	--	--
	B (Bulk)	3	30	ND	33
	C	--	--	--	--
	D	--	--	--	--
	E	--	--	--	--
8	A	--	--	--	--
	B	--	--	--	--
	C	--	--	--	--
	D	--	--	--	--
	E	--	--	--	--
	F	--	--	--	--
	G	--	--	--	--
10	A	--	--	--	--
	B	--	--	--	--
	C	--	--	--	--
	KC	--	--	--	--
	D	--	--	--	--
	E	--	--	--	--
	F	--	--	--	--
	G	--	--	--	--
	H	--	--	--	--
11	A	--	--	--	--
	B	--	--	--	--
	C	--	--	--	--
	D	--	--	--	--
	E	--	--	--	--
	F	--	--	--	--
	AC Composite	<1	<1	<1	<1
	DF Composite	3	ND	<1	3
12	A	--	--	--	--
	B	--	--	--	--
	C	<1	<1	<1	<1
	D	<1	<1	ND	<1
	E	<1	ND	<1	<1
	F	<1	<1	<1	<1
	G	<1	<1	<1	<1
	H	<1	<1	<1	<1
	AB Composite	ND	ND	ND	ND
14	A	--	--	--	--
	B	--	--	--	--
	C	<1	ND	ND	<1
	D	<1	<1	ND	<1
	E	<1	<1	ND	<1
	F	<1	<1	ND	<1
	G	<1	<1	<1	<1
	AB Composite	<1	1	<1	1
16	A	--	--	--	--
	B	--	--	--	--
	C	--	--	--	--
	D	--	--	--	--
	AD Composite	<1	<1	ND	<1
	E (Bulk)	ND	ND	ND	0

Notes:

KA = field duplicate

Bulk = sample of bulk suspect ACM, not soil

<1 = ACM present, but concentration is less than 1 percent

ND = not detected

-- = not sampled for ACM

Table 5-4. Summary Of Analytical Data For Composite Samples Analyzed By Woods Hole Group -- Soil
TBA Investigation -- Former Oxford Paper Mill -- May 2002

LOCATION NAME	4S	4D	6S	6D	8S	8D	10S	10D	K10D	12S	12D	14S	14D	MCP Reportable Concentrations **
APPROXIMATE SAMPLE DEPTH (ft bgs)	0 - 3	3 - 5	0 - 3	3 - 9	0 - 3	3 - 13	0 - 3	3 - 15		0 - 3	3 - 15	0 - 3	3 - 13	
M&E SAMPLE ID	4S	4D	4S	6D	8S	8D	10S	10D	K10D	12S	12D	14S	14D	
DATE SAMPLED	5/13/02	5/13/02	5/13/02	5/13/02	5/13/02	5/13/02	5/14/02	5/14/02	5/14/02	5/14/02	5/14/02	5/14/02	5/14/02	
COMMENTS									Duplicate					RCS-1
EXTRACTABLE PETROLEUM HYDROCARBONS - MADEP-EPH-98-1 (mg/kg)														
C_9-C_{18} Aliphatics (1)	3,700 U	3,800 U	3,700 U	4,000 U	4,200 U	15,000	3,500 U	3,600 U	3,600 U	3,300 U	3,400 U	3,600 U	3,500 U	1,000,000
C_{19}-C_{36} Aliphatics (1)	5,200	34,000	57,000	82,000	9,000	65,000	43,000	14,000 J	4,800 UJ	4,300 U	11,000	12,000	35,000	2,500,000
C_{11}-C_{22} Aromatics (1)	240,000	360,000	460,000	320,000	51,000	250,000	74,000	35,000 J	60,000 J	16,000	90,000	260,000	97,000	200,000
Acenaphthene	1,600	6,200	6400	5100	700 U	1000	700	590 U	780 J	540 U	1200	4200	1500	20,000
Acenaphthylene	620 U	1,300 U	1,200 U	660 U	700 U	660 U	580 U	590 U	600 U	540 U	560 U	590 U	560 U	100,000
Anthracene	4,100	11,000	14,000	9,200	1,000	4,300	1,300	930 J	1,900 J	540 U	2,400	7,800	2,900	1,000,000
Benzo(a)anthracene	16,000	29,000	35,000	21,000	2,900	17,000	2,700	1,900 J	4,300 J	540 U	5,400	16,000	5,700	700
Benzo(a)pyrene	14,000	21,000	24,000	16,000	2,400	13,000	2,600	1,800 J	3,500 J	540 U	4,700	13,000	4,700	700
Benzo(b)fluoranthene	17,000	27,000	35,000	23,000	2,300	22,000	2,700	2,000 J	4,500 J	540 U	5,700	17,000	5,300	700
Benzo(g,h,i)perylene	8,500	14,000	13,000	10,000	1,400	7,400	1,500	1,000 J	2,200	540 U	3,000	7,200	2,700	1,000,000
Benzo(k)fluoranthene	9,000	16,000	12,000	8,800	2,300	5,500	2,100	1,300 J	1,500	540 U	2,800	6,500	2,900	7,000
Chrysene	18,000	28,000	38,000	24,000	3,100	18,000	3,100	2,500 J	4,400 J	660	5,700	16,000	5,700	7,000
Dibenzo(a,h)anthracene	13,000	21,000	22,000	16,000	2,300	12,000	2,500	1,900 J	3,300 J	690	4,400	11,000	4,100	700
Fluoranthene	30,000	56,000	74,000	44,000	5,600	28,000	6,300	3,700 J	7,900 J	1,000	12,000	33,000	13,000	1,000,000
Fluorene	1,600	5,100	6,300	4,500	700 U	840	650	590 U	800 J	540 U	1,200	4,600	1,500	400,000
Indeno(1,2,3-cd)pyrene	13,000	21,000	22,000	16,000	2,300	12,000	2,500	1,900 J	3,300 J	690	4,400	11,000	4,100	700
Naphthalene	620 UJ	2,400 J	2,000 J	1,300 J	700 UJ	1,300 J	580 UJ	590 UJ	600 UJ	540 UJ	690 J	2,000 J	800 J	4,000
Phenanthrene	17,000	41,000	58,000	38,000	3,400	20,000	4,400	2,700 J	5,800 J	660	8,000	32,000	9,900	100,000
Pyrene	30,000	56,000	73,000	44,000	5,500	29,000	6,200	3,600 J	7,500 J	1,000	12,000	33,000	12,000	700,000
2-Methylnapthalene	620 U	1,500	1400	980	700 U	790	580 U	590 U	600 U	540 U	560 U	1100	580 U	4,000
Total Target PAHs (mg/kg)***	194	357	437	282	36	192	40	27	53	8	74	216	77	
INORGANICS - Priority Pollutant Metals Plus Barium and Vanadium (mg/Kg)														
Antimony	0.77 J	1.0 J	1.6 J	3.8 J	0.34 J	0.58 J	0.39 J	0.33 J	0.62 J	0.22 J	0.56 J	0.89 J	3.0 J	10
Arsenic	43 J	97 J	120 J	84 J	8.4 J	4.4 J	10 J	15 J	7.7 J	9.3 J	13 J	6.6 J	7.5 J	30
Barium	130	180	150	170	16	300	45	29	39	36	79	140	71	1,000
Beryllium	0.48	0.55	0.62	1.0	0.14	0.52	0.34	0.44	0.59	0.34	0.33	0.28	0.32	0.7
Chromium	32	43	46	50	6.8	13	15	18	19	26	21	27	20	1,000
Cadmium	2.5	2.3	1.9	1.6	0.16	0.79	0.24	0.13	0.14	0.24	0.52	0.81	0.82	30
Copper	54	85	91	72	12	140	36	32	33	14	30	36	37	1,000
Lead	180	250	230	210	28	140	49	44	52	26	65	53	70	300
Mercury	2.0	3.2	5.3	17	0.85	1.6	0.14	0.11	0.11	0.073	0.25	0.23	0.59	20
Nickel	79	86	130	83	26	18	14	16	19	19	25	28	19	300
Selenium	0.41 U	0.82	0.76	0.54 U	0.47 U	0.11 UJ	0.22 UJ	0.40 U	0.37 U	0.22 U	0.20 UJ	0.26 U	0.23 U	400
Silver	0.25	0.18	0.33	0.89	0.11	0.13	0.090	0.071	0.095	0.040	0.079	0.065	0.11	100
Thallium	0.46	0.71	1.3	1.0	0.063	0.11	0.11	0.11	0.13	0.16	0.14	0.097	0.14	8
Vanadium	350	330	520	360	80	27	36	51	83	21	80	20	27	400
Zinc	390	560	300	450	35	300	75	65	75	38	100	130	91	2,500
TCLP METALS (ug/L)														TCLP Regulatory Level (ug/L)
Arsenic	94 J	130 J	220	250	29 J	27 U	27 U	27 U	27 U	27 U	28 J	29 J	27 U	5,000
Barium	440 U	120 UJ	70 UJ	120 UJ	180 UJ	450 U	430 U	360 U	270 U	480 U	460 U	890	630 U	100,000
Cadmium	13	2.0 U	2.0 U	4.2 J	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.4 J	7.5 J	16	15	1,000
Chromium	11 J	11 J	9.8 U	15 J	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	10 J	13 J	9.8 U	5,000
Lead	29 U	29 U	29 U	29 U	29 U	230	33 UJ	42 UJ	29 U	65 UJ	31 UJ	91 UJ	72 UJ	5,000
Mercury	0.27 U	0.12 U	0.12 U	0.50	0.27 U	0.27 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	200
Selenium	120 U	41 U	54 UJ	52 UJ	120 U	120 U	41 U	41 UJ	41 U	41 U	64 UJ	41 U	41 U	1,000
Silver	150 J	20 J	20 J	29	170 J	160 J	42	27	25	1,9 U	46	34	17 J	5,000
REACTIVE SULFIDE														
None Detected														
LAB SAMPLE ID														
All Parameters	4S	4D	6S	6D	8S	8D	10S	10D	K10D	12S	12D	14S	14D	

TABLE 5-4 NOTES:

1. Hydrocarbon ranges are adjusted to exclude the concentration of target and QC (surrogate) analytes.

** - Values shown for standards are in the same units as the analytical data.
*** - Total Target PAHs calculated by summing all detected concentrations, and including one-half the detection limit for target PAHs that were not detected. Note that units are mg/kg (not ug/kg, as for individual analytes).

<u>MADEP Criteria</u>
MCP Reportable Concentrations, 310 CMR 40.0000 Subpart P Massachusetts Oil and Hazardous Material List
"--" indicates no MCP Reportable Concentration available
The MCP reportable concentrations are shown for comparison purposes only.

ft bgs - feet below ground surface
FD - Indicates Field Duplicate
J - Quantitation is approximate due to limitations identified in the quality control review.
U - Analyte was not detected. Value reported is the sample-specific detection limit.
UJ - Sample-specific detection limit is approximate due to limitations identified in the quality control review.

Bold - indicates value greater than applicable MCP reportable concentration

Table 5-5. Oxford Paper Mill Site: Mobile Lab and Fixed Lab Analytical Results: Selected Metals

Pit	Horizon	Mobile Laboratory			OEME Fixed Laboratory				Relative Percent Difference for Detections*		
		Metals by XRF (mg/kg, wet weight)			Metals (mg/kg, dry weight)						
		Lead	Arsenic	Chromium	Lead	Arsenic	Chromium	Percent Solids	Lead	Arsenic	Chromium
3	A	108	<60	<140	--	--	--	--	--	--	--
4	A	241	136	653	260	86	44	NR	-8	45	175
4	LA	213	107	200	--	--	--	--	-20	22	128
5	A	253	124	525	300	94	50	NR	-17	28	165
6	A	318	146	361	330	140	66	NR	-4	4	138
6	KA	--	--	--	290	130	60	NR	--	--	--
7	A	126	75	508	170	93	63	NR	-30	-21	156
7	LA	136	58	516	--	--	--	--	-22	-46	156
8	A	60	<60	<120	--	--	--	--	--	--	--
10	A	<40	<60	<130	16	<41	15	NR	--	--	--
10	LA	<40	<60	<100	--	--	--	--	--	--	--
11	A	<40	<60	<110	--	--	--	--	--	--	--
11	LA	<40	<60	<120	--	--	--	--	--	--	--
12	A	40	<60	<120	--	--	--	--	--	--	--
14	A	67	<60	<150	79	<42	25	NR	-16	--	--
16	A	44	<60	<160	--	--	--	--	--	--	--

NOTES:

K = field duplicate
L = lab duplicate
NR = not reported by fixed laboratory
* = Relative percent difference between mobile lab value (wet weight) and fixed lab value (dry weight). Conversion of mobile lab results to dry weight not possible at this time, because the fixed lab did not formally report the percent solids for each sample.
RPDs only calculated when the metal was detected by both the mobile lab and the fixed lab.
-- = Analysis was not performed.

Table 5-6. Summary Of Analytical Data For Surface And Subsurface Soil
Former Oxford Paper Mill – March 2003

LOCATION NAME	SB-6/14-16	KSB-6/14-16	SB-7/0-1	SB-7/7-9	SB-8/0-1	SB-8/7-9	SB-9/0-1	SB-9/5-7	SB-9-13-15	SB-10/0-1	SB-10/9-11	KSB-10/9-11	SB-10-13-15	MCP Reportable Concentrations **	MADEP Background Concentrations **	
APPROXIMATE SAMPLE DEPTH (ft bgs)	14-16	14-16	0-1	7-9	0-1	7-9	0-1	5-7	13-15	0-1	9-11	9-11	13-15			
M&E SAMPLE ID	SB-6/14-16	KSB-6/14-16	SB-7/0-1	SB-7/7-9	SB-8/0-1	SB-8/7-9	SB-9/0-1	SB-9/5-7	SB-9-13-15	SB-10/0-1	SB-10/9-11	KSB-10/9-11	SB-10-13-15			
DATE RECEIVED BY LAB:	3/14/03	3/14/03	3/14/03	3/14/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03			"Soil Containing Fill Material"
COMMENTS												FD		RCS-1	"Natural Soil"	
PARAMETER/ANALYTE																
PCBs - EPA SW-846 Method 8082 (ug/kg)																
Aroclor-1016	43 U	44 U	47 U	39 U	40 U	39 U	47 U	38 U	38 U	38 U	36 U	36 U	39 U	2,000	–	–
Aroclor-1221	43 U	44 U	47 U	39 U	40 U	39 U	47 U	38 U	38 U	38 U	36 U	36 U	39 U	2,000	–	–
Aroclor-1232	43 U	44 U	47 U	39 U	40 U	39 U	47 U	38 U	38 U	38 U	36 U	36 U	39 U	2,000	–	–
Aroclor-1242	43 U	44 U	47 U	39 U	40 U	39 U	47 U	38 U	38 U	38 U	36 U	36 U	39 U	2,000	–	–
Aroclor-1248	43 U	44 U	47 U	39 U	40 U	39 U	47 U	38 U	38 U	38 U	36 U	36 U	39 U	2,000	–	–
Aroclor-1254	43 U	44 U	47 U	100	40 U	180	170	71	38 U	600	36 U	36 U	39 U	2,000	–	–
Aroclor-1260	43 U	44 U	47 U	39 U	40 UJ	39 UJ	47 UJ	38 UJ	38 UJ	38 UJ	36 UJ	36 UJ	39 UJ	2,000	–	–
EXTRACTABLE PETROLEUM HYDROCARBONS - MADEP-EPH-98-1 (ug/kg)																
C_9-C_{18} Aliphatics (1)	11,000 J	12,000 J	16,000	13,000	4,500	3,300 UJ	26,000	5,000	6,000	20,000	460,000	380,000	150,000	1,000,000	–	–
C_{19}-C_{36} Aliphatics (1)	7,500 J	6,400 J	12,000	32,000	13,000	9,700 J	30,000	17,000	4,500 U	54,000	76,000	60,000	32,000	2,500,000	–	–
C_{11}-C_{22} Aromatics (1)	14,000 J	11,000 UJ	35,000	120,000	45,000	96,000	66,000	58,000	9,600 U	190,000	280,000	280,000	140,000	200,000	–	–
Acenaphthene	660 UJ	640 UJ	710 U	1,000	580 U	1,900	660 U	640	570 U	1,400 U	530 UJ	1,200 J	560 U	20,000	500	2,000
Acenaphthylene	660 UJ	640 UJ	710 U	600 U	580 U	560 U	950	560 U	570 U	1,400 U	530 UJ	1,900 J	970	100,000	500	1,000
Anthracene	660 UJ	640 UJ	710 U	2,400	580 U	2,900	1,800	1,200	570 U	2,200	530 U	540 U	560 U	1,000,000	1,000	4,000
Benzo(a)anthracene	660 UJ	640 UJ	710 U	5,900	1,400	5,000	1,200	2,600	570 U	7,700	910	540 U	560 U	700	2,000	9,000
Benzo(a)pyrene	660 UJ	640 UJ	710 U	4,200	1,100	3,300	660 U	1,900	570 U	6,100	800	540 U	560 U	700	2,000	7,000
Benzo(b)fluoranthene	660 UJ	640 UJ	900	6,800	1,900	5,400	1,900	3,000	570 U	10,000	1,200 J	540 UJ	560 U	700	2,000	8,000
Benzo(g,h,i)perylene	660 UJ	640 UJ	710 U	2,200	580 U	1,600	660 U	560 U	570 U	1,400 U	530 U	540 U	560 U	1,000,000	1,000	3,000
Benzo(k)fluoranthene	660 UJ	640 UJ	710 U	2,500	690	2,000	790	1,200	570 U	3,700	530 U	540 U	560 U	7,000	1,000	4,000
Chrysene	660 UJ	640 UJ	720	5,700	1,600	4,900	1,800	2,600	570 U	7,800	1,000	540 U	560 U	7,000	2,000	7,000
Dibenzo(a,h)anthracene	660 UJ	640 UJ	710 U	880	580 U	610	660 U	560 U	570 U	1,400 U	530 U	540 U	560 U	700	500	1,000
Fluoranthene	660 UJ	640 UJ	1,500	13,000	3,100	13,000	4,200	6,000	570 U	15,000	2,200 J	540 UJ	560 U	1,000,000	4,000	10,000
Fluorene	660 UJ	640 UJ	710 U	990	580 U	1,700	660 U	570	570 U	1,400 U	2,100	2,100	1,000	400,000	1,000	2,000
Indeno(1,2,3-cd)pyrene	660 UJ	640 UJ	710 U	3,000	580 U	2,100	660 U	1,200	570 U	5,000	530 U	540 U	560 U	700	1,000	3,000
Naphthalene	660 UJ	640 UJ	710 U	600 U	580 U	1,100	660 U	560 U	570 U	1,400 U	620	850	560 U	4,000	500	1,000
Phenanthrene	660 UJ	640 UJ	960	8,300	2,000	12,000	3,800	4,400	570 U	8,100	2,500	1,500	750	100,000	3,000	20,000
Pyrene	660 UJ	640 UJ	1,300	12,000	2,900	12,000	3,900	5,600	570 U	15,000	1,900 J	540 UJ	560 U	700,000	4,000	20,000
2-Methylnaphthalene	660 UJ	640 UJ	710 U	600 U	580 U	560 U	660 U	560 U	570 U	1,400 U	960	1,100	2,000	4,000	500	1,000
Priority Pollutant Metals Plus Barium and Vanadium (mg/Kg)																
Antimony	0.39 UJ	R	R	1.0 UJ	0.73 UJ	R	0.64 UJ	0.59 UJ	0.31 UJ	1.7 UJ	R	R	0.73 UJ	10	1	7
Arsenic	4.1 J	3.7 J	21.0 J	24.1 J	16.6 J	12.1 J	9.4 J	21.0 J	8.2 J	19.4 J	3.8 J	4.4 J	4.1 J	30	20	20
Barium	14.4 J	12.8 J	57.5 J	103 J	63.4 J	64.5 J	26.8 J	93.6 J	24.2 J	111 J	34.4 J	44.0 J	34.8 J	1,000	50	50
Beryllium	0.55	0.55	0.93	0.72	0.74	1.0	0.41	0.61	0.71	1.0	0.77	1.0	0.64	0.7	0.4	0.9
Cadmium	0.060 J	0.051 J	0.31	0.96	0.51 U	0.62 U	0.21 UJ	0.56 U	0.15 UJ	4.2	0.20 UJ	0.25 U	0.12 UJ	30	2	3
Chromium	16.1 J	16.4 J	12.5 J	31.2 J	13.4	31.5	5.8	17.3	17.8	38.6	26.2	31.3	17.6	1,000	30	40
Copper	4.1 U	4.0 U	16.2 U	64.1	34.8 J	36.7 J	8.7 J	27.5 J	6.5 J	43.3 J	16.1 J	19.7 J	7.5 J	1,000	40	200
Lead	4.6 J	3.8 J	24.4 J	103 J	93.1 J	91.9 J	13.2 J	91.6 J	10.1 J	120 J	15.0 J	20.4 J	4.8 J	300	100	600
Mercury	0.019 U	0.018 U	0.23	0.70	0.83	0.95	0.28	1.4	0.10 U	3.3	0.048 U	0.048 U	0.030 UJ	20	0.3	1
Nickel	11.4 J	10.6 J	32.5 J	90.3 J	36.2 J	65.1 J	11.8 J	65.0 J	13.4 J	41.1 J	17.7 J	21.8 J	11.0 J	300	20	30
Selenium	0.51 U	0.55 U	1.8	0.47 U	0.96 J	0.50 U	1.6 J	0.44 U	0.43 U	0.44 U	0.41 U	0.42 U	0.46 U	400	0.5	1
Silver	0.11 U	0.12 U	0.13 U	0.10 U	0.10 U	0.11 U	0.13 U	0.098 U	0.096 U	0.097 U	0.092 U	0.094 U	0.10 U	200	0.6	5
Thallium	0.17 U	0.18 U	0.71	0.16 U	1.0 U	1.1 UJ	1.3 U	1.0 U	0.98 U	1.0 UJ	0.94 UJ	0.96 UJ	1.1 U	8	0.6	5
Vanadium	174 J	157 J	166 J	598 J	159 J	247 J	54.4 J	505 J	52.2 J	54.0 J	19.8 J	23.9 J	12.3 J	400	30	30
Zinc	21.1 J	17.9 J	32.6 J	252 J	72.3 J	429 J	24.1 J	59.9 J	17.8 J	161 J	24.2 J	30.5 J	15.6 J	2,500	100	300
LAB SAMPLE ID																
PCBs	B0428-03A	B0428-04A	B0428-05A	B0428-06A	B0417-10A	B0417-11A	B0417-12A	B0417-13A	B0417-18A	B0417-14A	B0417-15A	B0417-16A	B0417-17A			
EPH	B0428-03A	B0428-04A	B0428-05A	B0428-06A	B0417-10A	B0417-11A	B0417-12A	B0417-13A	B0417-18A	B0417-14A	B0417-15A	B0417-16A	B0417-17A			
Priority Pollutant Metals plus Ba and V	B0428-03A	B0428-04A	B0428-05A	B0428-06A	B0417-10A	B0417-11A	B0417-12A	B0417-13A	B0417-18A	B0417-14A	B0417-15A	B0417-16A	B0417-17A			

Table 5-6. Summary Of Analytical Data For Surface And Subsurface Soil
Former Oxford Paper Mill – March 2003

LOCATION NAME	SB-1/0-1	SB-1/5-7	SB-1/17-19	SB-2/0-1	SB-2/7-9	SB-2/11-13	SB-3/0-1	SB-3/7-9	SB-3/13-15
APPROXIMATE SAMPLE DEPTH (ft bgs)	0-1	5-7	17-19	0-1	7-9	11-13	0-1	7-9	13-15
M&E SAMPLE ID	SB-1/0-1	SB-1/5-7	SB-1/17-19	SB-2/0-1	SB-2/7-9	SB-2/11-13	SB-3/0-1	SB-3/7-9	SB-3/13-15
DATE RECEIVED BY LAB:	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03
COMMENTS									
PARAMETER/ANALYTE									
PCBs - EPA SW-846 Method 8082 (ug/kg)									
Aroclor-1016	38 U	42 U	41 U	44 U	39 U	36 U	41 U	39 U	40 U
Aroclor-1221	38 U	42 U	41 U	44 U	39 U	36 U	41 U	39 U	40 U
Aroclor-1232	38 U	42 U	41 U	44 U	39 U	36 U	41 U	39 U	40 U
Aroclor-1242	38 U	42 U	41 U	44 U	39 U	36 U	41 U	39 U	40 U
Aroclor-1248	38 U	42 U	41 U	44 U	39 U	36 U	41 U	39 U	40 U
Aroclor-1254	1800 J	42 U	41 U	44 UJ	39 UJ	36 UJ	95	44	40 UJ
Aroclor-1260	38 UJ	42 UJ	41 UJ	44 UJ	39 UJ	36 UJ	41 UJ	39 UJ	40 UJ
EXTRACTABLE PETROLEUM HYDROCARBONS - MADEP-EPH-98-1 (ug/kg)									
C_9-C_{18} Aliphatics (1)	15,000	3,500 U	5,800	4,700	3,400 U	18,000	4,300	3,400 U	3,400 U
C_{19}-C_{36} Aliphatics (1)	150,000	5,500	9,400	38,000	13,000	23,000	270,000	4,500 U	14,000
C_{11}-C_{22} Aromatics (1)	120,000	51,000	25,000	49,000	34,000	52,000	110,000	15,000	9,800 U
Acenaphthene	1,400 U	590 U	600 U	650 U	570 U	520 U	580 U	560 U	580 U
Acenaphthylene	1,400 U	590 U	600 U	650 U	570 U	520 U	580 U	560 U	580 U
Anthracene	1,400 U	590 U	600 U	650 U	570 U	520 U	580	560 U	580 U
Benzo(a)anthracene	2,200	820	600 U	1,300	1,200	710	1,300	560 U	580 U
Benzo(a)pyrene	1,700	590	600 U	1,100	940	520 U	950	560 U	580 U
Benzo(b)fluoranthene	2,700	920	600 U	1,800	1,500	800	1,700	560 U	580 U
Benzo(g,h,i)perylene	1,400 U	590 U	600 U	650 U	570 U	520 U	580 U	560 U	580 U
Benzo(k)fluoranthene	1,400 U	590 U	600 U	820	610	520 U	640	560 U	580 U
Chrysene	2,300	880	600 U	1,400	1,300	760	1,400	560 U	580 U
Dibenzo(a,h)anthracene	*1,400 U*	590 U	600 U	650 U	570 U	520 U	580 U	560 U	580 U
Fluoranthene	4,900	1,800	600 U	2,700	2,700	1,800	2,800	740	580 U
Fluorene	1,400 U	590 U	600 U	650 U	570 U	520 U	580 U	560 U	580 U
Indeno(1,2,3-cd)pyrene	*1,400 U*	590 U	600 U	650 U	570 U	520 U	580 U	560 U	580 U
Naphthalene	1,400 U	590 U	600 U	650 U	570 U	520 U	740	560 U	580 U
Phenanthrene	3,700	1,400	600 U	1,500	1,600	1,000	1,800	560 U	580 U
Pyrene	4,500	1,700	600 U	2,600	2,500	1,500	2,600	630	580 U
2-Methylnaphthalene	1,400 U	590 U	600 U	650 U	570 U	520 U	580 U	560 U	580 U
Priority Pollutant Metals Plus Barium and Vanadium (mg/Kg)									
Antimony	8.8 J	2.1 UJ	0.25 UJ	0.81 UJ	0.72 UJ	0.41 UJ	1.4 UJ	0.36 UJ	0.17 UJ
Arsenic	9.3 J	9.5 J	2.3 J	19.6 J	18.9 J	7.0 J	14.8 J	13.2 J	2.5 J
Barium	68.4 J	47.8 J	9.8 J	67.2 J	42.8 J	25.8 J	52.1 J	42.7 J	12.9 J
Beryllium	0.98	0.83	0.44	0.73	0.75	0.44	0.75	0.58	0.54
Cadmium	1.2	0.46 U	0.080 UJ	0.40 U	0.31 U	0.16 UJ	0.39 U	0.23 UJ	0.085 UJ
Chromium	25.2	20.4	13.5	16.4	15.2	10.9	15.4	11.2	13.3
Copper	37.3 J	49.8 J	4.8 J	30.1 J	32.5 J	21.4 J	45.9 J	12.4 J	2.8 UJ
Lead	1970 J	208 J	3.5 J	87.2 J	163 J	30.0 J	142 J	28.5 J	2.4 J
Mercury	0.53	0.21	0.018 U	1.1	0.31	0.29	0.92	0.18	0.016 U
Nickel	22.7 J	11.8 J	9.4 J	41.1 J	23.9 J	15.2 J	36.2 J	27.3 J	10.3 J
Selenium	0.45 U	0.53 U	0.48 U	0.54 U	0.54 J	0.48 U	0.47 U	0.53 J	0.46 U
Silver	0.87 J	0.33 UJ	0.28 UJ	0.12 U	0.10 U	0.11 U	0.11 U	0.12 U	0.16 UJ
Thallium	1.0 UJ	1.2 UJ	1.1 UJ	1.2 U	1.0 UJ	1.1 U	1.08 UJ	1.2 U	1.0 UJ
Vanadium	30.7 J	14.4 J	7.7 J	148 J	95.2 J	45.0 J	128 J	90.1 J	26.1 J
Zinc	79.2 J	115 J	25.2 J	66.7 J	37.1 J	25.4 J	65.5 J	23.8 J	14.5 J
LAB SAMPLE ID									
PCBs	B0417-01A	B0417-02A	B0417-03A	B0417-07A	B0417-08A	B0417-09A	B0417-04A	B0417-05A	B0417-06A
EPH	B0417-01A	B0417-02A	B0417-03A	B0417-07A	B0417-08A	B0417-09A	B0417-04A	B0417-05A	B0417-06A
Priority Pollutant Metals plus Ba and V	B0417-01A	B0417-02A	B0417-03A	B0417-07A	B0417-08A	B0417-09A	B0417-04A	B0417-05A	B0417-06A

LOCATION NAME	SB-4/0-1	SB-4/5-7	SB-4/13-15	SB-5/0-1	SB-5/9-11	SB-5/14-16	SB-6/0-1	SB-6/5-7	MCP Reportable Concentrations **	MADEP Background Concentrations **	
APPROXIMATE SAMPLE DEPTH (ft bgs)	0-1	5-7	13-15	0-1	9-11	14-16	0-1	5-7			
M&E SAMPLE ID	SB-4/0-1	SB-4/5-7	SB-4/13-15	SB-5/0-1	SB-5/9-11	SB-5/14-16	SB-6/0-1	SB-6/5-7			
DATE RECEIVED BY LAB:	3/17/03	3/17/03	3/17/03	3/14/03	3/14/03	3/14/03	3/14/03	3/14/03		"Natural Soil"	"Soil Containing Fill Material"
COMMENTS									RCS-1		
PARAMETER/ANALYTE											
PCBs - EPA SW-846 Method 8082 (ug/kg)											
Aroclor-1016	44 U	36 U	44 U	42 U	39 U	42 U	42 U	40 U	2,000	–	–
Aroclor-1221	44 U	36 U	44 U	42 U	39 U	42 U	42 U	40 U	2,000	–	–
Aroclor-1232	44 U	36 U	44 U	42 U	39 U	42 U	42 U	40 U	2,000	–	–
Aroclor-1242	44 U	36 U	44 U	42 U	39 U	42 U	42 U	40 U	2,000	–	–
Aroclor-1248	44 U	36 U	44 U	42 U	39 U	42 U	42 U	40 U	2,000	–	–
Aroclor-1254	71	140	44 U	88	39 U	42 U	210	680	2,000	–	–
Aroclor-1260	44 U	36 U	44 U	42 U	39 U	42 U	42 U	40 U	2,000	–	–
EXTRACTABLE PETROLEUM HYDROCARBONS - MADEP-EPH-98-1 (ug/kg)											
C_9-C_{18} Aliphatics (1)	11,000	8,500	13,000 J	9,100	7,800	11,000	9,500 J	7,900 J	1,000,000	–	–
C_{19}-C_{36} Aliphatics (1)	66,000	49,000	14,000	10,000	4,700 U	5,000 U	180,000 J	46,000 J	2,500,000	–	–
C_{11}-C_{22} Aromatics (1)	110,000	160,000	11,000 U	65,000	32,000	19,000	400,000 J	220,000 J	200,000	–	–
Acenaphthene	670 U	1,400	650 U	640 U	590 U	630 U	2,900 J	4,100 J	20,000	500	2,000
Acenaphthylene	670 U	550 U	650 U	640 U	590 U	630 U	640 UJ	590 UJ	100,000	500	1,000
Anthracene	880	3,500	650 U	1,200	590 U	630 U	6,900 J	8,100 J	1,000,000	1,000	4,000
Benzo(a)anthracene	2,000	6,500	650 U	2,400	890	630 U	21,000 J	14,000 J	700	2,000	9,000
Benzo(a)pyrene	1,500	4,700	650 U	1,800	620	630 U	16,000 J	9,200 J	700	2,000	7,000
Benzo(b)fluoranthene	2,500	7,700	650 U	3,000	1,000	630 U	27,000 J	16,000 J	700	2,000	8,000
Benzo(g,h,i)perylene	670 U	2,200	650 U	640 U	590 U	630 U	8,000 J	4,400 J	1,000,000	1,000	3,000
Benzo(k)fluoranthene	960	2,700	650 U	1,200	590 U	630 U	8,900 J	5,400 J	7,000	1,000	4,000
Chrysene	1,900	6,300	650 U	2,400	900	630 U	20,000 J	15,000 J	7,000	2,000	7,000
Dibenzo(a,h)anthracene	670 U	900	650 U	640 U	590 U	630 U	3,300 J	1,800 J	700	500	1,000
Fluoranthene	4,500	14,000	650 U	6,000	2,000	630 U	44,000 J	39,000 J	1,000,000	4,000	10,000
Fluorene	670 U	1,600	650 U	640 U	590 U	630 U	2,400 J	3,900 J	400,000	1,000	2,000
Indeno(1,2,3-cd)pyrene	1,100	3,100	650 U	1,300	590 U	630 U	11,000 J	6,600 J	700	1,000	3,000
Naphthalene	670 U	620	650 U	640 U	590 U	630 U	800 J	920 J	4,000	500	1,000
Phenanthrene	2,800	12,000	650 U	4,800	1,700	630 U	23,000 J	38,000 J	100,000	3,000	20,000
Pyrene	4,300	13,000	650 U	5,400	1,900	630 U	42,000 J	35,000 J	700,000	4,000	20,000
2-Methylnaphthalene	670 U	550 U	650 U	640 U	590 U	630 U	640 UJ	720 J	4,000	500	1,000
Priority Pollutant Metals Plus Barium and Vanadium (mg/Kg)											
Antimony	1.1 UJ	2.3 J	0.21 UJ	R	1.7 J	R	7.0 J	1.1 UJ	10	1	7
Arsenic	11.1 J	31.8 J	4.4 J	7.0 J	47.4 J	5.7 J	49.1 J	30.9 J	30	20	20
Barium	53.3 J	101 J	20.0 J	20.8 J	55.8 J	24.1 J	143 J	113 J	1,000	50	50
Beryllium	1.0	0.84	1.1	0.33 J	0.57	0.66	0.91	0.77	0.7	0.4	0.9
Cadmium	1.0	1.7	0.22	0.15	0.75	0.038 U	2.0	2.4	30	2	3
Chromium	40.4 J	27.0 J	20.8 J	8.1 J	25.3 J	18.0 J	62.9 J	36.0 J	1,000	30	40
Copper	19.3	40.2	3.9 U	9.0 U	27.1	58.8	70.3	33.8	1,000	40	200
Lead	35.5 J	90.6 J	4.6 J	18.2 J	23.5 J	3.5 J	140 J	84.4 J	300	100	600
Mercury	R	R	R	0.46	1.1	0.039	1.3	0.51	20	0.3	1
Nickel	27.4 J	19.8 J	11.8 J	11.9 J	13.1 J	12.4 J	100 J	51.1 J	300	20	30
Selenium	0.53 UJ	0.42 UJ	0.48 UJ	1.3	0.50 J	0.49 U	0.55 U	0.49 U	400	0.5	1
Silver	0.12 UJ	0.10 UJ	0.14 UJ	0.12 U	0.10 U	0.11 U	0.12 U	0.11 U	200	0.6	5
Thallium	0.96	0.78	0.61	0.19 U	0.82	0.16 U	0.18 U	0.29 J	8	0.6	5
Vanadium	45.7 J	26.6 J	15.7 J	52.8 J	19.1 J	11.6 J	376 J	264 J	400	30	30
Zinc	57.9 J	125 J	23.2 J	29.4 J	33.5 J	22.5 J	274 J	134 J	2,500	100	300
LAB SAMPLE ID											
PCBs	B0428-11A	B0428-12A	B0428-13A	B0428-07A	B0428-08A	B0428-09A	B0428-01A	B0428-02A			
EPH	B0428-11A	B0428-12A	B0428-13A	B0428-07A	B0428-08A	B0428-09A	B0428-01A	B0428-02A			
Priority Pollutant Metals plus Ba and V	B0428-11A	B0428-12A	B0428-13A	B0428-07A	B0428-08A	B0428-09A	B0428-01A	B0428-02A			

TABLE 5-6 NOTES:

1. Hydrocarbon ranges are adjusted to exclude the concentration of target and QC (surrogate) analytes.

** - Values shown for standards are in the same units as the analytical data.

MADEP Criteria
MCP Reportable Concentrations, 310 CMR 40.0000 Subpart P Massachusetts Oil and Hazardous Material List
Background Values: MADEP, May 23, 2002. Technical Update: Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil.
"--" indicates no MCP Reportable Concentration or background value available
The MCP reportable concentrations and background values are shown for comparison purposes only.

ft bgs - feet below ground surface
FD - Indicates Field Duplicate
J - Quantitation is approximate due to limitations identified in the quality control review.
U - Analyte was not detected. Value reported is the sample-specific detection limit.
UJ - Sample-specific detection limit is approximate due to limitations identified in the quality control review.

Bold / Box - indicates value greater than applicable MCP reportable concentration
Bold / Italics indicates that the detection limit exceeds the applicable MCP reportable concentration.

Table 5-7. Summary Of Analytical Data For Groundwater
Former Oxford Paper Mill -- March 2003

LOCATION NAME M&E SAMPLE ID DATE RECEIVED BY LAB: DEPTH TO WATER FROM GROUND SURFACE: COMMENTS	MW-1 MW-1 3/27/03 16.5'	MW-3 MW-3 3/27/03 14.3'	MW-5 MW-5 3/27/03 14.8'	KMW-5 KMW-5 3/27/03 14.8' FD	MW-6 MW-6 3/27/03 15'	MW-10 MW-10 3/27/03 6.5'	MCP Reportable Concentrations ** GW-2
PARAMETER/ANALYTE							
PCBs - EPA SW-846 Method 8082 (ug/L)							
Aroclor-1016	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	0.3
Aroclor-1221	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	0.3
Aroclor-1232	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	0.3
Aroclor-1242	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	0.3
Aroclor-1248	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	0.3
Aroclor-1254	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	0.3
Aroclor-1260	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	*1.0 U*	0.3
VOLATILE PETROLEUM HYDROCARBONS - MADEP-VPH-98-1 (ug/L)							
C_5-C_8 Aliphatics (1)	100 U	100 U	100 U	100 U	100 U	100 U	1,000
C_9-C_{12} Aliphatics (1)	20 U	20 U	20 U	20 U	20 U	20 U	1,000
C_9-C_{10} Aromatics (1)	40 U	45 U	30 U	34 U	46 U	46 U	4,000
MTBE	15 U	15 U	15 U	15 U	15 U	15 U	50,000
Benzene	5 U	5 U	5 U	5 U	5 U	5 U	2,000
Toluene	15 U	15 U	15 U	15 U	15 U	15 U	6,000
Ethylbenzene	5 U	5 U	5 U	5 U	5 U	5 U	
m- and p-Xylenes	20 U	20 U	20 U	20 U	20 U	20 U	6,000
o-Xylene	10 U	10 U	10 U	10 U	10 U	10 U	6,000
Naphthalene	10 U	10 U	10 U	10 U	10 U	10 U	6,000
EXTRACTABLE PETROLEUM HYDROCARBONS - MADEP-EPH-98-1 (ug/L)							
C_9-C_{18} Aliphatics (1)	30 UJ	35	30 U	30 U	40 J	44	1,000
C_{19}-C_{36} Aliphatics (1)	45	44	40 U	40 U	49 J	45	20,000
C_{11}-C_{22} Aromatics (1)	85 U	85 U	85 U	85 U	85 U	85 U	30,000
Acenaphthene	5 U	5 U	5 U	5 U	5 U	5 U	5,000
Acenaphthylene	5 U	5 U	5 U	5 U	5 U	5 U	3,000
Anthracene	5 U	5 U	5 U	5 U	5 U	5 U	600
Benzo(a)anthracene	5 U	5 U	5 U	5 U	5 U	5 U	3,000
Benzo(a)pyrene	5 U	5 U	5 U	5 U	5 U	5 U	3,000
Benzo(b)fluoranthene	5 U	5 U	5 U	5 U	5 U	5 U	3,000
Benzo(g,h,i)perylene	5 U	5 U	5 U	5 U	5 U	5 U	3,000
Benzo(k)fluoranthene	5 U	5 U	5 U	5 U	5 U	5 U	3,000
Chrysene	5 U	5 U	5 U	5 U	5 U	5 U	3,000
Dibenzo(a,h)anthracene	5 U	5 U	5 U	5 U	5 U	5 U	3,000
Fluoranthene	5 U	5 U	5 U	5 U	5 U	5 U	200
Fluorene	5 U	5 U	5 U	5 U	5 U	5 U	3,000
Indeno(1,2,3-cd)pyrene	5 U	5 U	5 U	5 U	5 U	5 U	3,000
Naphthalene	5 U	5 U	5 U	5 U	5 U	5 U	6,000
Phenanthrene	5 U	5 U	5 U	5 U	5 U	5 U	50
Pyrene	5 U	5 U	5 U	5 U	5 U	5 U	3,000
2-Methylnaphthalene	5 U	5 U	5 U	5 U	5 U	5 U	3,000
Priority Pollutant Metals Plus Barium and Vanadium (ug/L)							
Antimony	3.4 UJ	6.7 UJ	6.8 UJ	4.3 UJ	7.1 UJ	4.7 UJ	300
Arsenic	3.0 U	4.2 J	7.9 J	4.8 J	11.0 J	4.4 J	400
Barium	76.8 J	83.4 J	34.2 J	81.6	44.0 J	14.7 UJ	30,000
Beryllium	0.50 U	0.50 U	0.50 U	0.71 J	0.50 U	0.50 U	50
Cadmium	0.70 U	0.70 U	0.70 U	0.70 U	0.70 U	0.70 U	10
Chromium	1.1 J	1.0 J	1.0 J	0.97 J	0.60 U	0.85 J	2,000
Copper	4.0 U	4.0 U	11.1 UJ	4.5 UJ	4.0 U	4.0 U	100,000
Lead	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	30
Mercury	0.12 U	0.14 U	0.13 U	0.13 U	0.12 U	0.14 U	1
Nickel	1.1 J	4.0 J	2.6 J	20.3 J	5.6 J	0.94 J	80
Selenium	9.0 U	188	9.0 U	16.0 J	12.1 J	9.0 U	80
Silver	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	100,000
Thallium	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	7
Vanadium	1.2 J	158	0.70 U	11.1 J	3710	15.0 J	2,000
Zinc	7.0 U	7.0 U	18.9 J	15.9 J	7.0 U	7.0 U	900
LAB SAMPLE ID							
PCBs	B0502-01D	B0502-04D	B0502-02D	B0502-03D	B0502-05D	B0502-07D	
VPH	B0502-01A	B0502-04A	B0502-02A	B0502-03A	B0502-05A	B0502-07A	
EPH	B0502-01C	B0502-04C	B0502-02C	B0502-03C	B0502-05C	B0502-07C	
Priority Pollutant Metals plus Ba and V	B0502-01B	B0502-04B	B0502-02B	B0502-03B	B0502-05B	B0502-07B	

TABLE 5-8

Soil Data Usability Assessment
Oxford Paper, Lawrence, Massachusetts
Initial TBA Samples Collected May 2002

*PARCCS Parameter	Data Usability Assessment
Precision :Field duplicates :MS/MSDs Field duplicates and MS/MSDs were collected at a rate of 1 per 20 samples for all matrices sampled.	Field Duplicates: Results did not meet acceptance criteria for relative percent difference (<50%) in field duplicate samples 10D and K10D for the following analytes: arsenic, C19-C36 aliphatics, C11-C22 aromatics, unadjusted C11-C22 aromatics, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene. Lack of field duplicate comparability is likely attributable to the extremely variable soil matrix. Results were flagged as estimated (J, UJ). MS/MSD: Laboratory duplicate results criteria (%RPD < 20) were not met for arsenic in soil sample 10D. Positive results were flagged as estimated (J). All criteria were met for internal standards.
Accuracy :Holding times :Surrogate Recovery :Matrix Spike Recovery :LCS Recovery :Calibration Verification 9 PE Samples	Holding times: All criteria met. Surrogate Recovery: All criteria met. Matrix Spike Recovery: EPH compounds for soil samples that did not meet acceptance criteria (40-140% recovery) in the matrix spike included fluoranthene and pyrene. Metals for soil samples that did not meet acceptance criteria included antimony. Positive results were flagged as estimated (J). LCS Recovery: The following compounds did not meet acceptance criteria of 40-140% recovery: naphthalene. Results were flagged as estimated (J, UJ). Calibration Verification: All criteria were met for initial and continuing calibrations. PE Samples: Based on project quality objectives and the approved FTWP, PE samples were not used.
Representativeness :Field duplicates :MS/MSD :Approved FTWP	For field duplicate and MS/MSD discussion refer to APrecision@ above. Approved FTWP: Sample locations were selected based on historical information and an EPA-approved Field Task Work Plan that detailed sample collection methods, sample preservation, and proposed analytical methods.
Completeness :Data completeness goal was 100%	Completeness: No data was rejected during the data validation process and the data collected is useable for project objectives.
Comparability :Analytical Methods :Detection Limits :Units of Concentration	Analytical Methods: The methodologies selected for analysis of samples by the directly-subcontracted laboratory were consistent with standard EPA or MADEP methods. Detection Limits: Detection limits were appropriate to allow comparison to published

	Regulatory Limits, such as Massachusetts S-1 or S-2 soil standards. Units of Concentration: Reported concentration units were standard for the industry.
Sensitivity 9 Field Blanks :Instrument Blanks :Method Blanks :Low-level Calibration Checks	Field blanks: Based on project quality objectives and the approved FTWP, field blanks were not collected. Instrument Blanks: A variety of analytes were qualified based on detection in blank samples as follows: selenium, TCLP barium, TCLP lead, TCLP selenium. Method Blanks: All criteria were met for internal standards. Low-level Calibration Checks: All criteria were met for initial and continuing calibrations and for internal standards.

* - Precision, accuracy, representativeness, completeness, comparability, and sensitivity

: - The noted method was used.

9 - The noted method was not used.

TABLE 5-9

Soil Data Usability Assessment
Laboratory Project Number B0417
Oxford Paper, Lawrence, Massachusetts
SSI Samples Collected March 2003

*PARCCS Parameters	Data Usability Assessment
Precision :Field duplicates :MS/MSDs Field duplicates and MS/MSDs were collected at a rate of 1 per 20 samples for all matrices sampled.	Field Duplicates: The compounds that did not meet acceptance criteria (RPD <50%) in field duplicate samples SD-10/9-11 and KSD-10/9-11 included: acenaphthene, acenaphtylene, benzo(b)fluoranthene, fluoranthene, and pyrene. Results in these 2 samples were flagged as estimated (J, UJ). All criteria were met for PCB and priority pollutant metals field duplicates. MS/MSD: All criteria were met for PCB and EPH MS/MSDs. Priority pollutant metals analytes that did not meet acceptance criteria (%RPD < 20) in the laboratory duplicate included: antimony, arsenic, copper, nickel, lead, and vanadium. Positive results in all samples were flagged as estimated (J). Due to other actions however (see below), some antimony results were rejected (R) due to severely low matrix spike recovery.
Accuracy :Holding times :Surrogate Recovery :Matrix Spike Recovery :LCS Recovery :Calibration Verification 9 PE Samples	Holding times: All criteria met. Surrogate Recovery: EPH surrogate compounds that did not meet acceptance criteria (%R of 40-140%) for chlorooctadecone impacted the following samples: SB-8/7-9, SB-8/7-9RE. C9-C18 and C19-C36 aliphatic results were flagged as estimated (J, UJ). PCB surrogate compounds that did not meet acceptance criteria (%R of 29-155% for decachlorobiphenyl (DCB) impacted the following samples: SB-8/0-1, SB-8/7-9, SB-9/5-7, SB-10/0-1. No action was needed though, because the other 3 surrogates met criteria. Surrogate criteria are not applicable for priority pollutant metals analysis. Matrix Spike Recovery: The priority pollutant metals analyses that did not meet acceptance criteria (%R of 75-125%) in MS sample SB-1/0-1 included: antimony and lead. All antimony results were estimated (J) or rejected (R) due to severely low matrix spike recovery. Priority pollutant metals analytes that did not meet acceptance criteria (%RPD < 20) in the laboratory duplicate included: antimony, arsenic, copper, nickel, lead, and vanadium. Positive results in all samples were flagged as estimated (J). LCS Recovery: Not applicable. Calibration Verification: All initial and continuing calibration criteria was met for EPH and priority pollutant metals. However, the laboratory did not follow method requirements for calculation of the EPH range continuing calibration factors. No action was taken since the individual calibration factors were all < 25% RPD. The following analytes failed to meet continuing calibration criteria (%D #15): Aroclor-1254, Aroclor-1260. Results in affected samples were flagged as estimated (J, UJ). PE Samples: Based on project quality objectives and the approved FTWP, PE samples were not used.
Representativeness	For field duplicate and MS/MSD discussion refer to APrecision@ above.

:Field duplicates :MS/MSD :Approved FTWP	Approved FTWP: Sample locations were selected based on historical information and an EPA-approved Field Task Work Plan that detailed sample collection methods, sample preservation, and proposed analytical methods.
Completeness :Data completeness goal was 100%	Completeness: Some antimony results were rejected (R) due to severely low matrix spike recovery.
Comparability :Analytical Methods :Detection Limits :Units of Concentration	Analytical Methods: The methodologies selected for analysis of samples by the directly-subcontracted laboratory were consistent with standard EPA or MADEP methods. Detection Limits: Detection limits were appropriate to allow comparison to published Regulatory Limits, such as Massachusetts S-1 or S-2 soil standards. Units of Concentration: Reported concentration units were standard for the industry.
Sensitivity 9 Field Blanks :Instrument Blanks :Method Blanks :Low-level calibration checks	Field blanks: Based on project quality objectives and the approved FTWP, field blanks were not collected. Instrument Blanks: The following analytes were blank qualified due to detection in blank samples: antimony, cadmium, copper, mercury, silver, and thallium. No blank contamination was detected in the PCB and EPH analyses. Method Blanks: ICP serial dilution criteria (10% difference) were not met for barium, lead, nickel and zinc. Positive results in all samples were flagged as estimated (J). Laboratory duplicates are not required in EPH and PCB analyses. Low-level Calibration Checks: All initial and continuing calibration criteria was met for EPH and priority pollutant metals. However, the laboratory did not follow method requirements for calculation of the EPH range continuing calibration factors. No action was taken since the individual calibration factors were all < 25% RPD. The following analytes failed to meet continuing calibration criteria (%D #15): Aroclor-1254, Aroclor-1260. Results in affected samples were flagged as estimated (J, UJ).

* - Precision, accuracy, representativeness, completeness, comparability, and sensitivity

: - The noted method was used.

9 - The noted method was not used.

TABLE 5-10

Soil Data Usability Assessment
Laboratory Project Number B0428
Oxford Paper, Lawrence, Massachusetts
SSI Samples Collected March 2003

*PARCCS Parameters	Data Usability Assessment
Precision :Field duplicates :MS/MSDs Field duplicates and MS/MSDs were collected at a rate of 1 per 20 samples for all matrices sampled.	Field Duplicates: Not applicable; soil field duplicate for SSI is included in related data package, Laboratory Project Number B0417. MS/MSD: The following EPH analytes did not meet the MS/MSD acceptance criteria in SB-4/13-15: C9-C18 aliphatics. The result was estimated (J). Priority pollutant metals analytes that did not meet acceptance criteria (%RPD < 20) in soil sample SB-6/0-1 included: antimony, nickel, and vanadium. Results in affected samples were flagged as estimated (J, UJ). Laboratory duplicates are not analyzed in EPH and PCB analyses.
Accuracy :Holding times :Surrogate Recovery :Matrix Spike Recovery :LCS Recovery :Calibration Verification 9 PE Samples	Holding times: Sample SB-6/0-1, SB-6/5-7, and KSB-6/14-16 underwent EPH extraction one day outside of the holding time of seven days. The positive and nondetect EPH results for these samples were qualified as estimated (J and UJ, respectively) due to the extraction hold time exceedence. Surrogate Recovery: PCB surrogate compounds that did not meet acceptance criteria (%R of 29-155%) for decachlorobiphenyl (DCB) impacted the following samples: SB-6/5-7, SB-7/7-9, SB-4/5-7. No action was needed because the other 3 surrogates were within criteria. Surrogate criteria are not applicable for priority pollutant metals analysis. Matrix Spike Recovery: The following analytes did not meet the %R criteria of 75-125% for the Matrix Spike: antimony, arsenic, and zinc. Positive results were estimated. Non-detects for antimony were rejected or estimated in certain samples based on professional judgment. The %R criteria were not met for C9-C18 aliphatics in SB-4/13-15; result was flagged as estimated (J). LCS Recovery: The priority pollutant metals that did not meet LCS acceptance criteria included: chromium and selenium. Results in affected samples were flagged as estimated (J, UJ). Calibration Verification: All initial and continuing calibration criteria were met for EPH. Continuing calibration criteria (%D #15%) were not met for Aroclor-1260; non detect results were flagged as estimated (UJ) in affected samples. Results that did not meet Initial Calibration Verification (ICV) criteria (%R between 90 and 110%) included mercury; results for affected samples were rejected. PE Samples: Based on project quality objectives and the approved FTWP, PE samples were not used.
Representativeness :Field duplicates	For field duplicate and MS/MSD discussion refer to APrecision@ above.

:MS/MSD :Approved FTWP	Approved FTWP: Sample locations were selected based on historical information and an EPA-approved Field Task Work Plan that detailed sample collection methods, sample preservation, and proposed analytical methods.
Completeness : Data completeness goal was 100%	Completeness: Mercury results were rejected in SB-4/0-1, SB-4/5-7, and SB-4/13-15 due to initial calibration verification (ICV) analysis results that failed to meet the % recovery criterion of 90 to 110%. Antimony results were rejected in KSB-6/14-16, SB-5/0-1, SB-5/14-16, and SB-7/0-1 due to matrix spike recovery outside criteria.
Comparability :Analytical Methods :Detection Limits :Units of Concentration	Analytical Methods: The methodologies selected for analysis of samples by the directly-subcontracted laboratory were consistent with standard EPA or MADEP methods. Detection Limits: Detection limits were appropriate to allow comparison to published Regulatory Limits, such as Massachusetts S-1 or S-2 soil standards. Units of Concentration: Reported concentration units were standard for the industry.
Sensitivity 9 Field Blanks :Instrument Blanks :Method Blanks :Low-level calibration checks	Field blanks: Based on project quality objectives and the approved FTWP, field blanks were not collected. Instrument Blanks: The following analytes were detected in blank samples and were qualified accordingly: antimony, beryllium, cadmium, copper, mercury, and silver. Method Blanks: ICP serial dilution analysis produced percent differences (%D) that exceeded acceptance criteria of < 10% for arsenic, barium, chromium, lead, nickel, and zinc. The positive results for lead, nickel, and zinc were qualified as estimated (J) in all samples. Low-level Calibration Checks: All initial and continuing calibration criteria were met for EPH. Continuing calibration criteria (%D #15%) were not met for Aroclor-1260; non- detect results were flagged as estimated (UJ) in affected samples. Results that did not meet Initial Calibration Verification (ICV) criteria (%R between 90 and 110%) included mercury; results for affected samples were rejected.

* - Precision, accuracy, representativeness, completeness, comparability, and sensitivity

: - The noted method was used.

9 - The noted method was not used.

TABLE 5-11

Groundwater Data Usability Assessment
Laboratory Project Number B0502
Oxford Paper, Lawrence, Massachusetts
SSI Samples Collected March 2003

*PARCCS Parameters	Data Usability Assessment
Precision :Field duplicates :MS/MSDs Field duplicates and MS/MSDs were collected at a rate of 1 per 20 samples for all matrices sampled.	Field Duplicates: All criteria met. MS/MSD: The EPH compounds for the groundwater MS/MSD sample MW-1 that did not meet acceptance criteria (%R of 40-140%) included C9-C18 aliphatics. The result was flagged as estimated (J) in MW-1. All criteria were met for PCB, VPH, and priority pollutant metals MS/MSDs. All criteria were met for internal standards, the Inductively Coupled Plasma (ICP) Interference Check Sample, and Laboratory Duplicates.
Accuracy :Holding times :Surrogate Recovery :Matrix Spike Recovery :LCS Recovery :Calibration Verification 9 PE Samples	Holding times: All criteria met. Surrogate Recovery: The EPH surrogate compounds that did not meet the acceptance criteria (%R of 40-140%) included chlorooctadecane in sample MW-6. Results for C9-C18 aliphatics and C19-C36 aliphatics in MW-6 were flagged as estimated (J). Surrogate criteria were met for PCB and VPH analysis. Surrogate criteria are not applicable for priority pollutant metals analysis. Matrix Spike Recovery: The EPH compounds for the groundwater sample MW-1 that did not meet acceptance criteria (%R of 40-140%) included C9-C18 aliphatics. Result for MW-1 was flagged as estimated (J). All criteria were met for PCB, VPH, and priority pollutant metals MS/MSDs. LCS Recovery: Not applicable. Calibration Verification: All initial and continuing calibration criteria were met for EPH, VPH and priority pollutant metals. Continuing calibration criteria were not met for the PCB Aroclor-1260 in lab blank and LCS samples only (not field samples); no action required. PE Samples: Based on project quality objectives and the approved FTWP, PE samples were not used.
Representativeness :Field duplicates :MS/MSD :Approved FTWP	For field duplicate and MS/MSD discussion refer to APrecision@ above. Approved FTWP: Sample locations were selected based on historical information and an EPA-approved Field Task Work Plan that detailed sample collection methods, sample preservation, and proposed analytical methods.
Completeness :Data completeness goal was 100%	Completeness: No data was rejected during the data validation process and the data collected is useable for project objectives.
Comparability	Analytical Methods: The methodologies selected for analysis of samples by the

:Analytical Methods :Detection Limits :Units of Concentration	directly-subcontracted laboratory were consistent with standard EPA or MADEP methods. <u>Detection Limits</u>: Reporting limits for Aroclors (1 ppb) were higher than the RCGW-2 (0.3 ppb). No Aroclor detections were reported in the groundwater samples. <u>Units of Concentration:</u> Reported concentration units were standard for the industry.
<u>Sensitivity</u> 9 Field Blanks :Instrument Blanks :Method Blanks :Low-level calibration checks	<u>Field blanks</u>: Based on project quality objectives and the approved FTWP, field blanks were not collected. <u>Instrument Blanks</u>: Blank contaminants were detected in the trip blank and the laboratory blanks, resulting in qualification as not detected for the following analytes in affected samples: C9-C10 Aromatics, antimony, barium, and copper. No blank contamination was detected in the PCB or EPH analyses. <u>Method Blanks</u>: All criteria were met for internal standards, the Inductively Coupled Plasma (ICP) Interference Check Sample, and Laboratory Duplicates. <u>Low-level Calibration Checks</u>: All initial and continuing calibration criteria were met for EPH, VPH and priority pollutant metals. Continuing calibration criteria were not met for the PCB Aroclor-1260 in two lab QC samples. Field samples were not affected.

* - Precision, accuracy, representativeness, completeness, comparability, and sensitivity

: - The noted method was used.

9 - The noted method was not used.

Table 7-1

Solubility of Site Contaminants

PHASE II – COMPREHENSIVE SITE ASSESSMENT
FOR AREAS NORTH OF THE RACEWAY

OXFORD PAPER MILL
LAWRENCE, MASSACHUSETTS

MADEP RTN 3-2691

Contaminants of Concern	Maximum Solubility (mg/L)
Extractable Petroleum Hydrocarbons	
C_{11}-C_{22} Aromatics	5.8
C_9-C_{18} Aliphatics	0.01
C_{19}-C_{36} Aliphatics	Considered Immobile
Target EPH Parameters/Semi-Volatiles	
2-Methylnapthalene	25.4
Acenaphthene	3.88
Benzo(a)anthracene	0.0140
Benzo(a)pyrene	0.0038
Benzo(b)fluoranthene	0.0140
Benzo(g,h,I)perylene	0.0003
Benzo(k)fluoranthene	0.0043
Chrysene	0.0060
Dibenzo(a,h)anthracene	0.0025
Fluoranthene	0.2750
Fluorene	1.9800
Indeno(1,2,3-cd)pyrene	0.0005
Naphthalene	31.7000
Phenanthrene	1.2900
Pyrene	0.1350
Asbestos	NS
Metals	
Arsenic	NS
Beryllium	<1
PCBS	
Aroclor-1248	0.05
Aroclor-1254	0.012

Legend -

NS - Not Soluble - Based on pH and Eh conditions and metals speciation

Sources
EPA 1997 - A One-Dimensional Finite Difference Vadose Zone Leaching Model (VLEACH)
DEP 2002 - Characterizing Risks Posed by Petroleum Contaminated Sites, Policy # WSC-02-411

Table 7-2
COPCs Sorption Capacity

PHASE II – COMPREHENSIVE SITE ASSESSMENT
FOR AREAS NORTH OF THE RACEWAY

OXFORD PAPER MILL
LAWRENCE, MASSACHUSETTS

MADEP RTN 3-2691

Contaminants of Concern	K_{oc} (mL/g)	f_{oc} (dec. %)	Calculated K_d (mL/g) (K_d=K_{oc}*f_{oc})
EXTRACTABLE PETROLEUM HYDROCARBONS			
C_9-C_{18} Aliphatics	680,000	0.003	2040.00
C_{19}-C_{36} Aliphatics		Considered Immobile	
C_{11}-C_{22} Aromatics	5,000	0.003	15.00
Target EPH Parameters/Semi-Volatiles			
2-Methylnapthalene	8511	0.003	25.53
Acenaphthene	5012	0.003	15.04
Benzo(a)anthracene	1.38E+06	0.003	4140.00
Benzo(a)pyrene	5.50E+06	0.003	16500.00
Benzo(b)fluoranthene	5.50E+05	0.003	1650.00
Benzo(g,h,i)perylene	1.50E+06	0.003	4500.00
Benzo(k)fluoranthene	5.49E+05	0.003	1647.00
Chrysene	2.00E+05	0.003	600.00
Dibenzo(a,h)anthracene	3.30E+06	0.003	9900.00
Fluoranthene	19,800	0.003	59.40
Fluorene	5,835	0.003	17.51
Indeno(1,2,3-cd)pyrene	1.59E+06	0.003	4755.00
Naphthalene	1,300	0.003	3.90
Phenanthrene	23,000	0.003	69.00
Pyrene	63,400	0.003	190.20
Metals			
Arsenic @ Soil pH=6.8	NA	NA	29.00
Beryllium @ Soil pH=6.8	NA	NA	4600.00
PCBS			
Aroclor-1248 (based on Arocolor 1242)	1.00E+05	0.003	300.00
Aroclor-1254 (based on Arocolor 1242)	1.00E+05	0.003	300.00
Asbestos	NA	NA	NA

NA - Not Available

Sources
EPA 1996 - Soil Screening Guidance: Technical Background Document, EPA/540/R95/128, May 1996
EPA 1997 - A One-Dimensional Finite Difference Vadose Zone Leaching Model (VLEACH)
DEP 2002 - Characterizing Risks Posed by Petroleum Contaminated Sites, Policy # WSC-02-411

Table 7-3
COPCs Retardation and Solute Velocity

PHASE II – COMPREHENSIVE SITE ASSESSMENT
FOR AREAS NORTH OF THE RACEWAY

OXFORD PAPER MILL
LAWRENCE, MASSACHUSETTS

MADEP RTN 3-2691

Contaminants of Concern	Calculated Kd (ml/g)	Calculated Retardation Value (Rf)	Solute Velocity based on 0.5 ft/day	
	$(K_d=K_{oc}*f_{oc})$	$Rf=1+(\rho b/\theta)*K_d$	(ft/day)	(ft/year)
EXTRACTABLE PETROLEUM HYDROCARBONS				
C_9-C_{18} Aliphatics	2040.00	14995.00	3.33E-05	1.22E-02
C_{19}-C_{36} Aliphatics	Considered Immobile			
C_{11}-C_{22} Aromatics	15.00	111.25	4.49E-03	1.64E+00
Target EPH Parameters/Semi-Volatiles				
2-Methylnapthalene	25.53	188.67	2.65E-03	9.67E-01
Acenaphthene	15.04	111.51	4.48E-03	1.64E+00
Benzo(a)anthracene	4140.00	30430.00	1.64E-05	6.00E-03
Benzo(a)pyrene	16500.00	121276.00	4.12E-06	1.50E-03
Benzo(b)fluoranthene	1650.00	12128.50	4.12E-05	1.50E-02
Benzo(g,h,I)perylene	4500.00	33076.00	1.51E-05	5.52E-03
Benzo(k)fluoranthene	1647.00	12106.45	4.13E-05	1.51E-02
Chrysene	600.00	4411.00	1.13E-04	4.14E-02
Dibenzo(a,h)anthracene	9900.00	72766.00	6.87E-06	2.51E-03
Fluoranthene	59.40	437.59	1.14E-03	4.17E-01
Fluorene	17.51	129.66	3.86E-03	1.41E+00
Indeno(1,2,3-cd)pyrene	4755.00	34950.25	1.43E-05	5.22E-03
Naphthalene	3.90	29.67	1.69E-02	6.15E+00
Phenanthrene	69.00	508.15	9.84E-04	3.59E-01
Pyrene	190.20	1398.97	3.57E-04	1.30E-01
Metals				
Arsenic @ Soil pH=6.8	29.00	214.15	2.33E-03	8.52E-01
Beryllium @ Soil pH=6.8	4600.00	33811.00	1.48E-05	5.40E-03
PCBS				
Aroclor-1248 (based on Arocolor 1242)	300.00	2206.00	2.27E-04	8.27E-02
Aroclor-1254 (based on Arocolor 1242)	300.00	2206.00	2.27E-04	8.27E-02
Asbestos	NA	NA	NA	NA

NA - Not Available

Sources
EPA 1997 - A One-Dimensional Finite Difference Vadose Zone Leaching Model (VLEACH)
DEP 2002 - Characterizing Risks Posed by Petroleum Contaminated Sites, Policy # WSC-02-411

Table 7-4
COPCs Henry's Law Constants (Dimensionless)

PHASE II – COMPREHENSIVE SITE ASSESSMENT
FOR AREAS NORTH OF THE RACEWAY

OXFORD PAPER MILL
LAWRENCE, MASSACHUSETTS

MADEP RTN 3-2691

Contaminants of Concern	Henry's Constant, H (Dimensionless)
Extractable Petroleum Hydrocarbons	
C_9-C_{18} Aliphatics	6.90E+01
C_{11}-C_{22} Aromatics	3.00E-02
C_{19}-C_{36} Aliphatics	Considered Immobile
Target EPH Constituents/Semi-Volatiles	
2-Methylnapthalene	2.06
Acenaphthene	4.88E-02
Benzo(a)anthracene	4.05E-05
Benzo(a)pyrene	1.98E-05
Benzo(b)fluoranthene	4.94E-04
Benzo(g,h,i)perylene	5.83E-06
Benzo(k)fluoranthene	1.60E-03
Chrysene	4.25E-05
Dibenzo(a,h)anthracene	2.96E-06
Fluoranthene	2.64E-04
Fluorene	3.11E-03
Indeno(1,2,3-cd)pyrene	2.81E-06
Naphthalene	5.16E-02
Phenanthrene	1.62E-03
Pyrene	4.88E-04
Metals	
Arsenic	NV
Beryllium	NV
PCBS	
Aroclor-1248 (based on Arocolor 1242)	1.38E-02
Aroclor-1254	1.14E-02
Asbestos	NA

Legend -

NA - Not Applicable
NV - Not Volatile

Sources
EPA 1997 - A One-Dimensional Finite Difference Vadose Zone Leaching Model (VLEACH)
DEP 2002 - Characterizing Risks Posed by Petroleum Contaminated Sites, Policy # WSC-02-411

SCANNED
SL=Zupkus

PHASE II – COMPREHENSIVE SITE ASSESSMENT FOR AREAS NORTH OF THE RACEWAY

21 Canal ST

OXFORD PAPER MILL
LAWRENCE, MASSACHUSETTS

MADEP RTN 3-2691

VOLUME II of II – Appendices A through K

Prepared for:

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DEP
NORTHEAST REGIONAL OFFICE

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December 2004

APPENDICES

Appendix A

Hager GeoScience Report for Geophysical Survey of Wedge Area

GEOPHYSICAL INVESTIGATION
OXFORD MILL SITE
LAWRENCE, MASSACHUSETTS

Prepared for:

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Prepared by:

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596 Main Street
Woburn, Massachusetts 01801

File 200208
April 2002

EXECUTIVE SUMMARY

In March 2002, Hager GeoScience, Inc. (HGI) of Woburn, Massachusetts performed a geophysical investigation for Metcalf & Eddy (M&E) of Wakefield, Massachusetts at the former Oxford Mill site in Lawrence, Massachusetts. The primary objectives of the survey were to establish whether foundations associated with the site's historical structures still existed and to delineate the spatial location and dimensions of subsurface voids.

The geophysical study was designed to acquire a distribution of subsurface data suitable for mapping the spatial extent of former subterranean structures and voids. To meet the primary objectives of the survey, the two geophysical methods of electromagnetic (EM) conductivity and ground penetrating radar (GPR) profiling were employed. The results of the EM conductivity survey revealed two different types of conductivity anomalies: i) broad rectilinear zones of high conductivity delineated by fairly linear boundaries; and ii) scattered point-like targets. Most of the latter anomalies correlate well with the locations of visible surface metal and other debris. The broad, rectilinear anomalies are suggestive of remnant building foundations that may be associated with the former Boiler (Building 19), Black Ash, and Tank Rooms. One oval-shaped EM anomaly, not associated with surface metal, is a candidate for further investigation. GPR records show this anomaly to be caused by buried debris.

EM and GPR data did not show large areas of potential voids. Areas of soil collapse or former razed basements have been identified.

1.0 INTRODUCTION

In March 2002, Hager GeoScience, Inc. (HGI) of Woburn, Massachusetts performed a geophysical investigation for Metcalf & Eddy (M&E) of Wakefield, Massachusetts at the former Oxford Mill site in Lawrence, Massachusetts. The primary objectives of the survey were to establish whether foundations associated with the site's historical structures still existed and to delineate the spatial location and dimensions of subsurface voids.

The study site is bordered to the north and east by the Spicket River, to the south by Canal Street, and to the east by an existing industrial facility. The surface topography gradually dips southward toward the old raceway, except for a north-south trending berm located in the north-central part of the survey area. Localized patches of vegetation and both metallic and non-metallic debris were scattered over the site. Based on borehole data provided by M&E, the site stratigraphy consists of a fine sand fill of variable thickness underlain by alluvial sands and glacial till above competent phyllitic bedrock.

The area of investigation, which was determined by M&E representatives, is shown in Figure 1. The corner of the existing O'Gara Building was chosen as the 0N, 0E grid coordinate, thereby rendering all data acquired as east and south of the coordinate origin. The area of investigation contained large quantities of surface obstructions, which created gaps in the spatial data and produced large anomalies in both EM and GPR records. These obstructions included piles of bricks, I-beams, heavy gauge steel plates, concrete blocks containing rebar, a large roll of chain-link fencing, and thick clusters of bamboo-like vegetation.

2.0 TECHNICAL APPROACH

The geophysical study at the Oxford Mill Site was designed to acquire a distribution of data suitable for mapping the spatial extent of historical subsurface structures and existing voids. To meet the primary objectives of the survey, the two geophysical methods of electromagnetic (EM) conductivity and ground penetrating radar (GPR) were used. Brief descriptions of these two methods are given below, with more detailed information about these techniques and their limitations provided in Section 5.0.

The technique of EM profiling is routinely used to delineate boundaries between natural and building construction materials. The success of this method is contingent on its ability to delineate the significant conductivity contrast between these two types of media. The EM method also measures both the in- and quadrature-phase (conductivity) responses of buried objects to an induced electromagnetic field, which is useful for discriminating between the signatures of metallic objects and variations in ground conductivity, respectively.

The GPR method is amenable to the interrogation and mapping of discontinuous subsurface interfaces, such as subsurface voids and base of foundations. GPR data are collected in two-way travel time, in which the time for the input radar wave pulse to travel to a discontinuity and reflect back to the surface is measured. Information about radar wave propagation velocities, determined through calibration (e.g., from borehole logs) or from other sources, must be used to convert travel times to depth estimates. When acquired at closely spaced intervals (i.e. 2 feet or less), GPR transects may also be used to construct three-dimensional images of the subsurface that help the interpreter infer localized trends.

3.0 DATA ACQUISITION AND REDUCTION

3.1 EM Terrain Conductivity Investigation

The EM survey was performed using a Geophysical Survey Systems, Inc. (GSSI) GEM-300 multi-frequency electromagnetic profiler. EM data were collected on March 7 and 8, 2002 in continuous mode at frequencies of 330, 2550, 5010, 7530, 10050, 12030 and 15030 Hz. Profiles were acquired in north-south and east-west orientations at an interline spacing of 5 feet. Following data acquisition, Magmapper® software was used to incorporate survey geometry into the raw data files and to prepare preliminary contour maps. Final contour plots were produced using SURFER® for Windows software.

3.2 Ground Penetrating Radar Investigation

The GPR survey was performed using a GSSI SIR System 2000 digital GPR unit and a 400-MHz antenna. GPR data were collected on March 7, 8, and 11, 2002. The acquisition window was set at 150 nanoseconds (ns), enabling the recording of backscattered energy from approximately 20 feet below grade. Line spacing for the north-south profiles was 2 feet where surface conditions permitted. GPR data were collected in survey wheel mode, where the antenna is towed behind the operator at the end of a 100-foot control cable and a calibrated wheel measures changes in spatial location.

Following acquisition, data were downloaded and processed using GSSI's RADAN for Windows NT®. Raw data were pre-processed prior to analysis to help mitigate the detrimental effects of difficult ground conditions, radio frequency interference, and reflections from surface structures and buried debris. Pre-processing steps included the application of band pass filters, horizontal stacking, background removal, deconvolution, and gain adjustments. As planned, sufficient data point density permitted the use of GSSI's 3-D modeling program and, consequently, facilitated interpretation of target anomalies.

4.0 RESULTS AND DISCUSSION

The EM and GPR survey results for the Oxford Mill investigation have been reduced and registered onto the site base plan provided by M&E. The CAD file presented with this report has a UCS grid with the origin defined by the south corner of the existing O'Gara Building. GPR data are also presented as images extracted from the three-dimensional model created from the survey data.

Preliminary results were presented in PowerPoint format at a meeting at the M&E offices on March 27, 2001. Final report plates were discussed at a second meeting at the HGI office on April 10, 2001. Appendix B contains pre-survey photographs taken during a site visit on February 12, 2002.

4.1 EM Investigation

Plates 1 and 2 present the results of multi-frequency EM ground conductivity profiling. In-phase data at the 7530 Hz frequency (Plate 1) revealed two types of conductivity anomalies: i) broad zones of moderate conductivity delineated by fairly rectilinear boundaries; and ii) scattered point-like targets. The 7530 Hz, Quadrature-phase component data (Plate 2) again reveal both rectilinear and point-like targets at spatial locations that correlate well with those delineated in Plate 1. Results at other interrogating frequencies are similar to the results presented for 7530 Hz.

The point-like anomalies noted above correspond well with the locations and typical signatures of the visible surface metal and the other debris observed during data acquisition. Accordingly, the type of debris associated with each of these anomalies has been annotated on the plates. Significant sources of point-like anomalies in both the in- and quadrature-phase data include piles of fence material and thick metal plates, a metal-filled berm, and other smaller metallic objects. An isolated anomaly at coordinates 190E, 73S does not correspond with known surface debris. GPR data confirm a debris-style anomaly at this location, while discounting large buried metal.

The spatial locations and dimensions of rectilinear anomalies correspond well with those of structures noted in historical site records. More precisely, the EM conductivity data suggest the existence of remnant building foundations associated with the Boiler (Building 19), Black Ash, and Tank Rooms. Significantly, the lack of quadrature-phase conductivity signatures at the former locations of the Coal Bin and Chemical Mill suggest that associated structures have been removed. In addition, the elevated, north-south trending conductivity anomaly in the western part of the grid may be related to a former railway bed; however, the EM data suggest that the metal railway ties have been removed.

Voids large enough to be resolved with the EM traverse spacing of 5 feet were not observed. Smaller voids or voids located beneath concrete slabs and metal plates cannot be detected by the EM method.

4.2 GPR Investigation

A three-dimensional model of the study area was constructed from the GPR data. Plates 3 through 7 illustrate "Z-slices" representing re-contoured data from horizontal slices through the model at various depths. Examples of actual model z-slices and x-slices (vertical N-S profiles) are presented in Appendix A.

The Z-slice images (Plates 3-7) show the buried foundation outlines, concrete slabs, and the spatial distribution of surface and subsurface debris. Different color transforms are used to emphasize the various features. The GPR model shows that the Boiler Room features occupy the central portion of the study area, extending from the southern limit northward to about 12N. The southern edge of the study area contains the remains of the Boiler, Chemical Mill, Black Ash, and Tank Rooms.

In addition to the foundation outlines, a linear feature that may be a utility passes through coordinates 244E, 49S and 148E, 108S...most likely from the Boiler Room to the Engine Room. This linear feature can be seen in Plates 4-7.

Large voids were not detected by the GPR survey; however, areas of potential collapse next to or under slabs are identified in Plate 8. These areas are most likely the collapsed basements of razed buildings filled with the building debris and containing loosely packed material.

4.3 Data Registration

All the plates show the survey results plotted on the M&E-provided site base plan. These data were registered to the site plan using the south corner of the existing O'Gara Building. On the basis of the survey control and the anomalies noted in the geophysical data, the other buildings shown on the site plan appear to be located 20 to 30 feet west of their correct location.

5.0 DESCRIPTION OF THE GEOPHYSICAL METHODS

5.1 Ground Penetrating Radar

5.1.1 The Method

The principles of ground penetrating radar (GPR) are similar as that of weather radar, but GPR transmits electromagnetic energy into the ground which is reflected back to the surface from interfaces between materials of contrasting electrical (dielectric and conductivity) and physical properties. In general, the greater the contrast between two materials in the subsurface, the stronger will be the GPR reflection. The depth penetration of the GPR signal depends on the properties of the subsurface materials and the frequency of the antenna used to collect radar data. A "rule of thumb" is that the lower the antenna frequency, the deeper the signal penetration; the caveat is, however, a loss of signal resolution.

HGI collects GPR data using a Geophysical Survey Systems (GSSI) SIR System 2 or 2000 digital ground penetrating radar unit, which consists of a computer connected to a transmit/receive antenna. Radar data are collected in point, continuous, or survey wheel mode while moving the antenna across the ground, and are displayed in color on the computer monitor and simultaneously recorded on a hard drive for later processing and interpretation using proprietary RADAN® for Windows software. Hard copies of the data may be printed in the field on a thermal printer.

5.1.2 Data Analysis and Interpretation

The horizontal scale of the GPR record shows distance along the survey traverse. In the continuous data collection mode, the horizontal scale on each GPR record is determined by the antenna speed. When a survey wheel is used, as at this site, the GPR record is automatically marked at specified intervals along the traverse. The vertical scale of the radar records is determined by the recording interval, which represents the maximum recorded two-way travel time. The conversion of two-way travel time to depth depends on the site-specific propagation velocity of the GPR signal. In the absence of site-specific stratigraphic information, propagation velocities are estimated from handbook values or experience at similar sites.

The size, shape, and amplitude of GPR reflections are used to interpret GPR data. Metal objects such as USTs or utilities produce reflections with high amplitude and distinctive hyperbolic shapes in GPR records when traverses are made perpendicular to their long axes. Clay or concrete pipes and boulders may produce radar signatures of similar shape but lower amplitude. Boundaries between saturated and unsaturated materials, sand and clay, and bedrock and overburden, generally also produce strong reflections.

5.1.3 Limitations

GPR signal penetration is site specific, determined by the dielectric properties of local soil and fill materials. GPR signals propagate well in resistive materials such as sand and gravel; however, soils containing clay, ash- or cinder-laden fill, or fill saturated with brackish or otherwise conductive groundwater cause GPR signal attenuation and loss of target resolution (i.e., limited detection of small objects). Concrete containing rebar or mesh also inhibits signal penetration.

Interpreted depths of objects detected using GPR are based on on-site calibration, handbook values, and/or estimated GPR signal propagation velocities from similar sites. GPR velocities and depth estimates may vary if the medium of investigation or soil water content is not uniform throughout the site. (Electromagnetic waves do not travel as fast through water as air, so the distance to a reflector below the water table may appear farther than in actuality.)

Utilities are interpreted on the basis of reflectors of similar size and depth that show a linear trend, but GPR cannot unambiguously determine that all such reflectors are related. Fiberglass USTs or utilities composed of plastic or clay may be difficult to detect, as well as objects underneath reinforced concrete pads.

Changes in the speed at which the GPR antenna is moved between stations causes slight variations in distance interpolations, and hence in interpreted object positions.

The GPR antenna produces a cone-shaped signal pattern that emanates approximately 45 degrees from horizontal fore and aft of the antenna. Therefore, buried objects may be detected before the antenna is located directly over them, and GPR anomalies may appear larger than actual target dimensions.

GPR is an interpretive method, based on the subjective identification of reflection patterns that may not uniquely identify a subsurface target. Borings, test pits, or site utility plans must verify the results.

5.2 EM Terrain Conductivity

5.2.1 Description of the Method

The EM technique operates on the principle that secondary electric and magnetic currents can be induced in metal objects and conductive bodies, such as USTs, utilities, and leachate, when an electric field is applied. This instrumentation measures the secondary magnetic field strength relative to the primary magnetic field and converts it directly into a conductivity value. Both the quadrature-phase (conductivity) and in-phase components of the secondary electric field are measured and values plotted in parts per million (ppm). In general, the quadrature-phase (conductivity) data provide information about soil and groundwater conditions, while the in-phase data provide information about metal objects. The instrument response is more affected by near surface than by deeper material.

We collect terrain conductivity data using a GSSI GEM-300 multi-frequency electromagnetic profiler. The GEM-300 is field-programmable to operate at simultaneous, multiple frequencies between 325 and 19975 Hz. The GEM sensor contains a transmitter and receiver coil separated by about 5.5 feet, and a third "bucking coil" that removes the primary field from the receiver coil. All coils are molded into a single board in a fixed geometry.

A removable signal-processing console is attached to the board, from which data are downloaded to a computer and processed. The GEM-300 is capable of detecting underground targets and features to a depth of 26 feet.

5.2.2 Data Analysis and Interpretation

Terrain conductivity surveys are commonly used to determine the lateral extent of fill and detect buried metal objects, utilities, and conductive leachate plumes. Typically, terrain conductivity values measured on fill materials are irregular and highly variable over short distances due to metal and the heterogeneous materials in the subsurface. The edge of fill materials is marked by a change to smoothly varying terrain conductivity values that represent native soils.

At sites free of metal objects and other cultural interference, the soil lithology and/or the conductivity of the ground water control the terrain conductivity measured at a particular location. In the presence of metal, conductivity values are often negative ("polarity reversals") and highly irregular. However, the exact identification of objects cannot be determined from the terrain conductivity data alone. The in-phase component helps confirm the location of metal objects when correlated with conductivity data. Irregular or high positive or negative in-phase values may be caused by metal objects and help define their lateral extent.

5.2.3 Limitations

EM conductivity values are influenced by proximity to aboveground metal objects, such as fences, vehicles, or buildings. Magnetic fields produced along overhead power lines also interfere with terrain conductivity readings.

The shape and amplitude of conductivity and in-phase anomalies do not uniquely describe a buried object or material. Rather, they are influenced by the orientation of EM survey lines and the buried object(s) relative to north, and the orientation of the EM sensor relative to this buried object(s). To better locate the source(s) of EM conductivity and in-phase anomalies, data are frequently collected in two perpendicular directions.

High ambient conductivity readings (from a conductivity plume, sludge, or naturally occurring geologic condition) may mask anomalous conductivity values caused by metal objects. Evaluating the in-phase component of the data minimizes this effect.

Closely spaced buried utilities may produce anomalies that interfere with each other. Hence, in areas where numerous utilities are present, the observed anomaly may result from an interference pattern and may not uniquely describe the location of a specific utility. Further, anomalies often appear larger than the object that produces them.

Smaller utilities, or utilities constructed from reinforced concrete, may be masked by larger utilities constructed of metal. Nonmetallic fill such as un-reinforced concrete rubble and utilities constructed from PVC, clay, or un-reinforced concrete may not be detected.

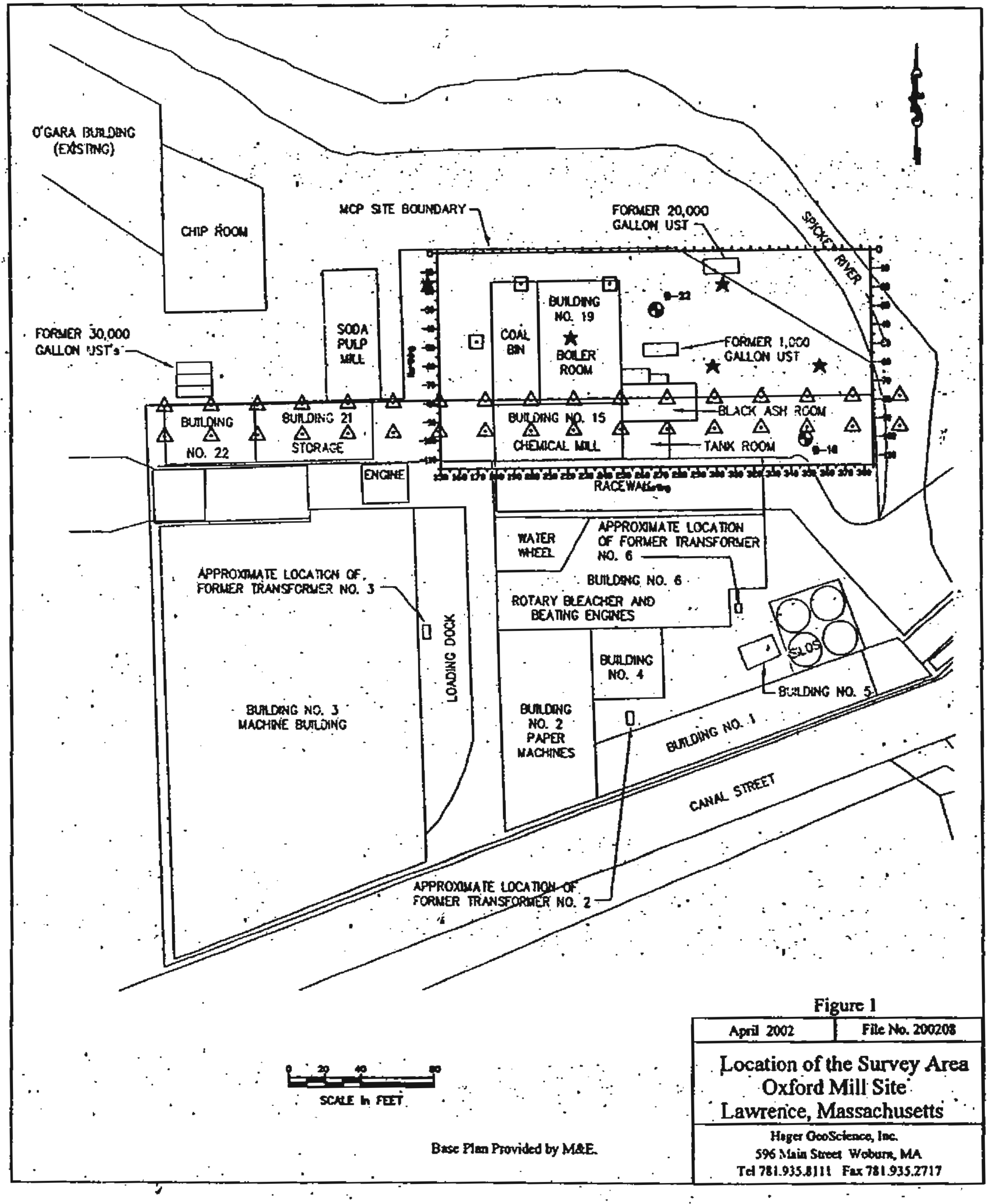


Figure 1

April 2002	File No. 200208

Location of the Survey Area
Oxford Mill Site
Lawrence, Massachusetts

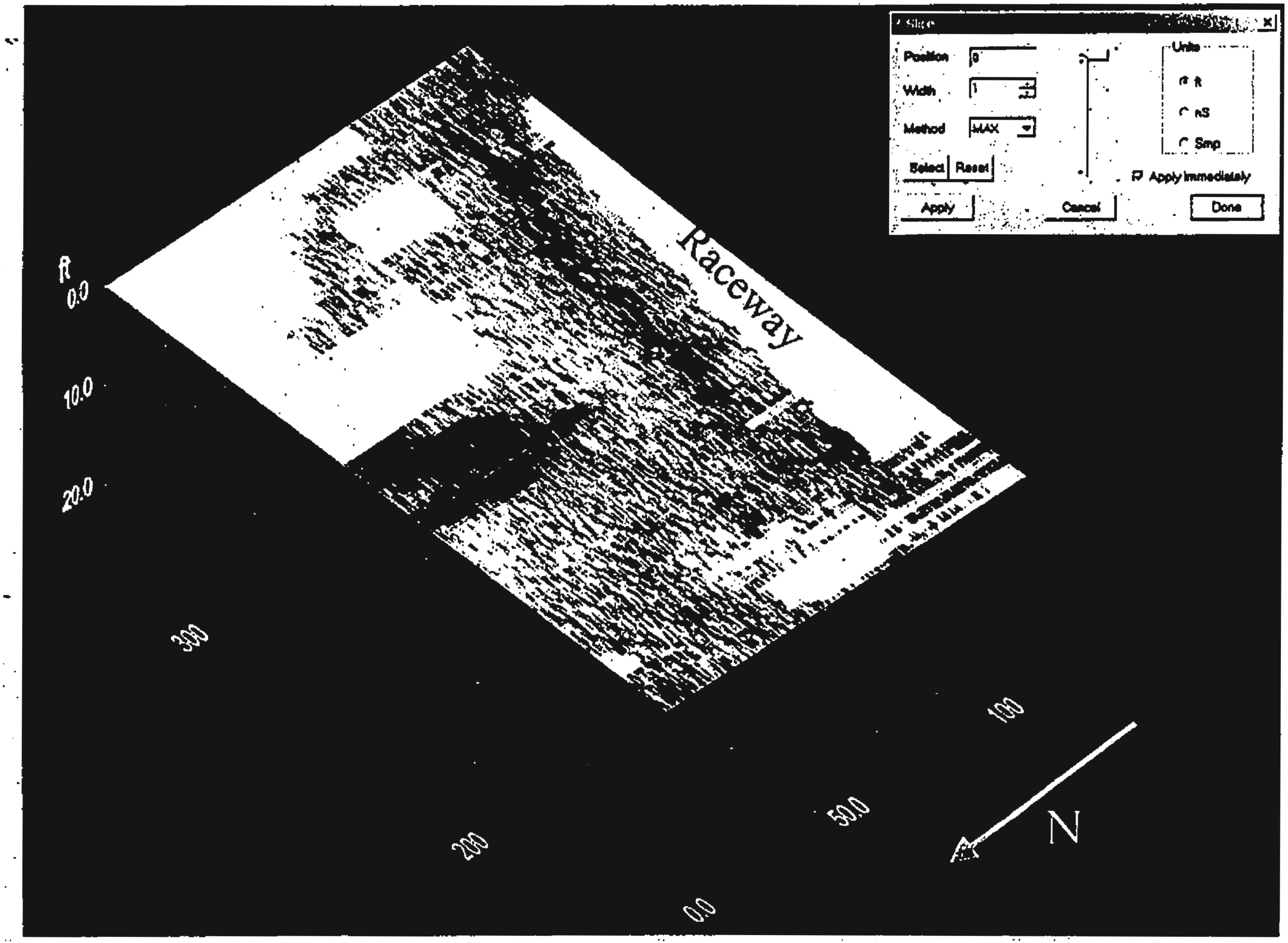
Hager GeoScience, Inc.
596 Main Street Woburn, MA
Tel 781.935.8111 Fax 781.935.2717

APPENDIX A. Z- AND X-SLICES THROUGH 3-D GPR MODEL

Geophysical Investigation
Oxford Mill Site
Lawrence, Massachusetts

File 200208

Depth=0 ft - 1 wide MAX



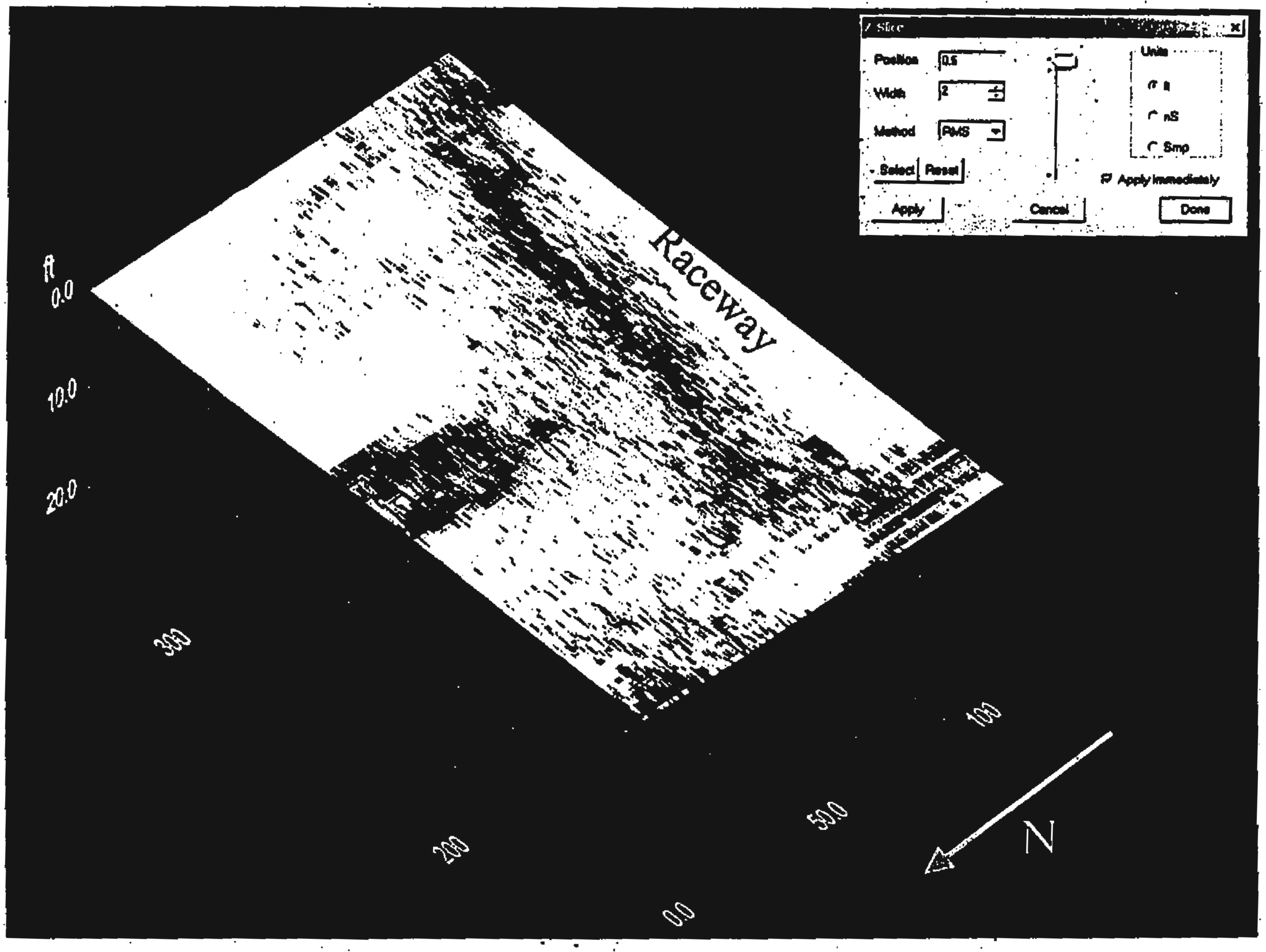
Slice

Position: 0
Width: 1
Method: MAX
Units: ● ft ○ nS ○ Smp
☑ Apply Immediately

Geophysical Investigation
Oxford Mill Site
Lawrence, Massachusetts

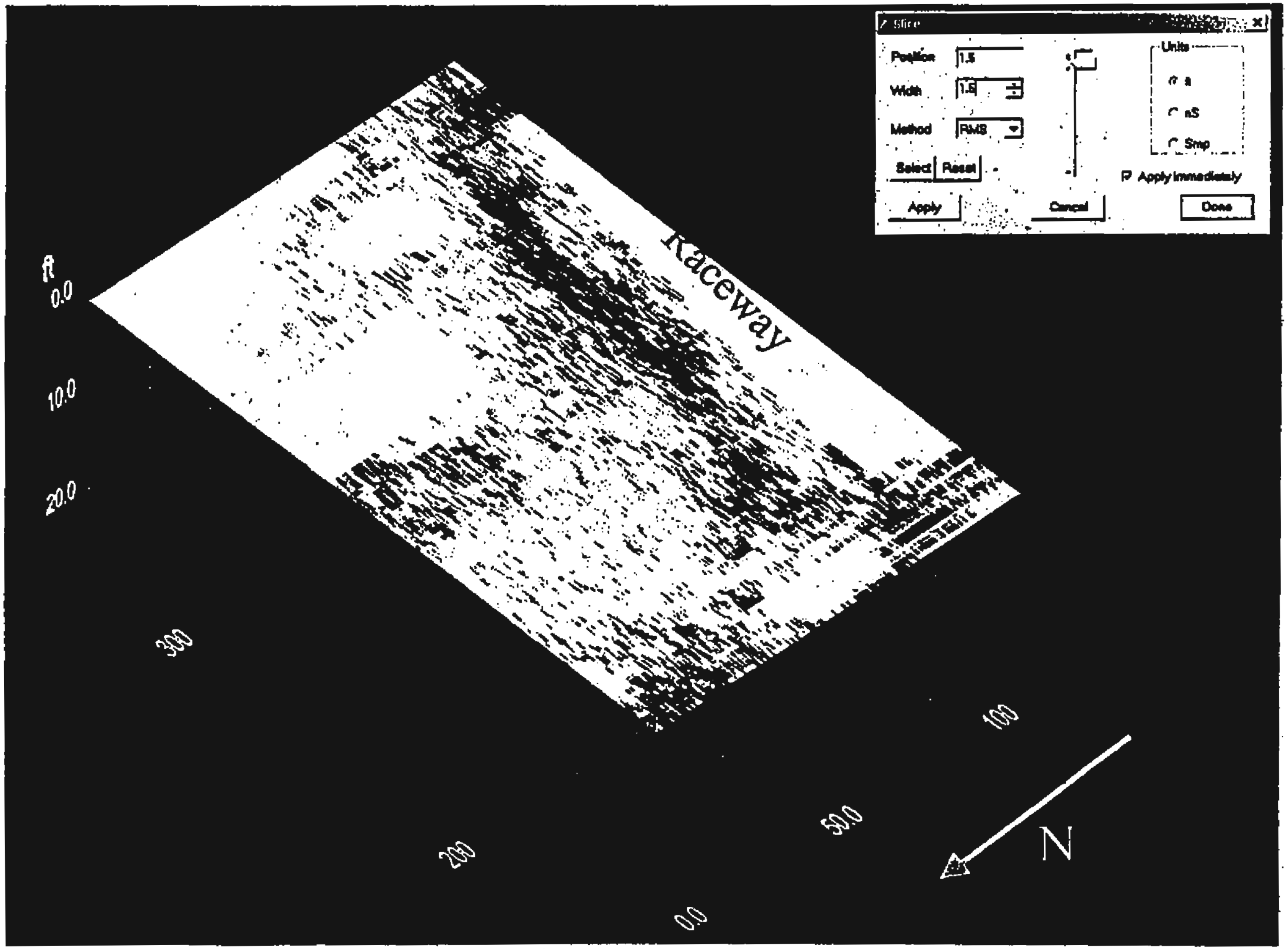
File 200208

Depth=0.5 ft - 2 wide RMS



Position 0.5
Width 2
Method RMS
Units ● ft ○ nS ○ Smp
☑ Apply immediately

Depth=1.5 ft - 1.5 wide RMS



Position 1.5

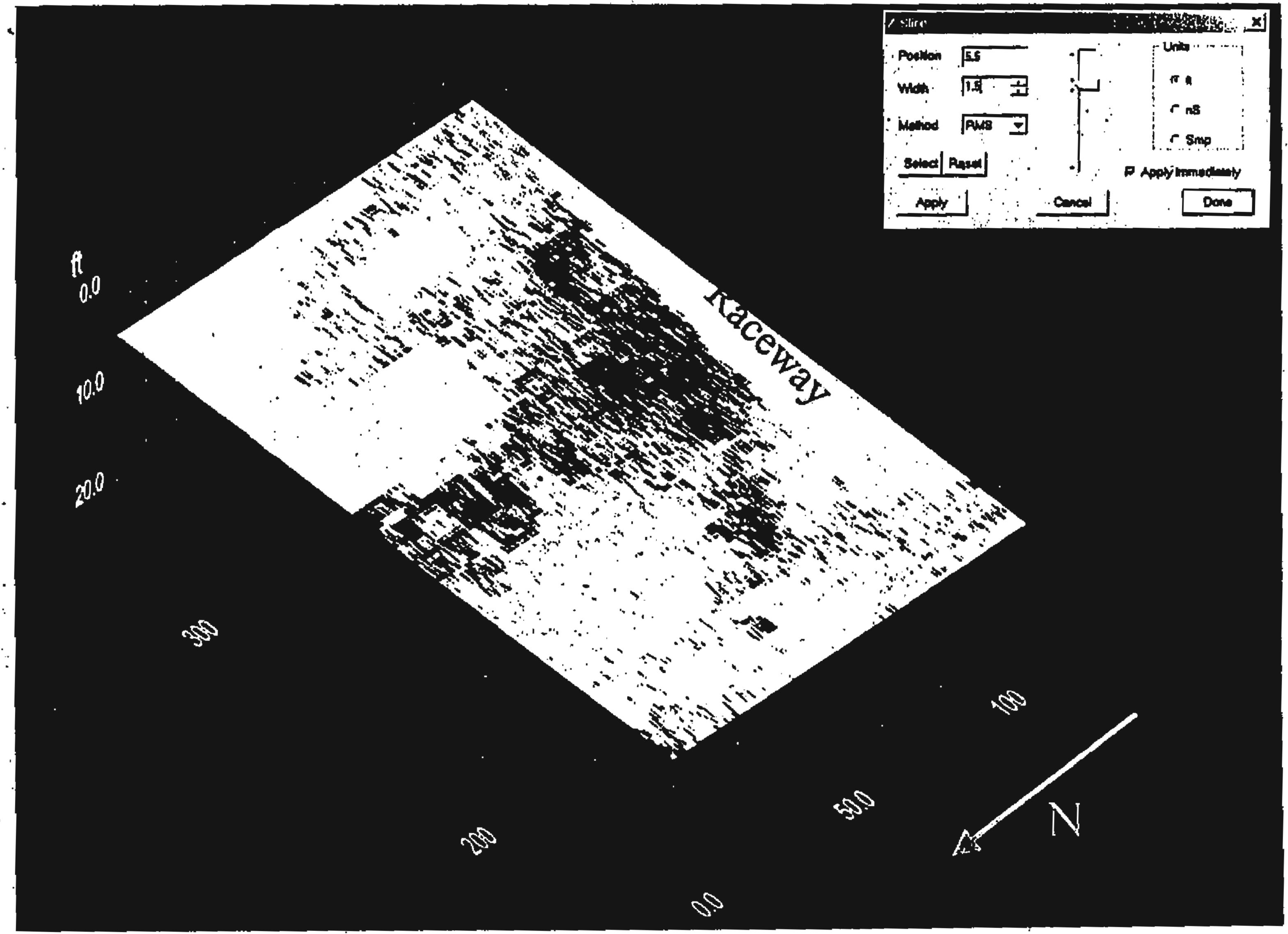
Width 1.5

Method RMS

Units
● ft
○ nS
○ Smp

☑ Apply Immediately

Depth=5 ft - 1.5 wide RMS



Slice

Position: 5.5

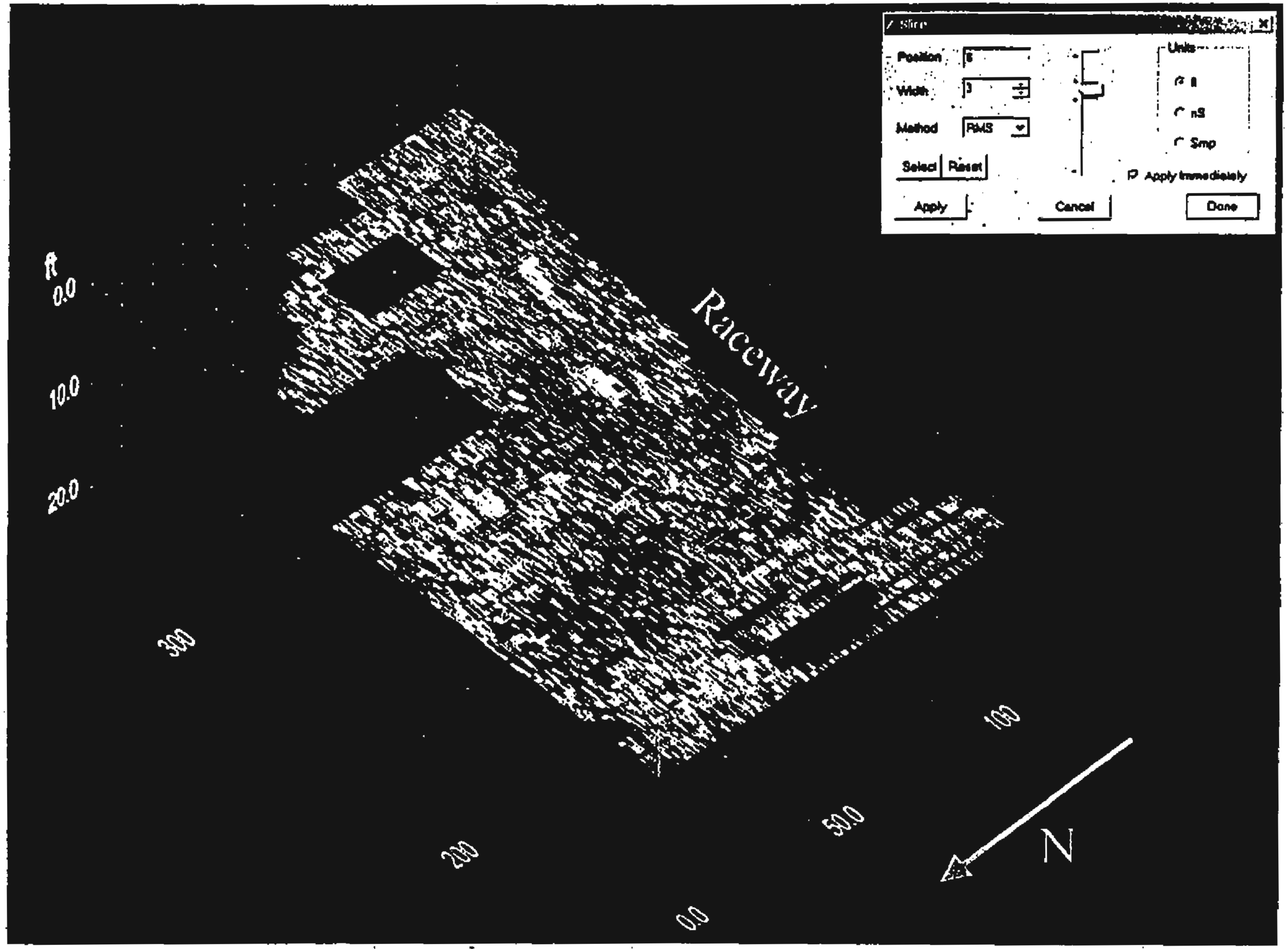
Width: 1.5

Method: RMS

Units: ● ft ○ nS ○ Smp

☑ Apply Immediately

Depth=6 ft - 3 wide RMS



Slice

Position 6

Width 3

Method RMS

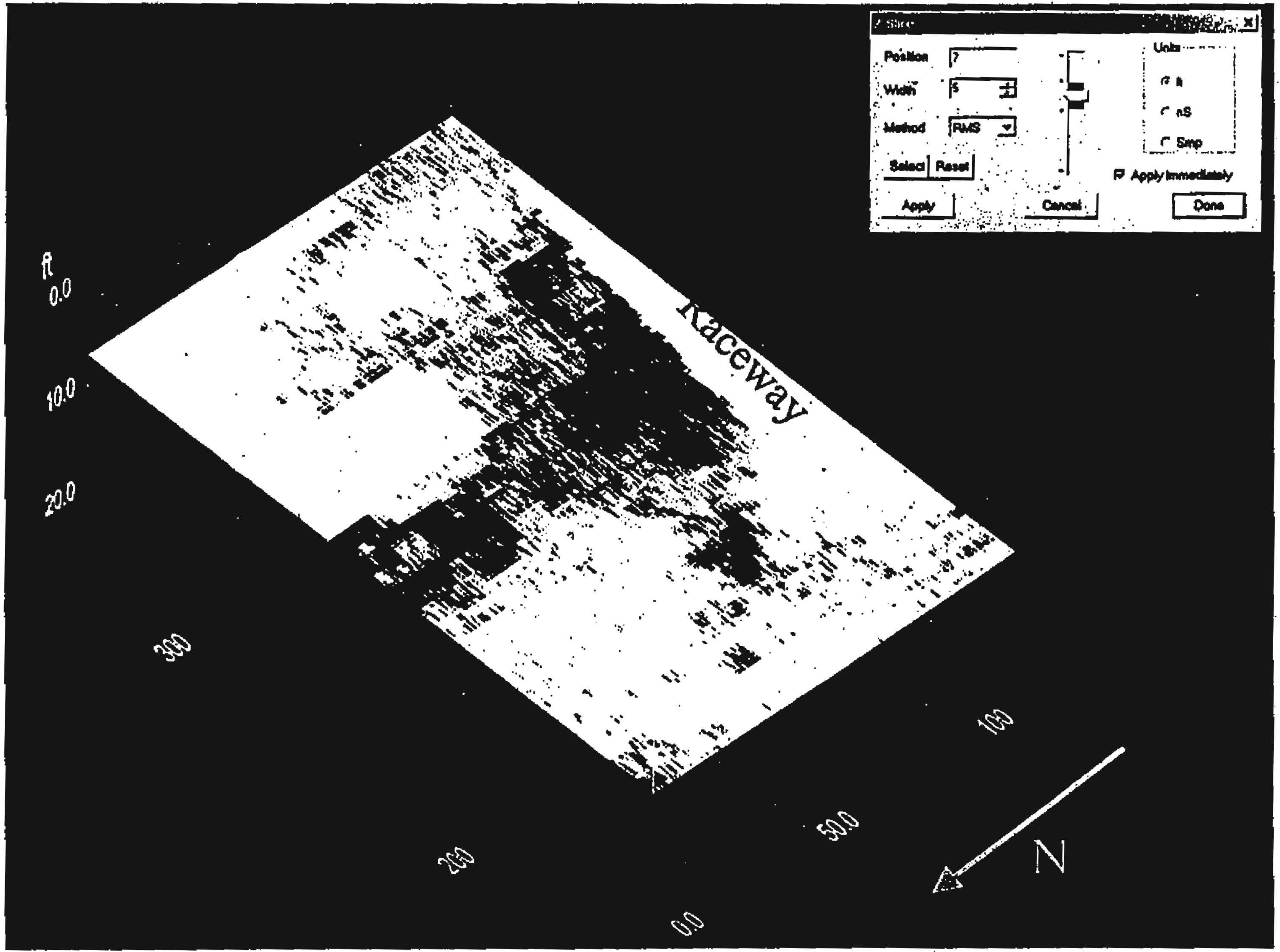
Units
● ft
○ nS
○ Smp

☑ Apply immediately

Geophysical Investigation
Oxford Mill Site
Lawrence, Massachusetts

Depth=7 ft - 5 wide RMS

File 200208

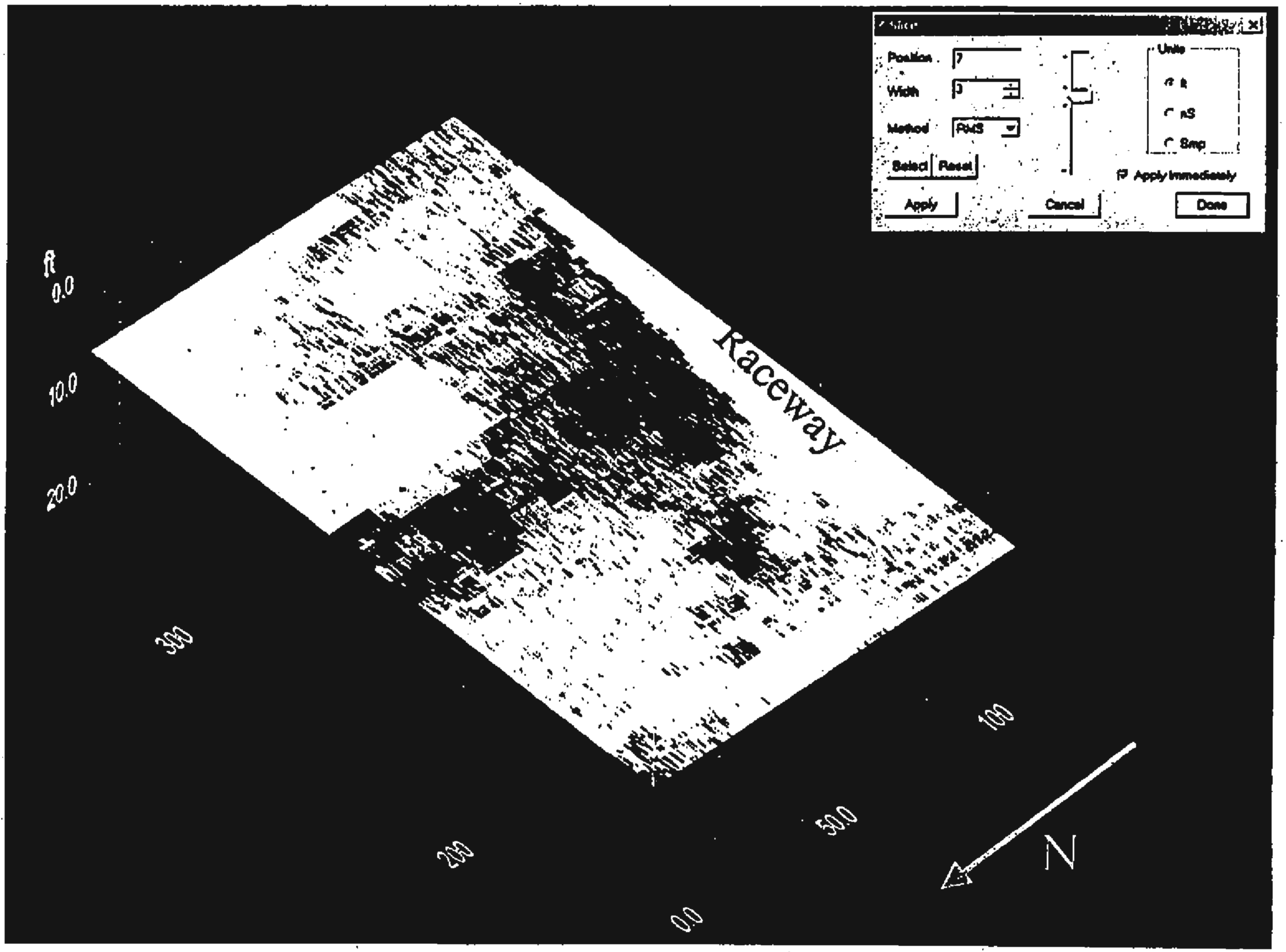


Position 7
Width 5
Method RMS
Units ◉ ft
☑ Apply Immediately

Geophysical Investigation
Oxford Mill Site
Lawrence, Massachusetts

File 200208

Depth=7 ft - 3 wide RMS


Z Slice

Position 7

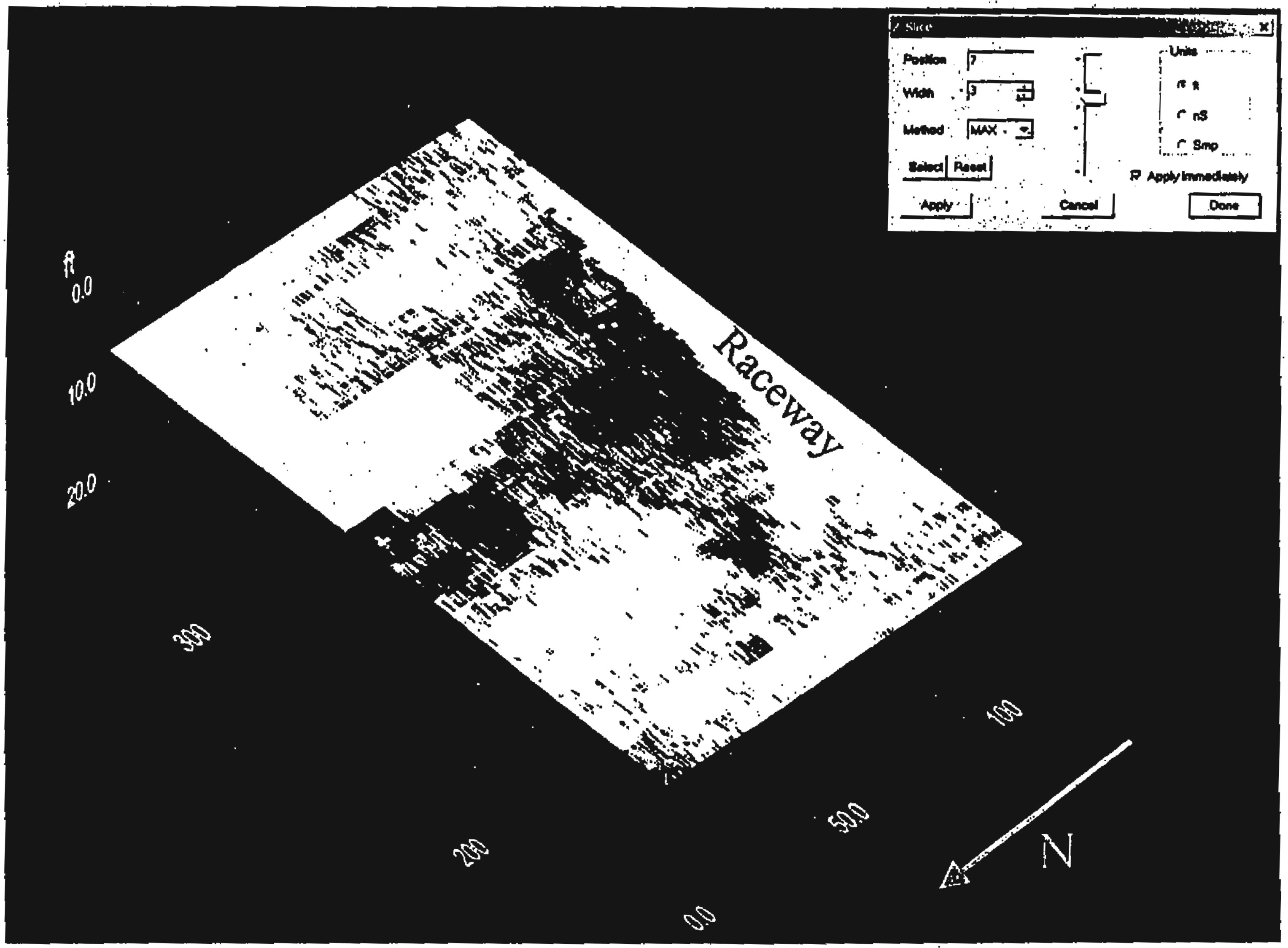
Width 3

Method RMS

Units: ● ft ○ nS ○ Smp

☑ Apply Immediately

Depth=7 ft - 3 wide MAX



Slice

Position 7

Width 3

Method MAX

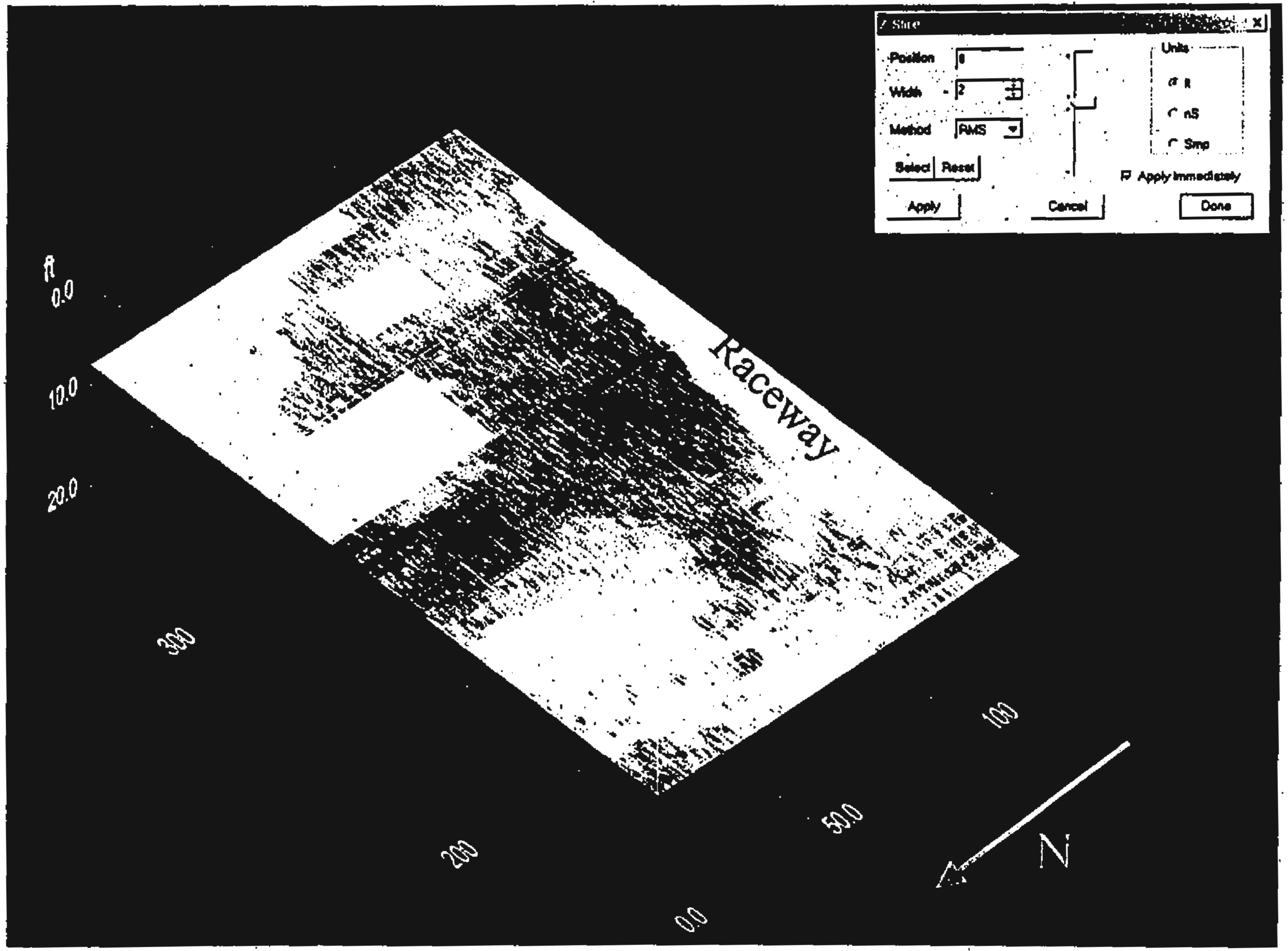
Units
- ● ft
- ○ nS
- ○ Smp

☑ Apply Immediately

Geophysical Investigation
Oxford Mill Site
Lawrence, Massachusetts

Depth=8 ft – 2 wide RMS

File 200208



Slice

Position: 8
Width: 2
Method: RMS

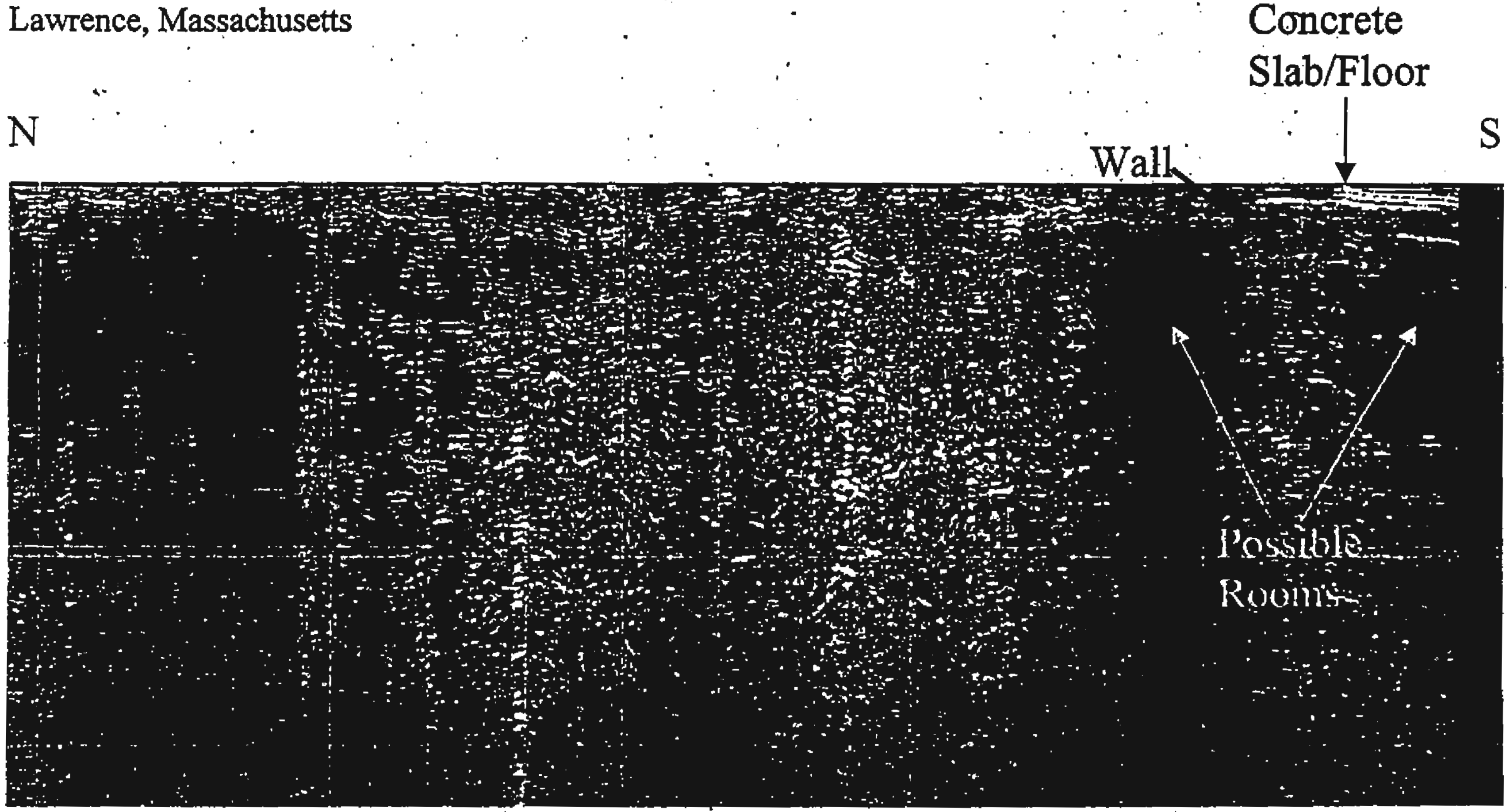
Units
● ft
○ nS
○ Smp

☑ Apply Immediately

Geophysical Investigation
Oxford Mill Site
Lawrence, Massachusetts

186E Slice

File 200208



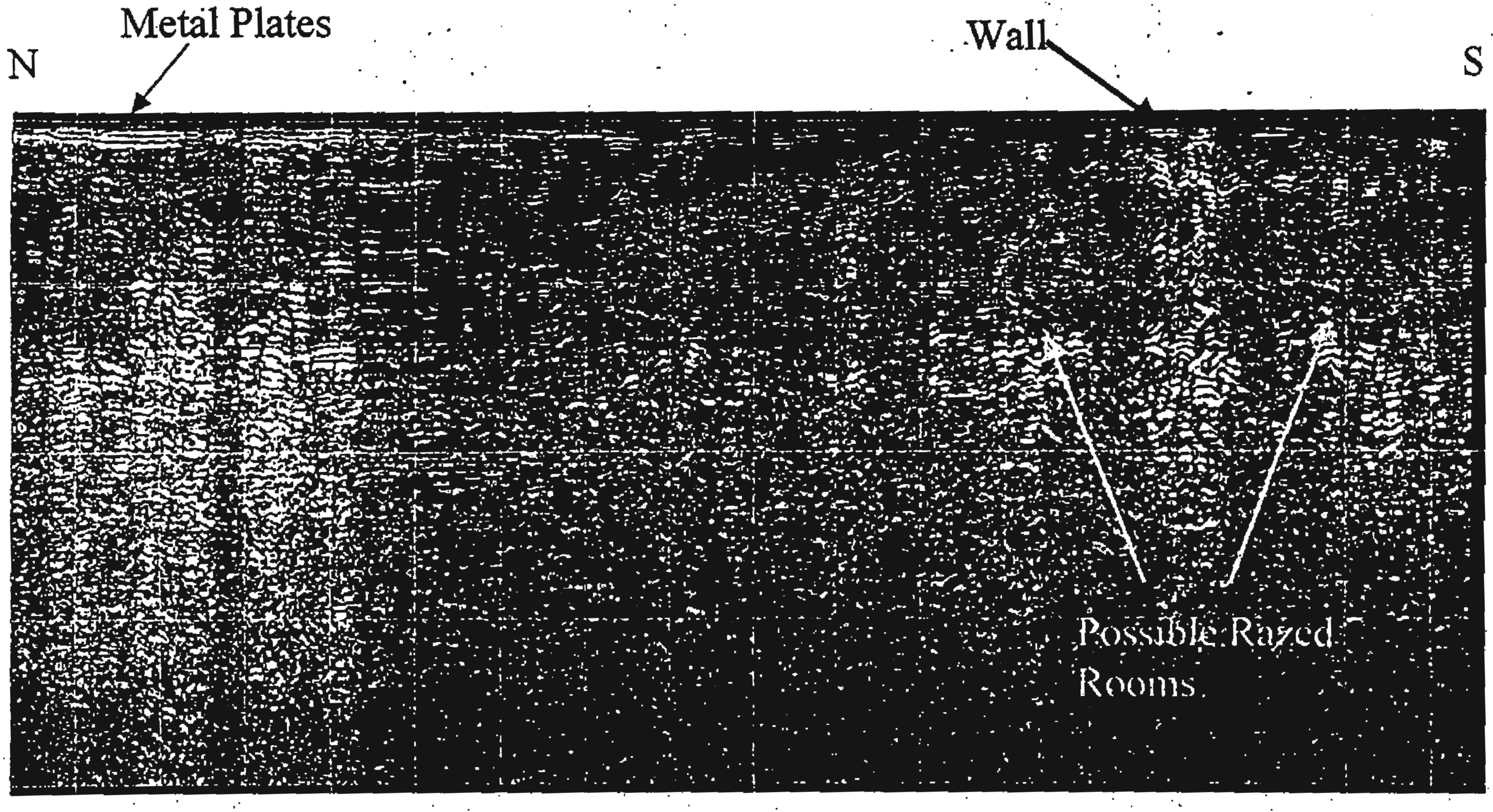
4/13/2002

Hager GeoScience, Inc.

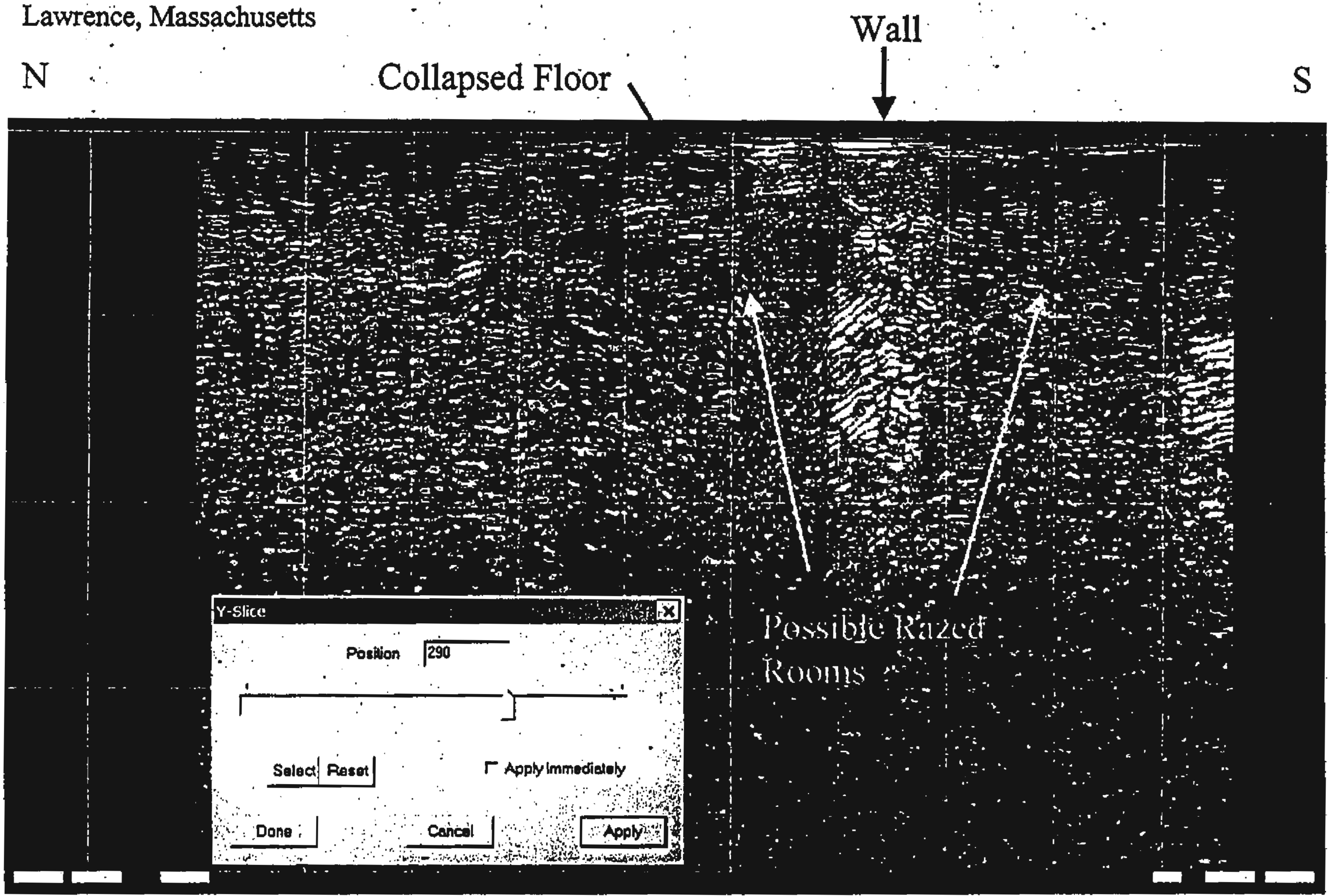
Geophysical Investigation
Oxford Mill Site
Lawrence, Massachusetts

247E Slice

File 200208



290E Slice



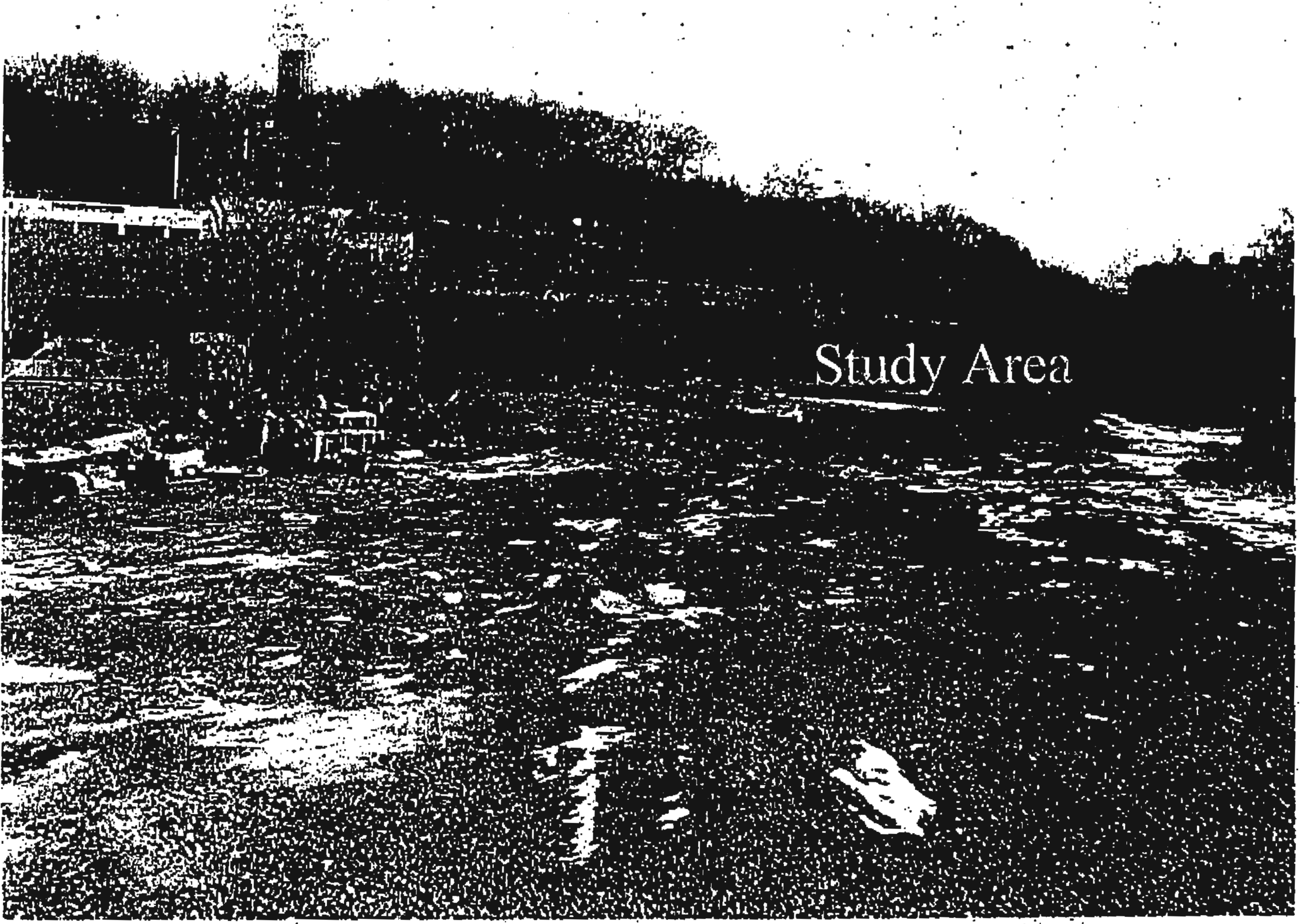
Position 290

APPENDIX B. SITE VISIT PHOTOS

Geophysical Investigation
Oxford Mill Site
Lawrence, Massachusetts

File 200208

Study Area
View Looking Northeast



4/13/2002

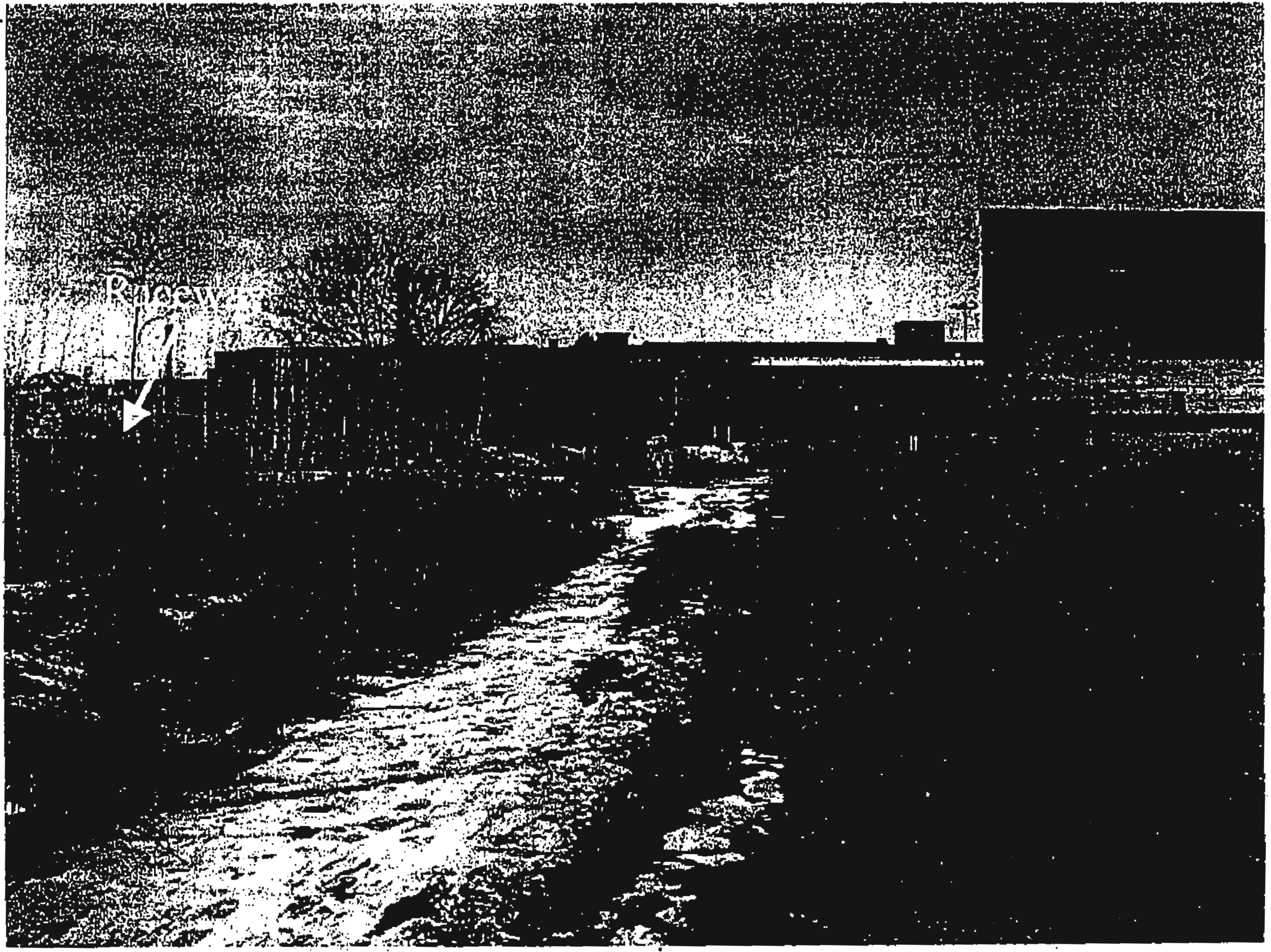
Hager GeoScience, Inc.

Geophysical Investigation
Oxford Mill Site
Lawrence, Massachusetts

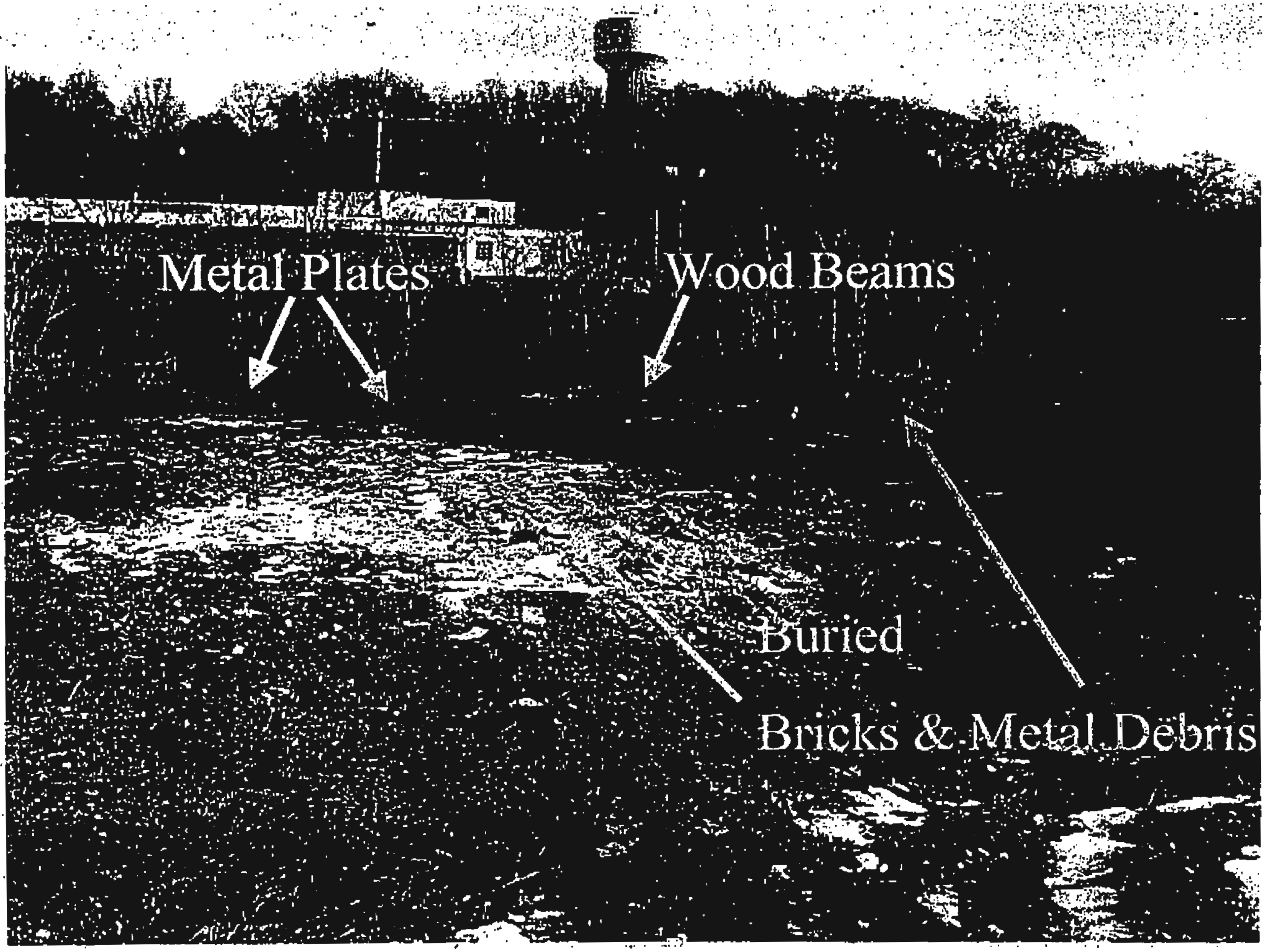
File 200207

Study Area
View Looking East

Study Area
View Looking West



Study Area
View Looking Northeast



Raceway

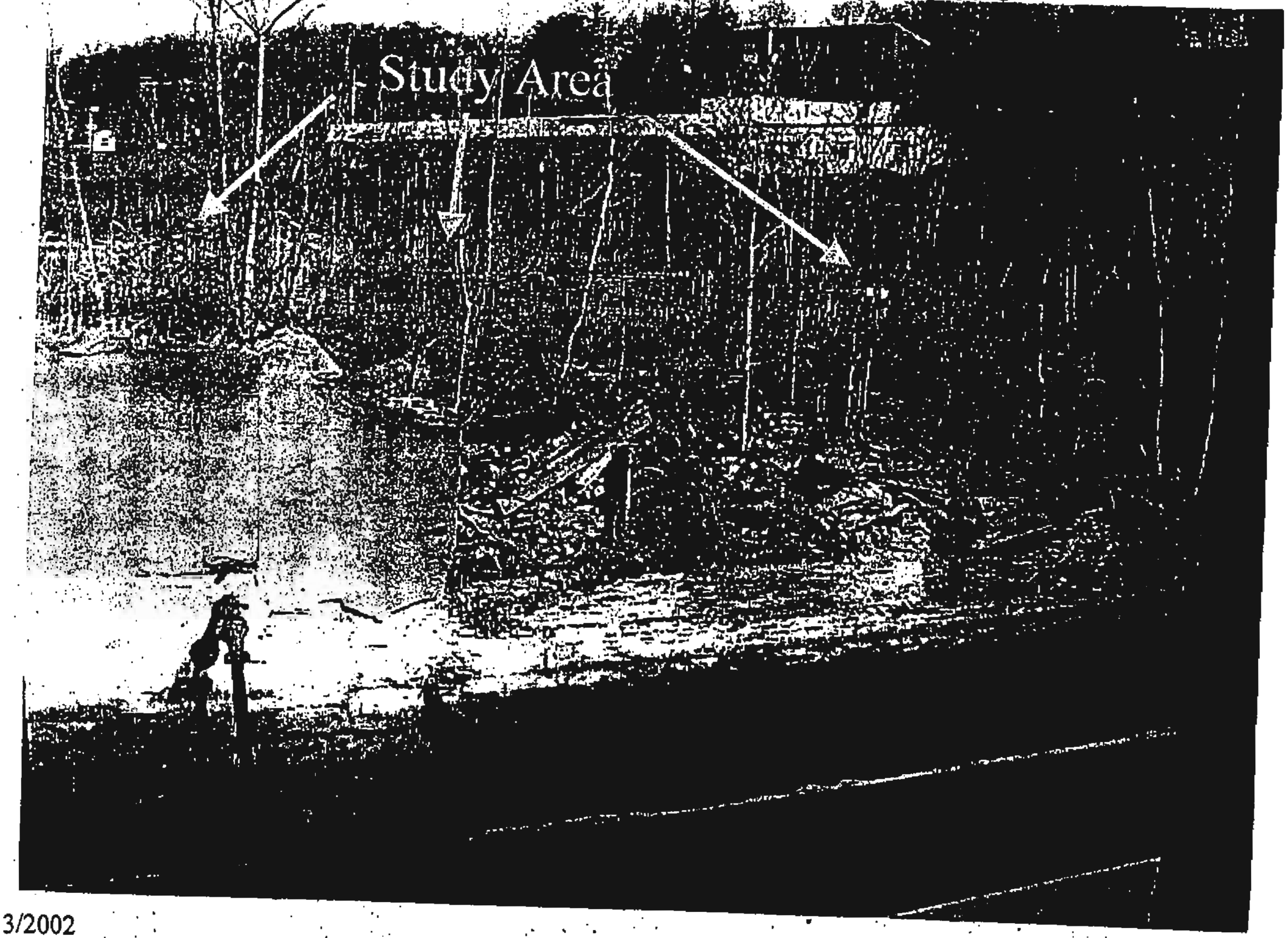
Looking East from West Walkway

Geophysical Investigation
Oxford Mill Site
Lawrence, Massachusetts

File 200208

Raceway

Looking Northeast from Building No. 6



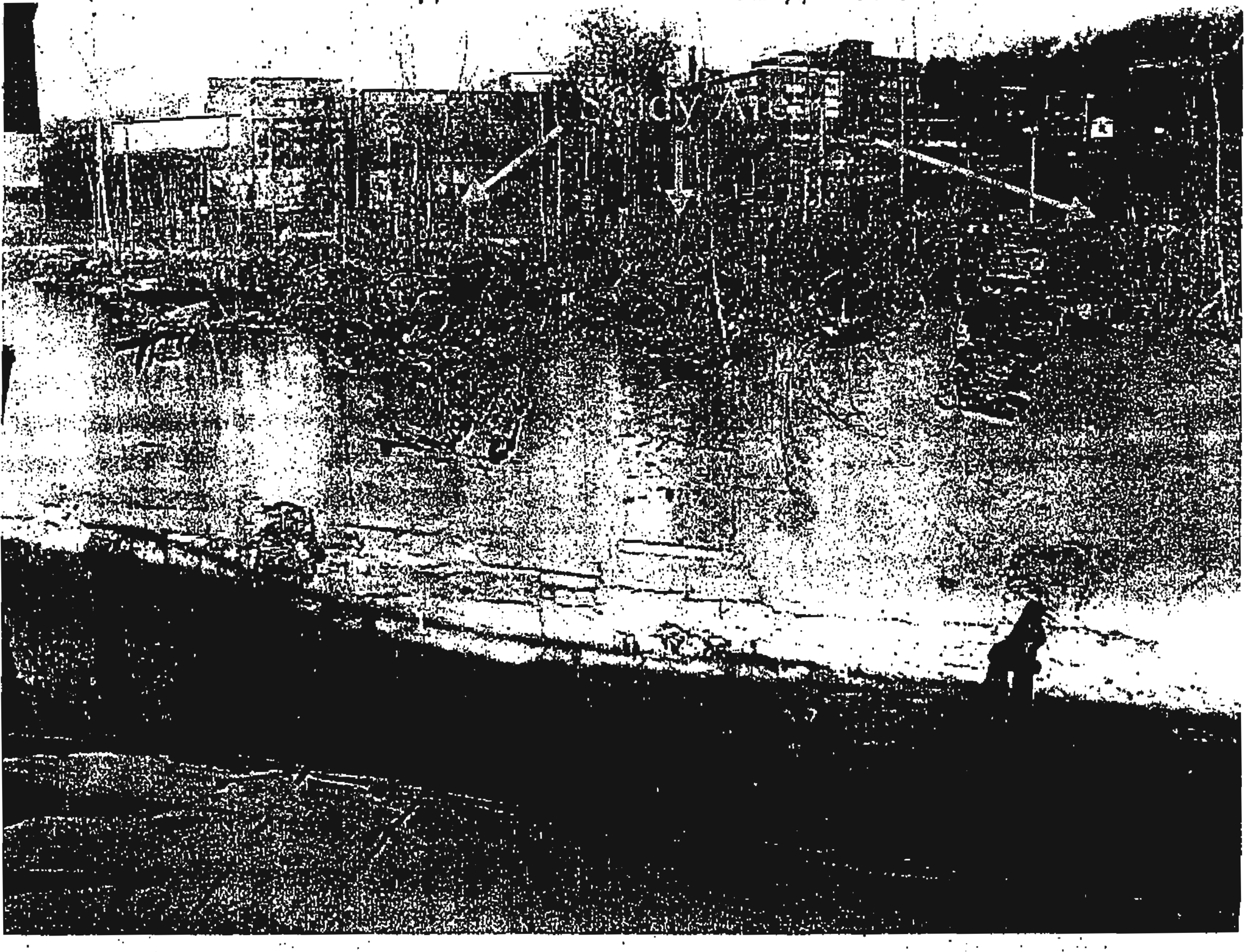
4/13/2002

Geophysical Investigation
Oxford Mill Site
Lawrence, Massachusetts

File 200208

Raceway

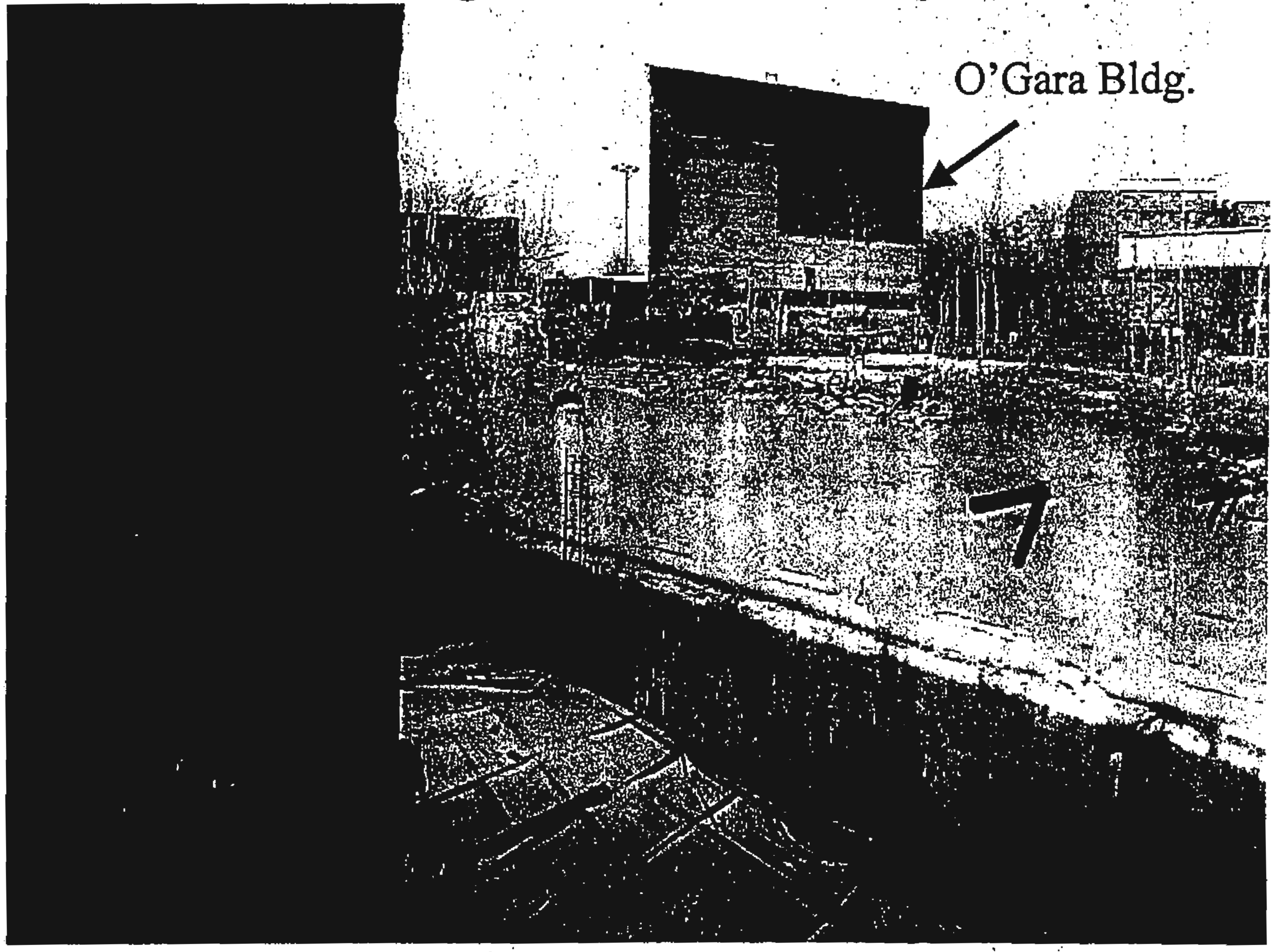
Looking North from Building No. 6



4/13/2002

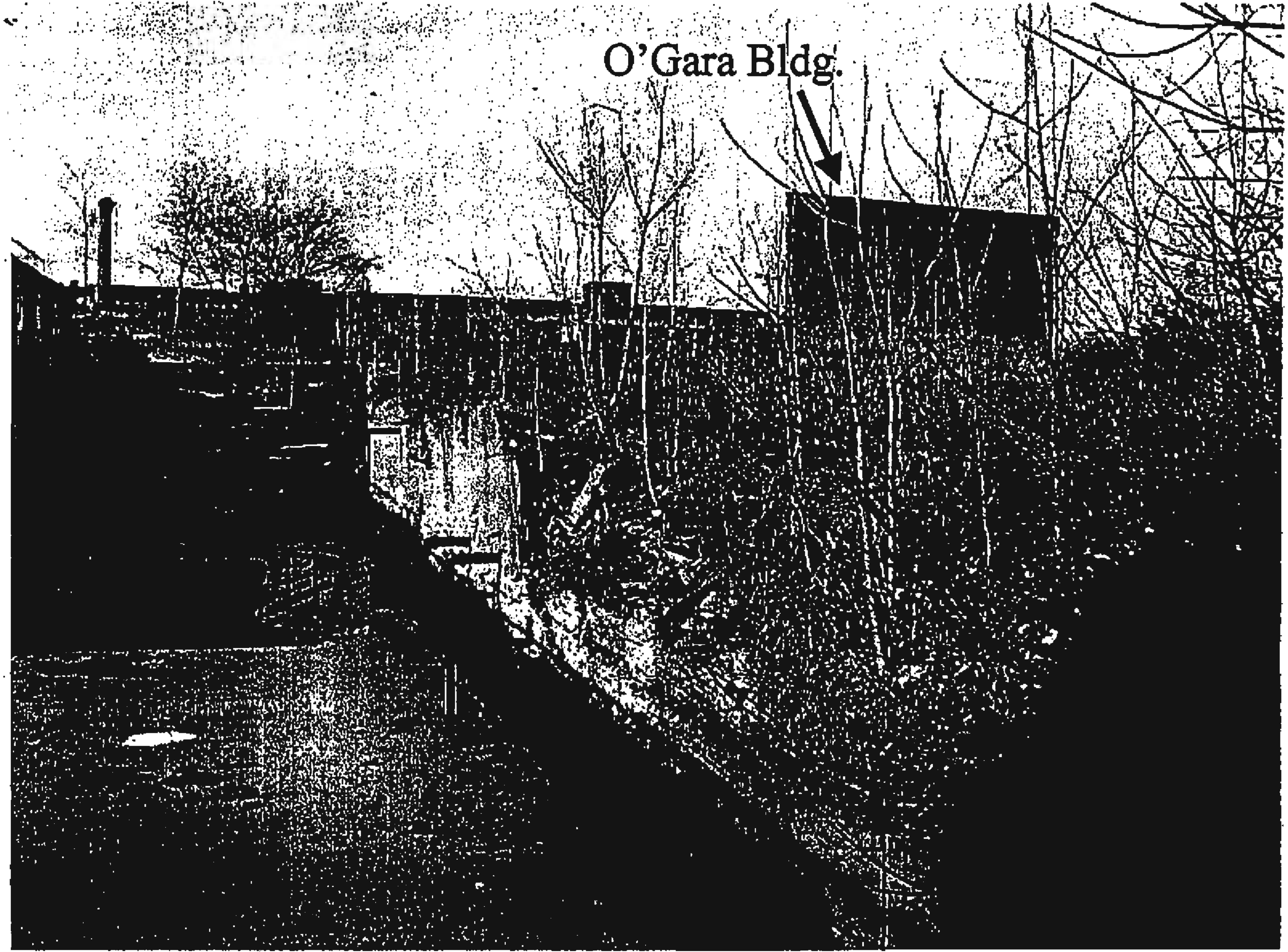
Raceway

Looking Northwest from Building No. 6



Raceway

Looking West from East Walkway



Appendix B

Asbestos Air Monitoring Results During March 2003 Site Investigation

March 05, 2003

DOH ELAP# 11626

Mr. Les Tyrala
Shaw Environmental & Infrastructure
100 Technology Center Drive
Stoughton, MA 02072

Re: Client Account# 14965 Login# L90677

Dear Mr. Tyrala:

Enclosed are the analytical results of the samples received by our laboratory March 04, 2003.

Results in this report are based on the sampling data provided by the client. Unless otherwise requested, all samples will be discarded sixty days from the date of this report.

Please contact your client service representative, Nancy Ackerman at (888) 577-5227, extension 305, if you require additional information regarding this report.

Thank you for using Galson Laboratories.

Sincerely,

Galson Laboratories

Pamela A. Weaver
Asbestos Section Supervisor

Enclosure(s)

Galson
Laboratories
6601 Kirkville Rd. E Syracuse,NY 13057

LABORATORY ANALYSIS REPORT

Client : Shaw Environmental & Infrastructure
Site : Oxford Paper Mill-Lawrence,MA
Project No. : 608134 05000000

Date Sampled : 03-MAR-03
Date Received : 04-MAR-03
Date Analyzed : 04-MAR-03

Account No.: 14965
Login No. : L90677

Total Fiber Count

Sample ID	Lab ID	Fibers/ Fields	Fibers/ mm2	Fibers/ Filter	Air Volume (cc)	Fibers/ cc
G150292	L90677-2	0/100	<13	<5000	780,000	<0.006
G150232	L90677-3	1/100	<13	<5000	776,000	<0.006
G150233	L90677-4	2.5/100	<13	<5000	789,000	<0.006
G150215	L90677-5	1.5/100	<13	<5000	715,000	<0.007
G150163	L90677-6	12.5/100	15.9	6122	720,000	0.009
G150166-BLANK	L90677-7	0/100	<13	<5000	NA	NA

COMMENTS: Field sampling was not performed by GALSON Laboratories.
Results are based on the sampling data provided by the client.

Sample Matrix : Air
Analytical Method : NIOSH 7400; PCM
Limit of Quantitation : 10 Fibers/ 100 Fields
Microscope field area : 0.00785 mm2
Filter collection area: 385 mm2

Submitted by : SKS
Approved by : SKS
Date : 04-MAR-03
QC by:
NYSDOH # : 11626

< -Less Than
\> -Greater Than
ND -Not Detected
NA -Not Applicable
cc -Cubic Centimeters
NS -Not Specified
mm2 -Square millimeters

Intralaboratory & Interlaboratory relative standard deviation records are on file and can be provided upon request.

Galson
Laboratories
6601 Kirkville Rd. E. Syracuse, NY 13057

LABORATORY ANALYSIS REPORT

Client : Shaw Environmental & Infrastructure
Site : Oxford Paper Mill-Lawrence,MA
Project No. : 608134 05000000

Date Sampled : 03-MAR-03
Date Received : 04-MAR-03
Date Analyzed : 04-MAR-03

Account No.: 14965
Login No. : L90677

Bulk Asbestos Analysis

Sample ID	Lab ID	Color	%Asb.	Type 1	%Asb.	Type 2	%Asb.	Type 3	%/Type Other Fibers
TP-E	1	Off White	65	CH	ND	NA	ND	NA	20 CE

COMMENTS: Field sampling was not performed by GALSON Laboratories.
Results are based on the sampling data provided by the client.
This report should not be reproduced, except in full, without the written approval of Galson Laboratories.

Analytical Method : Polarized light microscopy/ dispersion staining. EPA 40 CFR Ch. 1 (7-1-87 Ed.) Part 763, Subpart F, App. A.

Submitted by : SW
Approved by : SW
Date : 04-MAR-03 QC by:
NYSDOH # : 11626

TR- Trace(< 1%)	AC- Actinolite	CR- Crocidolite	NA- Not Applicable
CE- Cellulose	AM- Amosite	TM- Tremolite	NS- Not Specified
FG- Fibrous Glass	AN- Anthophyllite		ND- Not Detected
SY- Synthetic	CH- Chrysotile		> - Greater than

Results relate only to items analyzed, and may not be used to claim product endorsement by NVLAP or any US government agency. Laboratory accredited under NYS ELAP(#11626) and NVLAP(#101375-0). Measurement uncertainty records based on interlab analysis are on file, and are available upon request.

March 05, 2003

DOH ELAP# 11626

Mr. Les Tyrala
Shaw Environmental & Infrastructure
100 Technology Center Drive
Stoughton, MA 02072

Re: Client Account# 14965 Login# L90703

Dear Mr. Tyrala:

Enclosed are the analytical results of the samples received by our laboratory March 05, 2003.

Results in this report are based on the sampling data provided by the client. Unless otherwise requested, all samples will be discarded sixty days from the date of this report.

Please contact your client service representative, Nancy Ackerman at (888) 577-5227, extension 305, if you require additional information regarding this report.

Thank you for using Galson Laboratories.

Sincerely,

Galson Laboratories

Pamela A. Weaver
Asbestos Section Supervisor

Enclosure(s)

Galson Laboratories
6601 Kirkville Rd. E Syracuse,NY 13057

LABORATORY ANALYSIS REPORT

Client : Shaw Environmental & Infrastructure
Site : Lawrence, MA-Oxford Paper Mill
Project No. : 60813405000000

Date Sampled : 04-MAR-03
Date Received : 05-MAR-03
Date Analyzed : 05-MAR-03

Account No.: 14965
Login No. : L90703

Total Fiber Count

Sample ID	Lab ID	Fibers/ Fields	Fibers/ mm2	Fibers/ Filter	Air Volume (cc)	Fibers/ cc
G150394	L90703-1	1/100	<13	<5000	902,000	<0.006
G150371	L90703-2	1.5/100	<13	<5000	906,000	<0.006
G150219	L90703-3	0/100	<13	<5000	919,000	<0.005
G150211	L90703-4	13/100	16.6	6391	877,000	0.007
G150482	L90703-5	11.5/100	14.6	5621	891,000	0.006
G150417-BLANK 2	L90703-6	0/100	<13	<5000	NA	NA

COMMENTS: Field sampling was not performed by GALSON Laboratories.
Results are based on the sampling data provided by the client.

Sample Matrix : Air
Analytical Method : NIOSH 7400; PCM
Limit of Quantitation : 10 Fibers/ 100 Fields
Microscope field area : 0.00785 mm2
Filter collection area: 385 mm2

Submitted by : SW
Approved by : SW
Date : 05-MAR-03
QC by:
NYSDOH # : 11626

< -Less Than
\> -Greater Than
ND -Not Detected
NA -Not Applicable
cc -Cubic Centimeters
NS -Not Specified
mm2 -Square millimeters

Intralaboratory & Interlaboratory relative standard deviation records are on file and can be provided upon request.

March 07, 2003

DOH ELAP# 11626

Mr. Les Tyrala
Shaw Environmental & Infrastructure
100 Technology Center Drive
Stoughton, MA 02072

Re: Client Account# 14965 Login# L90739

Dear Mr. Tyrala:

Enclosed are the analytical results of the samples received by our laboratory March 06, 2003.

Results in this report are based on the sampling data provided by the client. Unless otherwise requested, all samples will be discarded sixty days from the date of this report.

Please contact your client service representative, Nancy Ackerman at (888) 577-5227, extension 305, if you require additional information regarding this report.

Thank you for using Galson Laboratories.

Sincerely,

Galson Laboratories

Pamela A. Weaver
Asbestos Section Supervisor

Enclosure(s)

Galson Laboratories
6601 Kirkville Rd. E Syracuse,NY 13057

LABORATORY ANALYSIS REPORT

Client : Shaw Environmental & Infrastructure
Site : Lawrence, MA-Oxford Paper Mill
Project No. : 60813405000000

Date Sampled : 05-MAR-03
Date Received : 06-MAR-03
Date Analyzed : 06-MAR-03

Account No.: 14965
Login No. : L90739

Total Fiber Count

Sample ID	Lab ID	Fibers/ Fields	Fibers/ mm2	Fibers/ Filter	Air Volume (cc)	Fibers/ cc
G150171	L90739-1	0/100	<13	<5000	880,000	<0.006
G150167	L90739-2	0/100	<13	<5000	869,000	<0.006
G150420	L90739-3	3.5/100	<13	<5000	898,000	<0.006
G150430	L90739-4	23/100	29.3	11,281	851,000	0.013
G150428	L90739-5	12.5/100	15.9	6122	861,000	0.007
G150196-BLANK 3	L90739-6	0/100	<13	<5000	NA	NA

COMMENTS: Field sampling was not performed by GALSON Laboratories.
Results are based on the sampling data provided by the client.

Sample Matrix : Air
Analytical Method : NIOSH 7400; PCM
Limit of Quantitation : 10 Fibers/ 100 Fields
Microscope field area : 0.00785 mm2
Filter collection area: 385 mm2

Submitted by : SKS
Approved by : PAW
Date : 06-MAR-03
QC by:
NYSDOH # : 11626

< -Less Than
\> -Greater Than
ND -Not Detected
NA -Not Applicable
cc -Cubic Centimeters
NS -Not Specified
mm2 -Square millimeters

Intralaboratory & Interlaboratory relative standard deviation records are on file and can be provided upon request.

March 13, 2003

DOH ELAP# 11626

Mr. Les Tyrala
Shaw Environmental & Infrastructure
100 Technology Center Drive
Stoughton, MA 02072

Re: Client Account# 14965 Login# L90931

Dear Mr. Tyrala:

Enclosed are the analytical results of the samples received by our laboratory March 12, 2003.

Results in this report are based on the sampling data provided by the client. Unless otherwise requested, all samples will be discarded sixty days from the date of this report.

Please contact your client service representative, Nancy Ackerman at (888) 577-5227, extension 305, if you require additional information regarding this report.

Thank you for using Galson Laboratories.

Sincerely,

Galson Laboratories

Pamela A. Weaver
Asbestos Section Supervisor

Enclosure(s)

Galson
Laboratories
6601 Kirkville Rd. E. Syracuse,NY 13057

LABORATORY ANALYSIS REPORT

Client : Shaw Environmental & Infrastructure
Site : Lawrence, MA Oxford Paper Mill
Project No. : 60813405000000

Date Sampled : 11-MAR-03
Date Received : 12-MAR-03
Date Analyzed : 12-MAR-03

Account No.: 14965
Login No. : L90931

Total Fiber Count

Sample ID	Lab ID	Fibers/ Fields	Fibers/ mm2	Fibers/ Filter	Air Volume (cc)	Fibers/ cc
G150170	L90931-1	0/100	<13	<5000	950,000	<0.005
G150228	L90931-2	1/100	<13	<5000	944,000	<0.005
G150244	L90931-3	.5/100	<13	<5000	964,000	<0.005
G150316	L90931-4	1/100	<13	<5000	873,000	<0.006
G150459	L90931-5	1.5/100	<13	<5000	888,000	<0.006
G150193-BLANK 5	L90931-6	0/100	<13	<5000	NA	NA

COMMENTS: Field sampling was not performed by GALSON Laboratories.
Results are based on the sampling data provided by the client.

Sample Matrix : Air
Analytical Method : NIOSH 7400; PCM
Limit of Quantitation : 10 Fibers/ 100 Fields
Microscope field area : 0.00785 mm2
Filter collection area: 385 mm2

Submitted by : SKS
Approved by : PAW
Date : 12-MAR-03
QC by:
NYSDOH # : 11626

< -Less Than
NA -Not Applicable
mm2 -Square millimeters
> -Greater Than
cc -Cubic Centimeters
ND -Not Detected
NS -Not Specified

Intralaboratory & Interlaboratory relative standard deviation records are on file and can be provided upon request.

March 26, 2003

DOH ELAP# 11626

Mr. Les Tyrala
Shaw Environmental & Infrastructure
100 Technology Center Drive
Stoughton, MA 02072

Re: Client Account# 14965 Login# L91168

Dear Mr. Tyrala:

Enclosed are the analytical results of the samples received by our laboratory March 19, 2003.

Results in this report are based on the sampling data provided by the client. Unless otherwise requested, all samples will be discarded sixty days from the date of this report.

Please contact your client service representative, Nancy Ackerman at (888) 577-5227, extension 305, if you require additional information regarding this report.

Thank you for using Galson Laboratories.

Sincerely,

Galson Laboratories

Pamela A. Weaver
Asbestos Section Supervisor

Enclosure(s)

Galson
Laboratories
6601 Kirkville Rd. E. Syracuse, NY 13057

LABORATORY ANALYSIS REPORT

Client : Shaw Environmental & Infrastructure
Site : Lawrenc, MA Oxford Paper Mill
Project No. : 608134 05000000

Date Sampled : 11-MAR-03 - 14-MAR-03 Account No.: 14965
Date Received : 19-MAR-03 Login No. : L91168
Date Analyzed : 25-MAR-03

Bulk Asbestos Analysis

Sample ID	Lab ID	Color	%Asb.	Type 1	%Asb.	Type 2	%Asb.	Type 3	%/Type Other Fibers
SB-7	1	Brown	1-5	CR	TR	CH	TR	AM	5 CE
SB-8	2	Brown	TR	CH	ND	NA	ND	NA	5 CE;FG
SB-9	3	Brown	TR	CH	TR	CR	ND	NA	TR CE;FG
SB-10	4	Brown	TR	CH	ND	NA	ND	NA	5 CE;FG

COMMENTS: Field sampling was not performed by GALSON Laboratories.
Results are based on the sampling data provided by the client.
This report should not be reproduced, except in full, without the written approval of Galson Laboratories.

Analytical Method : Polarized light microscopy/ dispersion staining. EPA 40 CFR Ch. 1 (7-1-87 Ed.) Part 763, Subpart F, App. A.

Submitted by : SW
Approved by : SW
Date : 25-MAR-03 QC by:
NYSDOH # : 11626

TR- Trace(< 1%)	AC- Actinolite	CR- Crocidolite	NA- Not Applicable
CE- Cellulose	AM- Amosite	TM- Tremolite	NS- Not Specified
FG- Fibrous Glass	AN- Anthophyllite		ND- Not Detected
SY- Synthetic	CH- Chrysotile		> - Greater than

Results relate only to items analyzed, and may not be used to claim product endorsement by NVLAP or any US government agency. Laboratory accredited under NYS ELAP(#11626) and NVLAP(#101375-0). Measurement uncertainty records based on interlab analysis are on file, and are available upon request.

March 26, 2003

DOH ELAP# 11626

Mr. Les Tyrala
Shaw Environmental & Infrastructure
100 Technology Center Drive
Stoughton, MA 02072

Re: Client Account# 14965 Login# L91175

Dear Mr. Tyrala:

Enclosed are the analytical results of the samples received by our laboratory March 19, 2003.

Results in this report are based on the sampling data provided by the client. Unless otherwise requested, all samples will be discarded sixty days from the date of this report.

Please contact your client service representative, Nancy Ackerman at (888) 577-5227, extension 305, if you require additional information regarding this report.

Thank you for using Galson Laboratories.

Sincerely,

Galson Laboratories

Pamela A. Weaver
Asbestos Section Supervisor

Enclosure(s)

Galson
Laboratories
6601 Kirkville Rd. E. Syracuse, NY 13057

LABORATORY ANALYSIS REPORT

Client : Shaw Environmental & Infrastructure
Site : Lawrence, MA-Oxford Paper Mill
Project No. : 60813405000000

Date Sampled : 13-MAR-03 - 17-MAR-03 Account No.: 14965
Date Received : 19-MAR-03 Login No. : L91175
Date Analyzed : 25-MAR-03

Bulk Asbestos Analysis

Sample ID	Lab ID	Color	%Asb.	Type 1	%Asb.	Type 2	%Asb.	Type 3	%/Type Other Fibers
SB-4	1	Brown	ND	NA	ND	NA	ND	NA	TR CE;FG
SB-5	2	Brown	ND	NA	ND	NA	ND	NA	TR CE;FG
SB-6	3	Brown	1-5	AM	1-5	CH	ND	NA	TR CE

COMMENTS: Field sampling was not performed by GALSON Laboratories.
Results are based on the sampling data provided by the client.
This report should not be reproduced, except in full, without the written approval of Galson Laboratories.

Analytical Method : Polarized light microscopy/ dispersion staining.
EPA 40 CFR Ch. 1 (7-1-87 Ed.)
Part 763, Subpart F, App. A.

Submitted by : SW
Approved by : SW
Date : 25-MAR-03 QC by:
NYSDOH # : 11626

TR- Trace(< 1%)
CE- Cellulose
FG- Fibrous Glass
SY- Synthetic

AC- Actinolite
AM- Amosite
AN- Anthophyllite
CH- Chrysotile

CR- Crocidolite
TM- Tremolite

NA- Not Applicable
NS- Not Specified
ND- Not Detected
> - Greater than

Results relate only to items analyzed, and may not be used to claim product endorsement by NVLAP or any US government agency. Laboratory accredited under NYS ELAP(#11626) and NVLAP(#101375-0). Measurement uncertainty records based on interlab analysis are on file, and are available upon request.

Appendix C

Wedge Area Test Pit Logs

Metcalf & Eddy

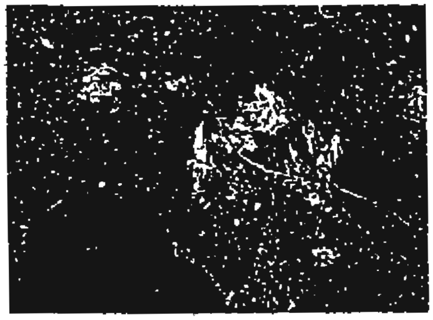
TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

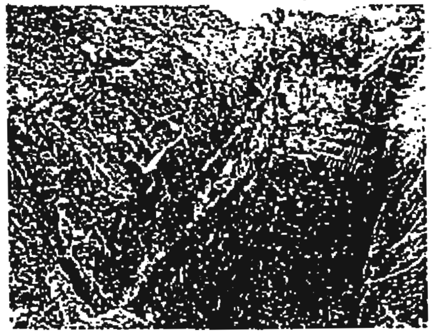
Location/ID:	Test Pit 3	Excavator:	ENPRO Services
Date:	May 15, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	15 feet bgs

A (0-1 ft)	Topsoil, brown, sandy loam, roots, grass, gravel, trace plastic. Little moisture. [0 ppm on PID]
B (1-3 ft)	Fill, olive-brown, fine sandy loam to sandy loam, trace coal chips, slag, bricks, metal and a boulder. Fibrous material. Little moisture. [0 ppm on PID]
C (3-5 ft)	Fill, olive, clayey-silt, blocky structure, dense, little gravel, trace coal chips and slag. Little moisture. [0 ppm on PID]
D (5-7 ft)	Fill, blackish, mix of coal chips, slag and sandy loam, some to little gravel, trace of tan, fine to medium sand found in pockets. Little moisture. [0 ppm on PID]
E (7-9 ft)	Same as 5-7 feet. [0 ppm on PID]
F (9-11 ft)	Same as 5-7 feet. [0 ppm on PID]
G (11-13 ft)	Fill, tan-brown, fine sand, little gravel, trace of coal chips. Little moisture. [0 ppm on PID]
H (13-15 ft)	Same as 11-13 feet. [0 ppm on PID] *End of test pit - target depth reached.*

Location of Test Pit 3 – east side of work area



Horizon B – light blue fibrous like material.



View of open test pit.
Note olive-yellow layer (3 to 4 ft).

PID = Photo Ionization Detector (readings in parts per million-ppm)

Metcalf & Eddy

SITE LOCATION
Oxford Paper Mills
Canal Street
Lawrence, MA

ANALYTICAL SUMMARY TABLE

Mobile Lab Analyses and Results	**Horizon**		**Direct Sub. Lab**		**Horizon**
Test Pit 3					
PCBs: 5-6 ppm Asbestos (A-B Composite) 3% Arsenic: < 60 ppm Chromium: < 140 ppm Lead: 108 ppm	▧	0-1 foot, Horizon A	Not Sampled		0-1 foot, Horizon A
PCBs: 5-6 ppm Asbestos: See A-B Composite above	▤	1-3 feet, Horizon B			1-3 feet, Horizon B
PCBs: ND	▧	3-5 feet, Horizon C			3-5 feet, Horizon C
PCBs: ND	▤	5-7 feet, Horizon D			5-7 feet, Horizon D
PCBs: 2.6-4.6 ppm	▧	7-9 feet, Horizon E			7-9 feet, Horizon E
PCBs: ND	▤	9-11 feet, Horizon F			9-11 feet, Horizon F
PCBs: ND	▧	11-13 feet, Horizon G			11-13 feet, Horizon G
PCBs: ND	▤	13-15 feet, Horizon H			13-15 feet, Horizon H

Metcalf & Eddy

TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit 4	Excavator:	ENPRO Services
Date:	May 13, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	5 ½ feet bgs

A (0-1 ft)	Fill, brown, sandy loam, loose, little bricks, trace rubber. Moisture in sample likely due to heavy precipitation. [0 ppm on PID]
B (1-3 ft)	Fill, brown, medium sandy loam, some concrete, brick, trace wire and plywood. Slab and vertical wall encountered, advanced pit 5 feet south. Little moisture. [0 ppm on PID]
C (3-5 ft)	Fill, brick, concrete, some medium to very coarse sand, trace wire, metal grate, and 4-inch steel pipe. Little moisture. [0 ppm on PID]
D (5-7 ft)	Foundation reached at 5 ½ feet. Solid when pounded on by excavator bucket. Southern wall of test pit within 10 feet of raceway.
E (7-9 ft)	*End of test pit due to proximity to raceway wall and concrete slab to the north.*
F (9-11 ft)	
G (11-13 ft)	
H (13-15 ft)	

Horizon C – note bricks, pipe, metal grate

Extending pit 5 feet south due to slab

South edge of slab and vertical wall. View is facing south.

PID = Photo Ionization Detector (readings in parts per million-ppm)

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SITE LOCATION
Oxford Paper Mills
Canal Street
Lawrence, MA

ANALYTICAL SUMMARY TABLE

Mobile Lab **Analyses and Results**	**Horizon**		**Direct Sub. Lab**	**Horizon**	
Test Pit 4					
PCBs: 3-4 ppm Asbestos (A-C Composite): 6% Arsenic: 136 ppm Chromium: 653 ppm Lead: 241ppm	▧	0-1 foot, Horizon A	4S composite collected from Horizons A and B 4D composite collected from Horizon C	▤	0-1 foot, Horizon A
PCBs: 3.9-4.9 ppm See Asbestos A-C Composite Above	▤	1-3 feet, Horizon B		▤	1-3 feet, Horizon B
PCB: 7.8-9.8 ppm See Asbestos A-C Composite Above	▧	3-5 feet, Horizon C		▨	3-5 feet, Horizon C
End of Excavation, Not Sampled		5-7 feet, Horizon D			5-7 feet, Horizon D
Not Sampled		7-9 feet, Horizon E			7-9 feet, Horizon E
Not Sampled		9-11 feet, Horizon F			9-11 feet, Horizon F
Not Sampled		11-13 feet, Horizon G			11-13 feet, Horizon G
Not Sampled		13-15 feet, Horizon H			13-15 feet, Horizon H

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TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit 5	Excavator:	ENPRO Services
Date:	May 15, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	1 feet bgs

A (0-1 ft)	Topsoil and fill, brown, sandy loam, loose, little bricks, grass. Red *"Danger Asbestos"* tape found hanging out of soil in bucket. Little moisture. [0 ppm on PID].	 Horizon A – "Danger Asbestos" tape in first bucket.
B (1-3 ft)	*End of test pit due to presence of asbestos warning tape.*	
C (3-5 ft)		
D (5-7 ft)		
E (7-9 ft)		
F (9-11 ft)		
G (11-13 ft)		
H (13-15 ft)		

PID = Photo Ionization Detector (readings in parts per million-ppm)

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SITE LOCATION
Oxford Paper Mills
Canal Street
Lawrence, MA

ANALYTICAL SUMMARY TABLE

Mobile Lab Analyses and Results	Horizon		Direct Sub. Lab	Horizon	
Test Pit 5					
PCBs: 6-8 ppm; 8-10 ppm (field duplicate) Asbestos: 5% Arsenic: 124 ppm Chromium: 525 ppm Lead: 253 ppm	▨	0-1 foot, Horizon A	Not Sampled		0-1 foot, Horizon A
End of Excavation, Not Sampled		1-3 feet, Horizon B			1-3 feet, Horizon B
Not Sampled		3-5 feet, Horizon C			3-5 feet, Horizon C
Not Sampled		5-7 feet, Horizon D			5-7 feet, Horizon D
Not Sampled		7-9 feet, Horizon E			7-9 feet, Horizon E
Not Sampled		9-11 feet, Horizon F			9-11 feet, Horizon F
Not Sampled		11-13 feet, Horizon G			11-13 feet, Horizon G
Not Sampled		13-15 feet, Horizon H			13-15 feet, Horizon H

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TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit 6	Excavator:	ENPRO Services
Date:	May 13, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	7 feet bgs

A (0-1 ft)	Fill, brown, medium to coarse sand, some loam, loose, little brick (red and white) and concrete. Moisture in samples likely due to precipitation. [0 ppm on PID]	 Horizon A-B – Note brick (possible floor)
B (1-3 ft)	Same as 0 - 1 feet, plus trace rebar and lead pipe. [0 ppm on PID]	
C (3-5 ft)	Same as 0 - 1 feet, plus spigot and valve, rebar, and various metal and pipe. [0 ppm on PID]	 Horizon C – Note bricks, pipe, rebar and fibrous* material
D (5-7 ft)	Same as 0-1 feet, more pipe, wood, and white/pinkish fibrous* like material, which was saturated. [0 ppm on PID].	
E (7-9 ft)	Same as 0-1 feet, plus steel grating and wire. Slab encountered at 7.0 feet (material sampled is possibly cave-in from above). Slab included floor with drain grates and north-south trending drain pit.	 Horizon E – location of concrete slab with steel grate (possible slot drain - north-south trend)
F (9-11 ft)	*End of test pit due to slab and proximity to raceway wall.*	
G (11-13 ft)		
H (13-15 ft)	*Lab analyses indicated the presence of asbestos fibers	

PID = Photo Ionization Detector (readings in parts per million-ppm)

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SITE LOCATION
Oxford Paper Mills
Canal Street
Lawrence, MA

ANALYTICAL SUMMARY TABLE

Mobile Lab Analyses and Results	Horizon		Direct Sub. Lab	Horizon	
Test Pit 6					
PCBs: 7-8 ppm Asbestos (A-B Composite): 7% Arsenic: 146 ppm Chromium: 361 ppm Lead: 318 ppm	▧	0-1 foot, Horizon A	6S composite collected from Horizons A and B 6D composite collected from Horizons C, D, and E	▤	0-1 foot, Horizon A
PCBs: 10-15 ppm See Asbestos A-B Composite above	▤	1-3 feet, Horizon B		▤	1-3 feet, Horizon B
PCBs: 8-10 ppm Asbestos: 8%	▧	3-5 feet, Horizon C		▨	3-5 feet, Horizon C
PCBs: 4-5 ppm Asbestos: 8%	▤	5-7 feet, Horizon D		▨	5-7 feet, Horizon D
PCBs: 5-8 ppm Asbestos: 7%	▧	7-9 feet, Horizon E		▨	7-9 feet, Horizon E
End of Excavation, Not Sampled		9-11 feet, Horizon F			9-11 feet, Horizon F
Not Sampled		11-13 feet, Horizon G			11-13 feet, Horizon G
Not Sampled		13-15 feet, Horizon H			13-15 feet, Horizon H

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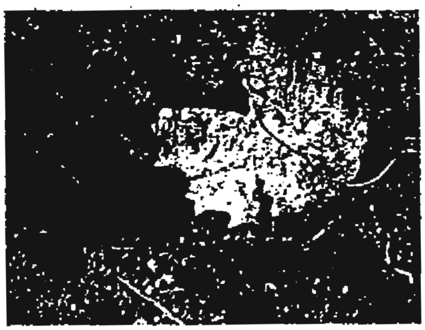
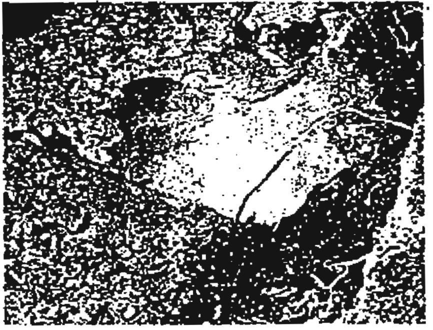
TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit 7	Excavator:	ENPRO Services
Date:	May 15, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	9 feet bgs

A (0-1 ft)	Fill, brown, medium sandy loam, and brick, trace coal chips, rebar, and white fines. Slightly moist, loosely packed. [0 ppm on PID]	 Horizon B – Note pink fibrous material* (white and yellow varieties also found) similar to that encountered in Test Pit 6
B (1-3 ft)	Fill, peppery mix of black sandy loam and white fines. Some bricks, concrete, pipes and rebar, trace of tile and some fibrous material* [0 ppm on PID]	
C (3-5 ft)	Fill, wood, brick, wire, rebar, concrete. Little to trace black sandy loam. White fines and fibrous materials were moist to wet. [0 ppm on PID]	 White fines – clay-like (possibly lime)
D (5-7 ft)	Same as 3-5 feet, plus less brick and concrete and more fines. Pipes in sidewalls of pit. [0 ppm on PID]	
E (7-9 ft)	Same as 5-7 feet, very saturated. Water infiltrated at ~8.5', sheen on water. [0 ppm on PID]	
F (9-11 ft)	*End of test pit due to slab at ~9 feet, proximity to raceway wall and water intrusion.*	 Water infiltration and sheen observed at ~8.5 feet. Water pH = 12, indicating possibility that white fines are lime. Source of sheen unknown.
G (11-13 ft)	*Slab at 9 feet was encountered within 15 feet of raceway. Additional slabs were encountered at more shallow depths as the test pit was opened away from the raceway (appeared to create steps up from the raceway).*	
H (13-15 ft)		

PID = Photo Ionization Detector (readings in parts per million-ppm)
* Lab analyses indicated the presence of asbestos fibers

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SITE LOCATION
Oxford Paper Mills
Canal Street
Lawrence, MA

ANALYTICAL SUMMARY TABLE

Mobile Lab Analyses and Results	Horizon		Direct Sub. Lab	Horizon	
Test Pit 7					
PCBs: 3-4 ppm Arsenic: 75 ppm Chromium: 508 ppm Lead: 126 ppm	▨	0-1 foot, Horizon A	Not Sampled		0-1 foot, Horizon A
PCBs: 8-10 ppm Bulk Asbestos Sample: 33%	▤	1-3 feet, Horizon B			1-3 feet, Horizon B
PCBs: 8-10 ppm	▨	3-5 feet, Horizon C			3-5 feet, Horizon C
PCBs: 10-15 ppm	▤	5-7 feet, Horizon D			5-7 feet, Horizon D
PCBs; 10-15 ppm	▨	7-9 feet, Horizon E			7-9 feet, Horizon E
End of Excavation, Not Sampled		9-11 feet, Horizon F			9-11 feet, Horizon F
Not Sampled		11-13 feet, Horizon G			11-13 feet, Horizon G
Not Sampled		13-15 feet, Horizon H			13-15 feet, Horizon H

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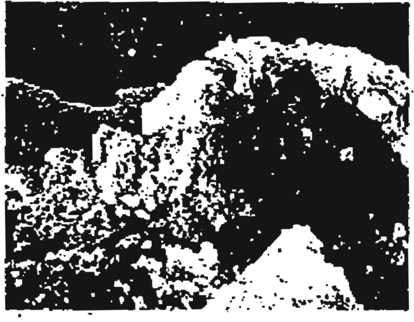
TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit 8	Excavator:	ENPRO Services
Date:	May 13, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	9 feet bgs

A (0-1 ft)	Fill, brown, sandy loam, little white fines – clay like (possibly lime). Materials were moist and loosely packed. [0 ppm on PID]
B (1-3 ft)	Fill, white fines - clay like, trace brick and concrete. [0 ppm on PID]
C (3-5 ft)	Same as 1-3 feet, plus trace black sandy material and pipe pieces. [0 ppm on PID]
D (5-7 ft)	Same as 3-5 feet, plus trace coal chips. [0 ppm on PID].
E (7-9 ft)	Fill, mix of bricks, roots, wood, concrete, trace of white lime and black sandy loam. Slightly moist. [0 ppm on PID]
F (9-11 ft)	*End of test pit due to slab at 9 feet* and *proximity to raceway wall.*
G (11-13 ft)	*Note: Samples labeled as Levels F and G were also collected and analyzed, but are most likely cave in from above. These samples were from the same as Horizon E (7 to 9 feet).*
H (13-15 ft)	



Mix of white fines material and black sandy fill and brick.

Horizon B – mostly white fines (clay-like)

Bottom of test pit. Dark area appears to be part of a brick wall adjacent to a deposit of white fines.

PID = Photo Ionization Detector (readings in parts per million-ppm)

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SITE LOCATION
Oxford Paper Mills
Canal Street
Lawrence, MA

ANALYTICAL SUMMARY TABLE

Mobile Lab Analyses and Results	**Horizon**		**Direct Sub. Lab**	**Horizon**	
Test Pit 8					
PCBs: 2-3 ppm Asbestos: No Samples Taken Arsenic: < 60 ppm Chromium: < 120 ppm Lead: 60 ppm	▧	0-1 foot, Horizon A	8S composite collected from Horizons A and B 8D composite collected from Horizons C, D, E, F, and G	▤	0-1 foot, Horizon A
PCBs: ND	▤	1-3 feet, Horizon B		▤	1-3 feet, Horizon B
PCBs: 4-5 ppm	▧	3-5 feet, Horizon C		▨	3-5 feet, Horizon C
PCBs: 8-10 ppm	▤	5-7 feet, Horizon D		▨	5-7 feet, Horizon D
PCBs: 8-10 ppm	▧	7-9 feet, Horizon E		▨	7-9 feet, Horizon E
PCBs: 8-10 ppm	▤	9-11 feet, Horizon F		▨	9-11 feet, Horizon F
PCBs: 4-5 ppm	▧	11-13 feet, Horizon G		▨	11-13 feet, Horizon G
End of Excavation, Not Sampled		13-15 feet, Horizon H			13-15 feet, Horizon H

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TEST PIT LOG

**Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts**

Location/ID:	Test Pit 9	Excavator:	ENPRO Services
Date:	May 13, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	<1 feet bgs

A (0-1 ft)	White fines material of 3-6 inches in thickness overlies a concrete, brick and I-beam slab.
B (1-3 ft)	*End of test pit due to slab at surface.*
C (3-5 ft)	*Note: From visual inspections of small openings in the slab, void space was evident under the area which may be separated by vertical walls.* *Upon further inspection, it appeared that the slab is supported to the south by the raceway wall and to the north by a brick wall, and in the center by a reinforced concrete wall.* *An additional test pit (9A) was excavated to further evaluate the void space.*
D (5-7 ft)	
E (7-9 ft)	
F (9-11 ft)	
G (11-13 ft)	
H (13-15 ft)	

North (brick) wall and overlying slab (floor) at location of Test Pit 9

Test Pit 9A between Test Pits 8 and 9 showing the void space under the surficial slab at the location of Test Pit 9. Note reinforced concrete wall (center of photo).

Void space under Test Pit 9 location, south of what appears to be a dividing wall.

PID = Photo Ionization Detector (readings in parts per million-ppm)

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TEST PIT LOG

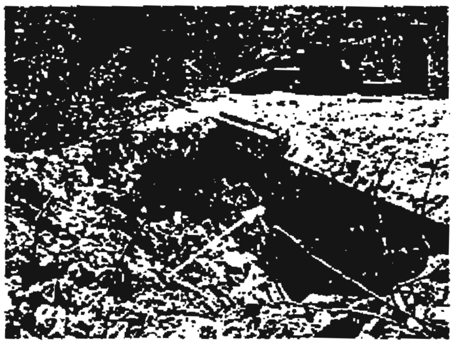
Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit 9A	Excavator:	ENPRO Services
Date:	May 16, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	6 feet bgs

This additional test pit was excavated in the area between the locations of Test Pits 8 and 9. The purpose of the additional test pit was to observe conditions beneath the slab encountered at the surface of Test Pit 9.

The presence of vertical walls indicated that the area under Test Pit 9 included possibly two portions (or rooms) of a former structure. Based on visual observations from a distance, the southern portion of the test pit (nearest the raceway) was mostly void. The northern area was filled with the white fines/claylike material (possibly lime).

Test pit located between 8 and 9 shows void.



Additional excavation reveals a dividing wall of reinforced concrete. The space north of this wall was partially filled, while the space south of the wall appeared void.

South void space – view of the raceway wall from the inside of the void space. Concrete slab on top.

South void space – concrete slab on top, note pipes.

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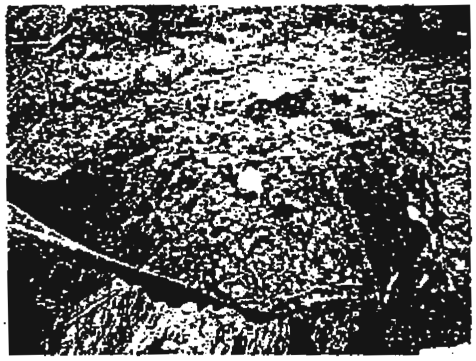
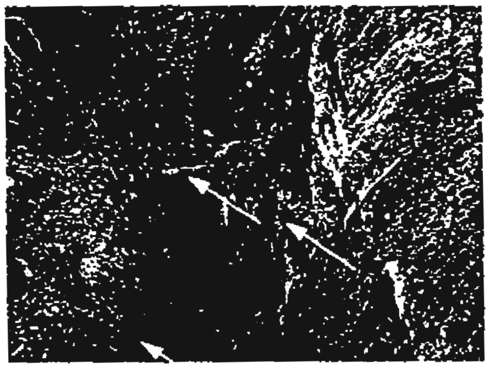
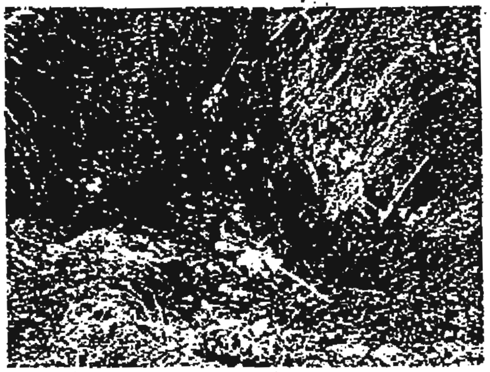
TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit 10	Excavator:	ENPRO Services
Date:	May 16, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	15 feet bgs

A (0-1 ft)	Recent fill, tan, fine sand, little large gravel, trace brick. Little moisture. [0 ppm on PID]	 Horizon A – Clean fill.
B (1-3 ft)	Fill, black, sandy loam, little brick and recent fill (see A) and trace of white fines. [0 ppm on PID]	
C (3-5 ft)	Fill, mix of yellow-tan, dense, fine sand and dark brown, dense fine sand with little-trace silt. Little-trace gravel, roots, and wood. Intermittent horizons of black sandy loam. Little moisture. [0 ppm on PID]	
D (5-7 ft)	Fill, grey-brown/black, fine sand and fine sandy loam. Contains coal chips, ash, wood at little-trace levels. Little large gravel, and trace cobbles. Water at depth in hole from broken pipe. [0 ppm on PID]	 Pipes along west and south. Steel pipe (not seen in this picture) runs along the east.
E (7-9 ft)	Fill, mix of yellow-tan fine sand with roots, and trace gravel and brick with grey-tan, mottled, very fine sand and silt with trace gravel. Convoluted black sandy horizons throughout. Little moisture. [0 ppm on PID]	
F (9-11 ft)	Same as 7-9 feet.	 Water leaked into pit from broken pipe in west sidewall (right side of photo).
G (11-13 ft)	Fill, grey-black/brown very fine sand, little silt. Several gray-white lamina intermittent in soil. One lamina had muscovite mica throughout.	
H (13-15 ft)	Fill, yellow-brown fine sand, with similar materials from above. *End of test pit*	

PID = Photo Ionization Detector (readings in parts per million-ppm)

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SITE LOCATION
Oxford Paper Mills
Canal Street
Lawrence, MA

ANALYTICAL SUMMARY TABLE

Mobile Lab Analyses and Results	Horizon		Direct Sub. Lab	Horizon	
Test Pit 10					
PCBs: ND Asbestos: No Samples Taken Arsenic: < 60 ppm Chromium: < 100 ppm Lead: < 40 ppm	▧	0-1 foot, Horizon A	10S composite collected from Horizons A and B 10D composite collected from Horizons C, D, E, F, G, and H	▤	0-1 foot, Horizon A
PCBs: 3-4 ppm	▤	1-3 feet, Horizon B		▤	1-3 feet, Horizon B
PCBs: ND	▧	3-5 feet, Horizon C		▨	3-5 feet, Horizon C
PCBs: 10-12 ppm	▤	5-7 feet, Horizon D		▨	5-7 feet, Horizon D
PCBs: ND	▧	7-9 feet, Horizon E		▨	7-9 feet, Horizon E
PCBs: ND	▤	9-11 feet, Horizon F		▨	9-11 feet, Horizon F
PCBs: ND	▧	11-13 feet, Horizon G		▨	11-13 feet, Horizon G
PCBs: ND	▤	13-15 feet, Horizon H		▨	13-15 feet, Horizon H

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TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit 11	Excavator:	ENPRO Services
Date:	May 16, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	15 feet bgs

A (0-1 ft)	Fill, tan-yellow, fine-medium sand, clean, little large gravel, roots. Topsoil lost during site clearing. Little moisture. [0 ppm on PID]
B (1-3 ft)	Fill, brown-black, fine sandy loam, some-little brick and trace metal, and trace coal chips, wood, and roots. Metal: conduit, wire, angle iron, rebar and bolts. Little moisture. [0 ppm on PID]
C (3-5 ft)	Same as 1-3 feet plus concrete and trace plastic, part of wood beam. [0 ppm on PID]
D (5-7 ft)	Same as 1-3 feet plus trace glass and moderate creosote odor. [0 ppm on PID]
E (7-9 ft)	Same as 1-3 feet plus light creosote odor and milk crate size piece of machinery with wires. [0 ppm on PID]
F (9-11 ft)	Large pump and piping along with sandy loam fill with brick. Concrete slab reached at 10 feet. Some water observed on top of concrete slab. Slab thickness ~8 inches. [0 ppm on PID]
G (11-13 ft)	After breaking through floor, which was reinforced, materials included tan, medium-coarse sand and gravel. Little moisture. [0 ppm on PID]
H (13-15 ft)	Same as 11-13 feet except sand is finer. *Note: subsurface structures included a concrete slab 10 feet bgs and 25 feet north of the raceway. As the test pit opened away from the raceway, a 12-inch drain pipe was encountered. Then, walls and more slabs were encountered out to 35 feet north of the raceway (rising in a step-like fashion).*

Horizon F - Turbine pump and large pipe

Wall along east side of test pit. Concrete slab on top was not penetrable.

Horizon H – view south of rising slabs (step-like)

PID = Photo Ionization Detector (readings in parts per million-ppm)

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SITE LOCATION
Oxford Paper Mills
Canal Street
Lawrence, MA

ANALYTICAL SUMMARY TABLE

Mobile Lab Analyses and Results	Horizon		Direct Sub. Lab	Horizon	
Test Pit 11					
PCBs: ND Asbestos (A-C Composite): present at < 1% Arsenic: < 60 ppm Chromium: < 110 ppm Lead: < 40 ppm	▨	0-1 foot, Horizon A	Not Sampled		0-1 foot, Horizon A
PCBs: 10.1-12.1 ppm Asbestos: See A-C Composite above	▤	1-3 feet, Horizon B			1-3 feet, Horizon B
PCBs: 4.5-5.5 ppm Asbestos: See A-C Composite above	▨	3-5 feet, Horizon C			3-5 feet, Horizon C
PCBs: 6-8 ppm Asbestos (D-F Composite): 3%	▤	5-7 feet, Horizon D			5-7 feet, Horizon D
PCBs: 3-4 ppm Asbestos: See D-F Composite above	▨	7-9 feet, Horizon E			7-9 feet, Horizon E
PCBs: ND Asbestos: See D-F Composite above	▤	9-11 feet, Horizon F			9-11 feet, Horizon F
End of Excavation, Not Sampled		11-13 feet, Horizon G			11-13 feet, Horizon G
Not Sampled		13-15 feet, Horizon H			13-15 feet, Horizon H

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TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit 12	Excavator:	ENPRO Services
Date:	May 14, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	15 feet bgs

A (0-1 ft)	Fill, brown, fine sandy loam, clean, some gravel, roots, trace boulders and brick. Dry. [0 ppm on PID]
B (1-3 ft)	Fill, brown-yellow coarse to very coarse sand and gravel, trace roots; and brown, medium sand, little brick, plastic, metal. Dry. [0 ppm on PID]
C (3-5 ft)	Fill, dark brown fine sandy loam and light tan medium sand, some fine sand, brick, and cobble, little roots, trace rebar and flesh colored tape. Brick post with rebar also unearthed. [0 ppm on PID]
D (5-7 ft)	Brown-black, coarse sandy loam and brick (in various stages of decay), large beam that smelled strongly of creosote, and large wire. [PID = 31.7 ppm].
E (7-9 ft)	Fill, brown, sandy loam, some brick, slight creosote odor, trace wood. I-beam at 8.5 ft. [PID = 27.7 ppm].
F (9-11 ft)	Fill, brown, sand and gravel, some brick, concrete and rebar, trace rubber. [0 ppm on PID]
G (11-13 ft)	Same as 9-11 feet plus pipe and large concrete slab. Little moisture. [0 ppm on PID]
H (13-15 ft)	Same as 11-13 plus large wood beams, various metal objects and little-trace burnt looking asphalt shingles. *End of Test Pit*

Typical debris found in Test Pit 12. Beam had creosote type odor.

Horizon G - Void space underlying concrete slab

Very moist fines with clay-like texture found at depth in test pit

PID = Photo Ionization Detector (readings in parts per million-ppm)

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SITE LOCATION
Oxford Paper Mills
Canal Street
Lawrence, MA

ANALYTICAL SUMMARY TABLE

Mobile Lab Analyses and Results	Horizon	Direct Sub. Lab	Horizon
Test Pit 12			
PCBs: ND Asbestos (A-B Composite): ND Arsenic: < 60 ppm Chromium: < 120 ppm Lead: 40 ppm	▧ 0-1 foot, Horizon A	12S composite collected from Horizons A and B 12D composite collected from Horizons C, D, E, F, G, and H	▤ 0-1 foot, Horizon A
PCBs: ND	▤ 1-3 feet, Horizon B		▤ 1-3 feet, Horizon B
PCBs: ND Asbestos: present at < 1%	▧ 3-5 feet, Horizon C		▨ 3-5 feet, Horizon C
PCBs: ND Asbestos: present at < 1%	▤ 5-7 feet, Horizon D		▨ 5-7 feet, Horizon D
PCBs: ND Asbestos: present at < 1%	▧ 7-9 feet, Horizon E		▨ 7-9 feet, Horizon E
PCBs: ND Asbestos: present at < 1%	▤ 9-11 feet, Horizon F		▨ 9-11 feet, Horizon F
PCBs: 4-5 ppm Asbestos: present at < 1%	▧ 11-13 feet, Horizon G		▨ 11-13 feet, Horizon G
PCBs: 3.1 ppm Asbestos: present at < 1%	▤ 13-15 feet, Horizon H		▨ 13-15 feet, Horizon H

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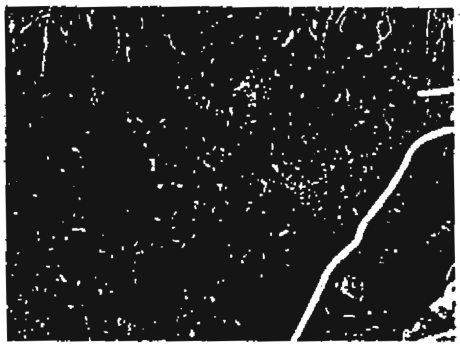
TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit 14	Excavator:	ENPRO Services
Date:	May 14, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	15 feet bgs

A (0-1 ft)	Fill, brown, sandy loam, brick, gravel, and roots. Little moisture. [0 ppm on PID]
B (1-3 ft)	Same as 0-1 feet, plus trace amounts of wire, wood, 2" pipe, and ceramic pieces. Slightly moist. [0 ppm on PID]
C (3-5 ft)	Same as 0-1 feet plus little concrete and brick, trace asphalt and red "Danger – Asbestos" tape. [Intact drum exposed at this depth from test pit cave-in (left in place)] [0 ppm on PID]
D (5-7 ft)	Fill, brown, sandy loam, little-trace bricks, long metal bar, ceramic pipe pieces, trace roots, wood, gravel, cobble and a small boulder, lens of clean fine sand. Slightly moist-dry, [0 ppm on PID]
E (7-9 ft)	Fill, brown, sandy loam, some fine sandy loam, various metal bars and rebar, little brick, trace cobble, roots and asphalt. Glass bottle. PID = 0
F (9-11 ft)	Same as 7-9 feet, less metal and more wood. Little moisture. [0 ppm on PID]
G (11-13 ft)	Same as 7-9 feet, plus paper, crushed metal container, and a half bucket of concrete and rebar. Little moisture. PID = 0
H (13-15 ft)	*End of test pit - unearthed a section of pit wall containing more "Danger-Asbestos" red tape. At this point the 55-gallon drum was more visible on the south wall (about 3 to 4 feet bgs).* *An intact brick wall also lined the west side of the test pit.*

Intact wall corner. Example of the size of some of the building debris found.



Brick wall on west side of test pit

55-Gallon drum (on side) intact in wall of test pit. Approximately 3-4 feet deep. Note red "danger – asbestos" tape in wall of test pit.

PID = Photo Ionization Detector (readings in parts per million-ppm)

Metcalf & Eddy

SITE LOCATION
Oxford Paper Mills
Canal Street
Lawrence, MA

ANALYTICAL SUMMARY TABLE

Mobile Lab Analyses and Results	Horizon		Direct Sub. Lab	Horizon	
Test Pit 14					
PCBs: 4-5 ppm Asbestos (A-B Composite): 1% Arsenic: < 60 ppm Chromium: < 150 ppm Lead: 67 ppm	▧	0-1 foot, Horizon A	14S composite collected from Horizons A and B 14 D composite collected from Horizons C, D, E, F, and G	▤	0-1 foot, Horizon A
PCBs: 2-3 ppm Asbestos: See A-B Composite Above	▤	1-3 feet, Horizon B		▤	1-3 feet, Horizon B
PCBs: 10-11 ppm Asbestos: present at < 1%	▧	3-5 feet, Horizon C		▨	3-5 feet, Horizon C
PCBs: 1-2 ppm Asbestos: present at < 1%	▤	5-7 feet, Horizon D		▨	5-7 feet, Horizon D
PCBs: 1-2 ppm Asbestos: present at <1%	▧	7-9 feet, Horizon E		▨	7-9 feet, Horizon E
PCBs: 2-3 ppm Asbestos: present at < 1%	▤	9-11 feet, Horizon F		▨	9-11 feet, Horizon F
PCBs: 2-3 ppm Asbestos: present at <1%	▧	11-13 feet, Horizon G		▨	11-13 feet, Horizon G
End of Excavation, Not Sampled		13-15 feet, Horizon H			13-15 feet, Horizon H

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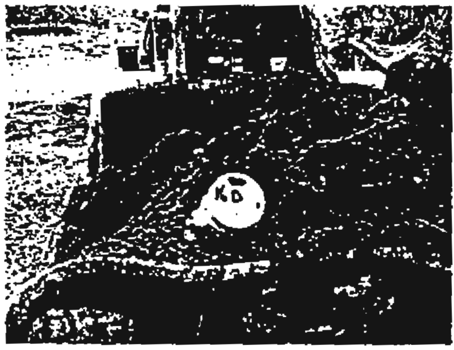
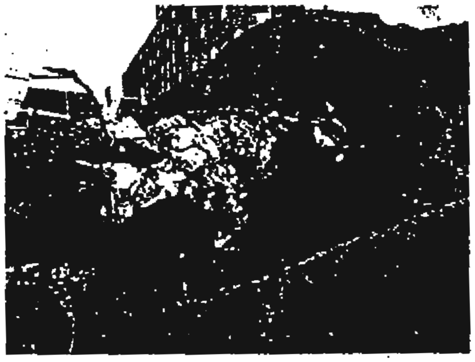
TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit 16	Excavator:	ENPRO Services
Date:	May 14, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	13 feet bgs

A (0-1 ft)	Fill, light brown, sandy loam, and gravel, little brick and roots. Little moisture. [0 ppm on PID]	 Horizon D –relatively clean looking fill.  Horizon D – commingled fibrous material, steel, and aluminum.  Collecting sample from bucket from Horizon D.
B (1-3 ft)	Same as 0-1 feet, plus rebar, concrete and a trace of asphalt. [0 ppm on PID]	
C (3-5 ft)	Same as 1-3 feet plus more metal, little tile and asphalt, trace plastic pipe. Little moisture. [0 ppm on PID]	
D (5-7 ft)	Same as 3-5 feet plus a piece of fabric and commingled steel (possible drum), aluminum, and fibrous material. Little moisture. [0 ppm on PID]	
E (7-9 ft)	*End of test pit due to concerns of asbestos. Fibrous material collected for analysis was later determined to not contain asbestos fibers (possibly glass wool).*	
F (9-11 ft)		
G (11-13 ft)		
H (13-15 ft)		

PID = Photo Ionization Detector (readings in parts per million-ppm)

M&E
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SITE LOCATION
Oxford Paper Mills
Canal Street
Lawrence, MA

ANALYTICAL SUMMARY TABLE

Mobile Lab Analyses and Results	Horizon	Direct Sub. Lab	Horizon
Test Pit 16			
PCBs: 1-2 ppm Asbestos (A-D Composite): present at <1% Arsenic: < 60 ppm Chromium: < 160 ppm Lead: 44 ppm	▧ 0-1 foot, Horizon A	Not Sampled	0-1 foot, Horizon A
PCBs: 2-3 ppm Asbestos: See A-D Composite above	▤ 1-3 feet, Horizon B		1-3 feet, Horizon B
PCBs: 2-3 ppm Asbestos: See A-D Composite above	▧ 3-5 feet, Horizon C		3-5 feet, Horizon C
PCBs: 2-3 ppm Asbestos: See A-D Composite above	▤ 5-7 feet, Horizon D		5-7 feet, Horizon D
End of Excavation, Soil Not Sampled Suspect Asbestos Bulk Sample Collected; no asbestos detected.	▧ 7-9 feet, Horizon E		7-9 feet, Horizon E
Not Sampled	▤ 9-11 feet, Horizon F		9-11 feet, Horizon F
Not Sampled	▧ 11-13 feet, Horizon G		11-13 feet, Horizon G
Not Sampled	▤ 13-15 feet, Horizon H		13-15 feet, Horizon H

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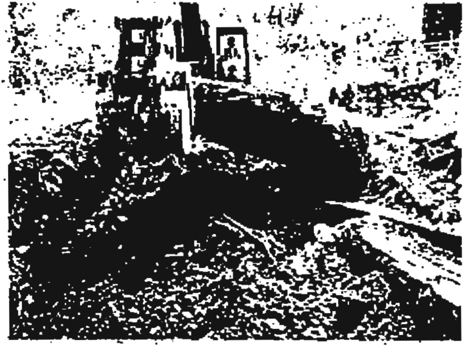
TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Trench A	Excavator:	ENPRO Services
Date:	May 16, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	Varies to 4 feet bgs

This trench was excavated to observe conditions just northeast of the raceway arch. It was also the location of a previously identified anomaly from ground penetrating radar (located at 73S/190E on survey grid)

The trench included fill materials such as brick, concrete, wood, and pieces of railroad ties. A large concrete slab was encountered and two vertical wall (east-west trend). The exact feature that caused the anomaly on the geophysical survey was not identified, but may have been the vertical walls.



Concrete slab at 3 feet below surface.

Looking East – view of concrete slab and vertical wall at ~3 ft below grade.

Looking West at vertical wall near surface.

Debris found near surface (bricks and wire)

Looking East at two vertical walls running parallel in east/west trend (one wall same as shown above).

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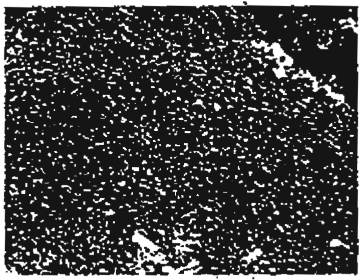
TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Trench B	Excavator:	ENPRO Services
Date:	May 16, 2002	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	Varies to 4 feet bgs

This trench was completed in an east-west trend, approximately 75 north of the raceway. Concrete slabs and walls were encountered that appeared to be "in place". Fill and coal were encountered in several areas of the trench. Features appeared to be placed symmetrically around brick fill.

Looking East across trench (about 150 feet in length). From center downwards, note brick, coal, and fill. This pattern was observed east and west of the brick fill noted, with concrete walls separating each material.



Black coal, with sandy texture, encountered between an 8-inch concrete reinforced wall and a 12-foot building footing.

Center of trench (top center) was 90% bricks. Also shown is an 8-inch concrete reinforced wall between brick and black coal (lower left).

12-foot building footing. This object was immovable and impenetrable by the excavator bucket.

Yellow-green, oxidized looking material

Appendix D

North Area Test Pit Logs

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TEST PIT LOG

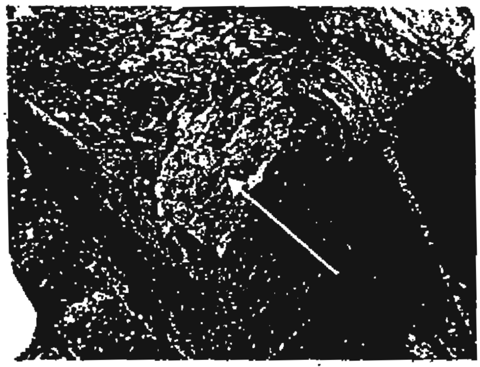
Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit A	Excavator:	ENPRO Services
Date:	March 5, 2003	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	15 feet bgs

Located on the south west section of the site, just north of former buildings 21 and 22.

Soils were sandy and somewhat cohesive compared to other test pits. 'Bricks and other debris can be seen in the south wall while the north wall contained much less debris. Debris included brick, concrete, asphalt like material, steel piping, wires, tar shingles, coal ash and slag (7-8 ft), and a trace of suspected asbestos. Tan and grey mottled sands were found at 12 feet. Floor and wall found at ~5 ft on east side of pit.

Suspected asbestos piping, brick, and typical soils.



Example of burned tar shingle remnants found at depths of 3 plus feet in pit.

Asphalt like substances found throughout pit.

Profile of test pit showing bricks over sandy fill.

Typical soils. Light colored material is suspected asbestos.

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TEST PIT LOG

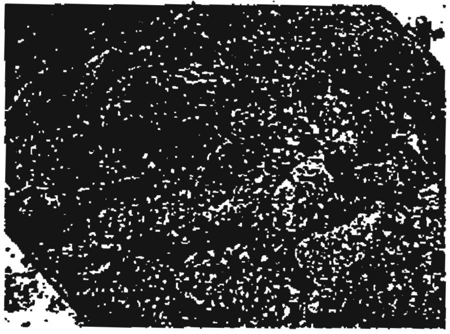
Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Test Pit B		Excavator:	ENPRO Services
Date:	March 5, 2003	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	13 feet bgs*

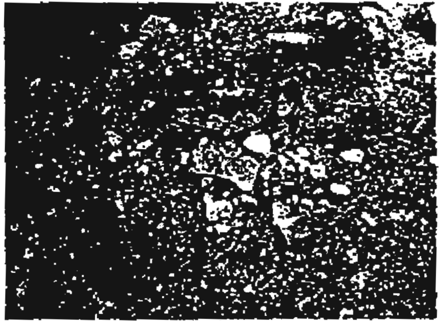
Located southwest portion of site, north of Engine Room building, which lies over the raceway.

West side of pit ran into concrete floor at 1 and 7 feet and was repeatedly lengthened to the west where a depth of ~13 ft was reached, before persistent cave in halted excavation. Top 2 feet were mostly soil, but rapidly changed to brick, coal ash, wood, and steel. A 1.5 inch pipe was noted at 4.5 feet (trending north-south). A layer of tar roofing tiles (apparently burnt/heated) was found at ~6 feet. The roofing tiles had a strong tar like odor. A brick wall was visible on the east end of the pit.

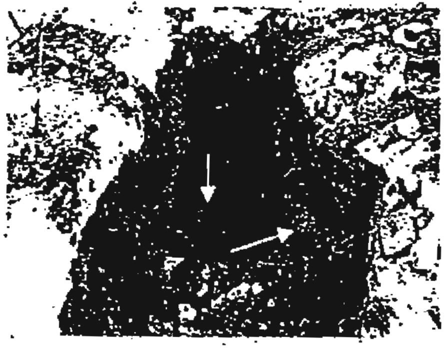
Typical soils 5-7 feet of pit. Note brick wall top of picture.



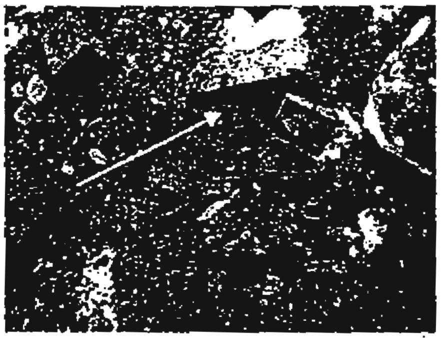
Soils at depth of 11-13 feet. Note mottled appearance.



Typical soils 7-11 feet. Note tiles and coal ash/soil mixture.



View of excavation facing west. In foreground is concrete flooring at 5 feet. On right side wall the overhang is a layer of tar type roofing tiles, which also appear in other parts of the pit. Brick appears to decrease around 8 feet.



Tar type roof tiles subjected to fire and heat.

* Soil appeared consistent at 11 feet. Sidewall cave-in making it difficult to keep pit open, pit halted at ~13 ft.

TEST PIT LOG

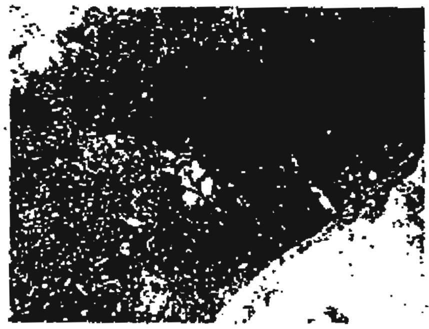
Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit C	Excavator:	ENPRO Services
Date:	March 5, 2003	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	15 feet bgs

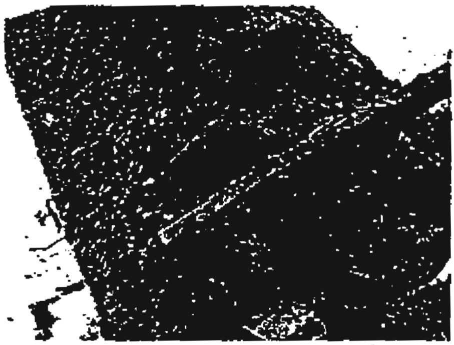
Located south central on site, north and northwest of raceway arch.

Test Pit C was originally dug trending east-west, but refusal was encountered in the 17 foot long pit at a depth of 5 feet. The flooring (wall?) was of brick construction and solid (as determined from blows by the excavator bucket). [As a side note, the O'Gara mill building that abuts the site to the west has brick floors in parts of the building.] Soils above the floor were typical medium brown loamy sand with brick, cement and metal parts. Due to the refusal, the east end of Test Pit C was extended to the south where a depth of 15 feet was reached. Soils in this direction contained relatively no brick, and little to trace amounts of coal slag. At depth, the soil appeared to be clean medium textured sand with an orange/tan hue.

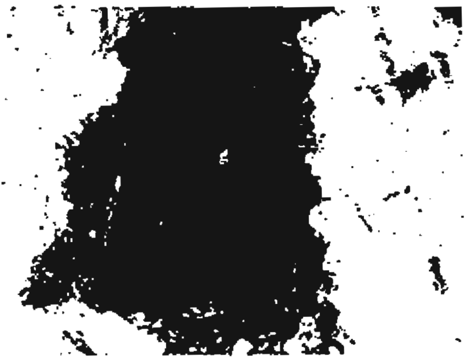
Wood, concrete, and coal ash typical of top 5 feet of soils.



View looking down into test pit. Note unusual color of sand.



Typical soils and debris in found in first 2 feet.



Brick floor located at 5 feet in east/west section of pit.

Aluminum sheeting found in several pits , including Test Pits A and B.

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TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

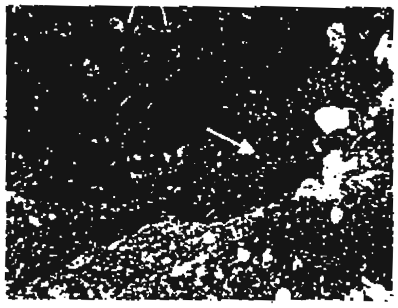
Location/ID:	Test Pit D	Excavator:	ENPRO Services
Date:	March 5, 2003	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	5 feet bgs

Located south central on site, across raceway from the Water Wheel (Building 6) on the south side of the raceway.

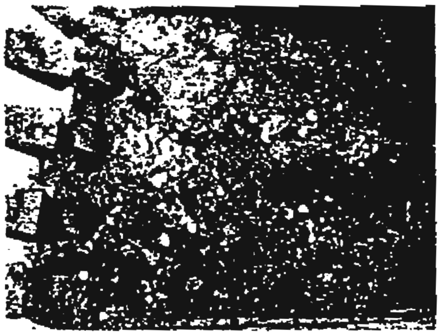
Test Pit D was extended ~25 ft. east/west and another 15 feet north/south before excavation ceased. The pit was roughly 5 feet deep in the east/west direction and as shallow as 1 to 2 feet in the north/south direction. A brick floor was the refusing layer (see note in Test Pit C), though some areas showed a concrete floor.

The soils were typically debris laden, containing such items as brick, rebar, cement, occasional scraps of iron or steel machinery parts, wood, and some lime. In the western end of the pit burnt timbers and blacker soils were encountered. Though the blacker soils were likely due to past fires, some of the soils may have contained coal ash as well.

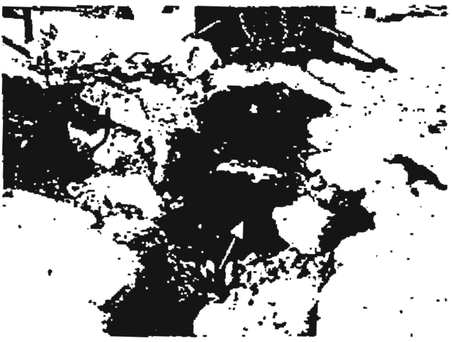
Large pieces of concrete and brick found in this general area were also found to the west during a previous investigation.



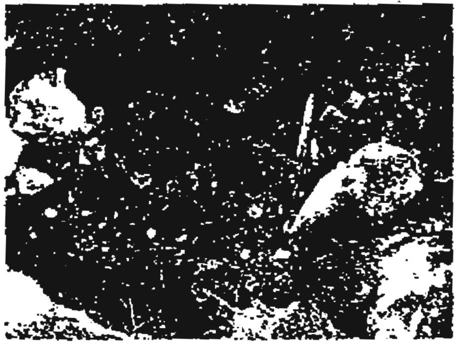
Near bottom of pit (~4 feet). Note unusually colored sands. These chartreuse and olive colors are seen in many pits across the site (including C, G, and J).



Soils from top 2 feet. White material is lime.



Center of picture: Brick floor overlying cement floor with rebar. This piece was not intact and removed. Similar to pieces found in previous investigation pit directly to the west.



Horizon E – location of concrete slab with steel grate (possible slot drain - north-south trend)

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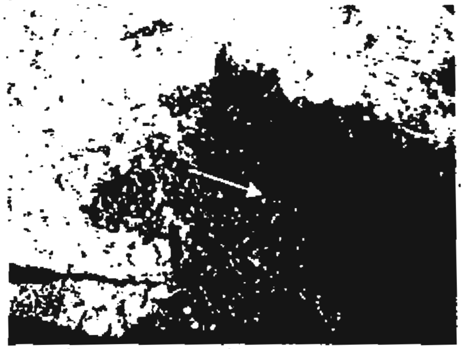
TEST PIT LOG

**Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts**

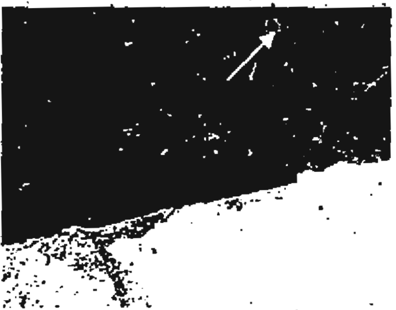
Location/ID:	Test Pit E	Excavator:	ENPRO Services
Date:	March 3, 2003	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	15 feet bgs

Located on the southeast portion of the site, just west of the foot bridge leading to the silos on the south side of the raceway.

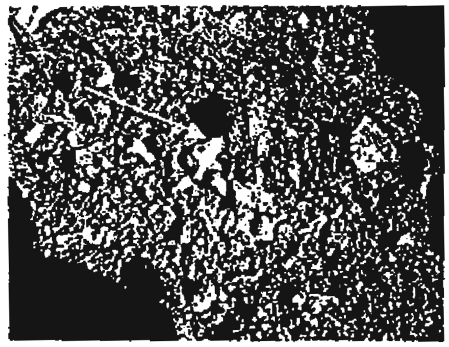
A lot of suspected asbestos containing materials (ACM) were encountered in this pit. The initial hole grounded out at ~2.5 and was subsequently extended to the east where the depth increased to 9 feet before reaching a floor and then finally to depth at the eastern most end of the pit. At the 2.5 foot level a vertical I-beam was encountered, then at 9 feet drain grating was found, and at depth as well as on the shallower end of the pit the materials encountered were brick, plywood, concrete, pipes, and various other metal objects. Unlike some other pits, the debris appeared to be well mixed throughout.



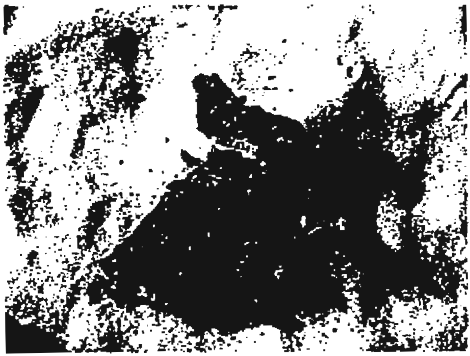
Vertical I-beam located in center of pit, before expanding pit to the east



Concreted floor encountered in pit. Note 4 inch pipe in upper right of picture



Top 2 feet of soil. Note suspect ACM in center of picture.



Suspect ACM - typical of that found throughout the pit.

Typical debris found throughout Test Pit E.

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TEST PIT LOG

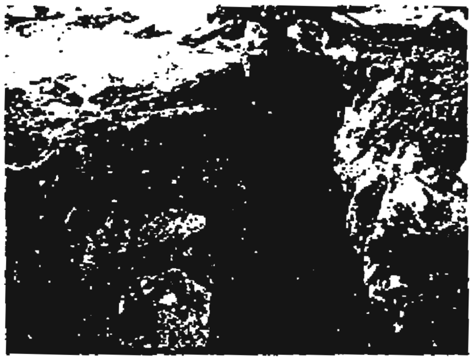
Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit F	Excavator:	ENPRO Services
Date:	March 4, 2003	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	4 feet bgs

Located approximately center on the site over the area that was formerly the boiler room and coal bin.

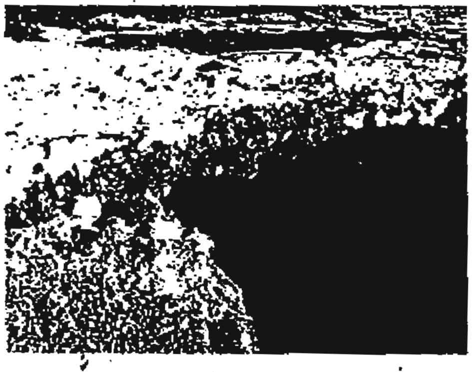
Test Pit F achieved a maximum depth of 4 feet, running into refusal. The refusal appeared to be a concrete floor that is still intact and apparently expansive. From north to south the floor was at 4 feet until a brick wall was reached on the south end of the pit. The floor then rose to ~1 foot from surface. East to west the pit went ~10 feet before reaching a brick wall and rising to ~1.5 feet from surface and eventually sloping up to ~1 feet to surface. No attempt was made to find the extent of the floor because of the size of the excavation that would be necessary to do so.

Top 2 feet of pit is predominantly lime, brick, and some soil.



At ~4 feet deep, the soil (lime fill) changes over to the more typical medium to dark brown and black fine to medium sand, brick, coal chip/slag/ash.

The combination of lime and brick (with little soil) is extensive in this area. The trench here is 20 feet long. A perpendicular trench 35 feet long (not pictured) shows the same characteristics.



'T' section of Test Pit F. The corner to the bottom left in this picture is point 200E,40S of the geophysical grid referred to in previous geophysical work completed on site (M&E, November 2002)..

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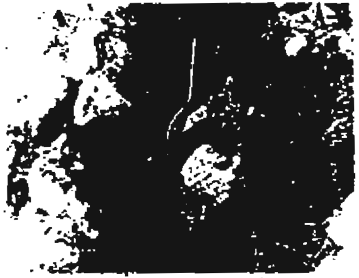
TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit G	Excavator:	ENPRO Services
Date:	March 4, 2003	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	*13 feet bgs

Located east central on the site, adjacent to the southwest side of the large berm. This pit was in the area north of the Black Ash Room and east of the Boiler Room.

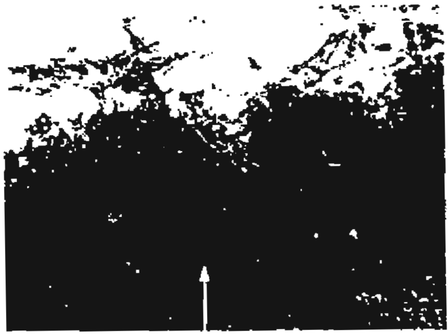
The debris found in this test pit appeared to be well sorted and predominantly brick. Many of the bricks unearthed were yellow, though just as many red bricks were found. The soil part of the mix was medium to dark brown sand with little to trace loamy material. Some greyer soils were also noted. Other debris found in the pit included a crushed canister of some type, steel plate, conduit size piping, rebar, various metal machine parts, coal ash, and several large pieces of building. Some black fluid was found to be leaking from a couple of the conduit size pipes; however, PID screening did not indicate any volatile compounds. Digging in this area was particularly difficult. [As a side note, drilling in this area, which occurred after completion of test pits, was unable to penetrate past ~9 feet – see soil borings 7 and 9.]



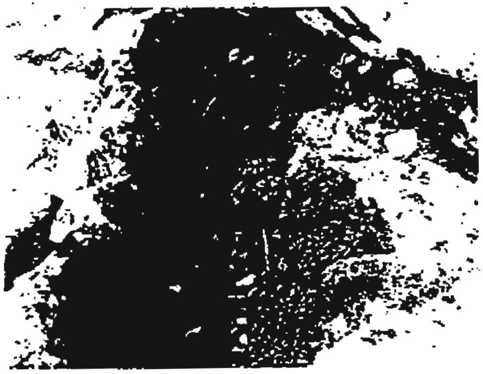
Several large in tact pieces of building found.

Typical debris and metal parts.

Top 2 feet of soil. Mostly brick.



Top section of pit. Note odd colored soils found at various locations at the site.



Typical debris found through Test Pit G.

* Continuous sidewall cave in prevented an open hole to 15 feet, however, 13-15 feet was reached by bucket of excavator. Soils at this depth were the same as those immediately overlying them.

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TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit H	Excavator:	ENPRO Services
Date:	March 3, 2003	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	15 feet bgs

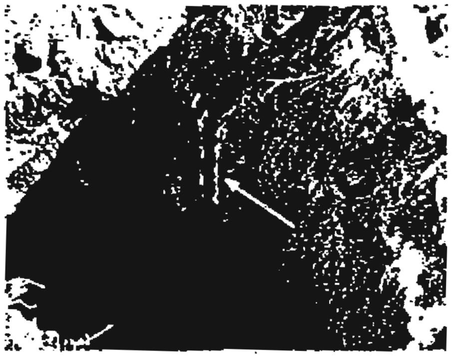
Located on the northwest corner of the site, south of foot bridge that crosses the Spicket River to the hospital.

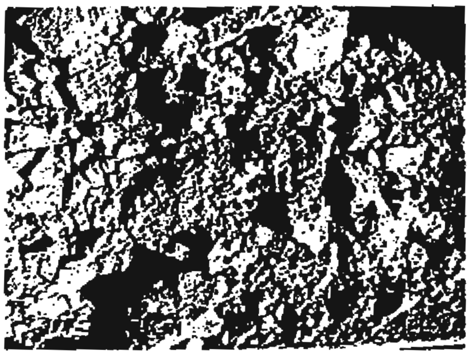
Except for a shallow layer (0 to 2 feet) of lime, brick, concrete, and black loamy soil, the pit was devoid (relatively) of brick and concrete. Rather the soils below 2 feet appeared to alternate between layers of black fine to medium sand, slag, coal ash and chip; and layers of 'clean' fine or fine to medium sand that were olive-gray to yellow-brown with gravel and little to trace coal chips. A reddish-brown sand and gravel was encountered at/near depth along with a random piece of 2 inch steel pipe. Two walls were encountered in the pit. The first wall spanned the pit at ~ 0.5 ft below ground surface. The second was parallel to the east side wall of the test pit.


Looking north: Note wall in foreground (arrow).


Sidewall of Test Pit H, note bedded layers (arrow) of light and dark soils (dark soils have smeared over some of the lighter colored soils).


Example of mixed soils: black coal ashy soil and clean sand fill.


Concrete wall east side of pit (arrow), orientated perpendicular to wall across pit (not shown).


Sand and gravel found near depth in test pit.

M&E
Metcalf & Eddy

TEST PIT LOG

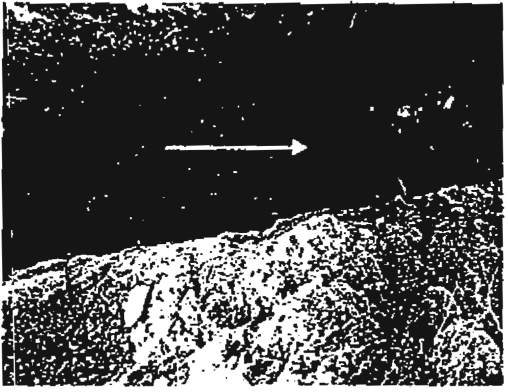
Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit I	Excavator:	ENPRO Services
Date:	March 4, 2003	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	15 feet bgs

Located on northeast portion of site, south of former 20,000 gallon UST grave.

Test Pit I was one of the top three suspect ACM containing pits. Approximately a half dozen coated pipes and many loose fragments of suspect ACM were dug out of the pit, which also contained brick, coal ash/slag/chips, and concrete. Like Test Pit H, there were many pockets of apparently 'clean' sand; several of these pockets of sand appeared to coincide with buried pipes. No major obstructions were encountered, however, an 8 to 10 inch suspect 200299.0001. covered pipe was found on the south side of the pit at 8 feet below ground surface. The pipe was firmly in place and could not be budged by the backhoe.

Suspect ACM coated pipe. One of approximately a half dozen suspect asbestos coated pipes found in pit I.



An 8 to 10 inch suspected asbestos coated pipe was found at 8 feet below ground surface on the south side of the pit. The pipe trended east/west.

Top 2 feet, brown loamy sand and bricks. Note pipe on right side of picture (arrow). Bricks and pipes increase with depth. All other pipes covered in suspected ACM.

North/south trending 4 inch pipe. One of many pipes.

Mixed soils. Pockets of 'clean' sands are mixed into the matrix of dark brown to black soils containing coal ash, chips, and slag.

Metcalf & Eddy

TEST PIT LOG

Former Oxford Paper Mill
Canal Street
Lawrence, Massachusetts

Location/ID:	Test Pit J	Excavator:	ENPRO Services
Date:	March 4, 2003	M&E Geologist:	B. Abrahams-Dematte
Coordinates:	See separate figure	Total Depth:	15 feet bgs

Located east central on the site, east of the large berm and north of MW-10.

Like all other test pits on site, this pit contains a multitude of building demolition and the pervasive coal ash and slag. The first couple of feet in the pit were predominantly brick, after which a couple of wood beams were excavated, a particularly large one was found at 8 feet. Coal ash and slag started to appear at 4 feet, the size of the slag increasing with depth. At approximately 3 feet plastic bags or possible geotextile were found in the west wall (adjacent the berm) of the pit. At 15 feet, the soil appeared to possibly be native fine sand. A foundation was also found on the south side of the pit at 2 feet below grade.

Typical debris from greater than 4 feet below ground surface. Metal, wood, brick, ash, slag, etc...

Foundation wall located 2 feet below ground surface on south side of pit.

Top 2 to 3 feet contained large amounts of brick.

Large pieces of coal slag found at 10 feet below grade.

Plastic bags or geotextile material found in sidewall of pit at 2-3 feet below grade.

Appendix E

North Area Soil Boring Logs

METCALF & EDDY
30 Harvard Mill Square
Wakefield, MA 01880
(781)-246-5200

SITE LOCATION
Oxford Paper Mill
Corner of Canal Street and Marston Street
Lawrence, Massachusetts

BORING NUMBER
SB-1/MW-1

CONTRACTOR: TDS, Inc.
DRILLER: Scott Lombard
INSPECTOR: William Abrahams-Dematte
START DATE: 3/10/03
FINISH DATE: 3/10/03

DRILLING METHOD: Hollow Stem Auger
WELL INSTALLED: Yes
SAMPLING METHOD: Split-spoons
SIZE I.D.: 2 Inch
TOTAL DEPTH: 24 ft.

PAGE
1 of 2

Depth	No.	Range (ft.)	Sample Blows	Recovery (ft.)	PID* (ppm)	Water Table	Interval (ft.)	Sample Description	Stratigraphic Description
0.0	1	0-1'	75+	0.2	ns		0.0-0.8	Void	
1.0			-				0.8-1.0	Dark br rwn, SANDY LOAM, trace frost.	FILL TO
	2	1-3	*5	1.0	0		1.0-2.0	Void	~15 FT.
			*5				2.0-3.0	Brown-black, LOAMY SAND, little coal	
			*5					chip, trace coal ash, loose, dry.	
3.0			*5				3.0-3.4	Void	
	3	3-5	5	1.6	0		3.4-3.7	Fall in.	
			6				3.7-5.0	Brown-black, LOAMY FINE SAND, little-	
			6					trace pebble, trace coal ash, loose, dry.	
5.0			7				5.0-6.0	Void	
	4	5-7	10	1.0	0		6.0-7.0	Brown, FINE SAND, trace silt, brick, loose	
			6					slightly moist.	
			6				7.0-7.6	Void	
7.0			6				7.6-9.0	Brown/Black, LOAMY FINE SAND, trace	
	5	7-9	1	1.4	0			coal chips, loose, slightly moist.	
			3				9.0-9.8	Same As 7.6-9.0 feet.	
			3				9.8-11.0	Brown and tan, FINE SAND, loose, dry.	
9.0			5				11.0-11.4	Fall in.	
	6	9-11	3	2.0	0		11.4-13.0	Dark brown, FINE SAND, slightly firm,	
			3					very slightly moist to dry.	
			3				13.0-13.3	Void	
11.0			3				13.3-15.0	Black/Brown, FINE SAND, very slightly	
	7	11-13	2	2.0	0			moist to dry. Color becomes light brown	
			4					at 14.1 ft.	
			4				15.0-16.2	Brown, FINE SAND, very slightly moist	
13.0			5					to dry.	
	8	13-15	4	1.7	0		16.2-17.0	Grey, FINE SAND, very slightly moist to	
			4					dry. Upper edges of capillary fringe.	
			4				17.0-17.2	Void	
15.0			5				17.2-18.0	Grey, FINE SAND, wet.	NATIVE?
	9	15-17	5	2.0	0			Driller having trouble, augered to 18 feet	TO DEPTH
			7			Water		and sampled.	
			8			Table			
17.0			10			~16.5'			
18.0	10	17-19	5	0.8	0				
			6						
			-						
			-						

*PID calibrated with isobutylene. To read as benzene, multiply by 0.6 *5 = Driller failed to keep count. Split-spoon went in readily.

METCALF & EDDY
30 Harvard Mill Square
Wakefield, MA 01880
(781)-246-5200

SITE LOCATION
Oxford Paper Mill
Corner of Canal Street and Marston Street
Lawrence, Massachusetts

BORING NUMBER
SB-1/MW-1

CONTRACTOR: TDS, Inc.
DRILLER: Scott Lombard
INSPECTOR: William Abrahams-Dematte
START DATE: 3/10/03
FINISH DATE: 3/10/03

DRILLING METHOD: Hollow Stem Auger
WELL INSTALLED: Yes
SAMPLING METHOD: Split-spoons
SIZE I.D.: 2 Inch
TOTAL DEPTH: 24 ft.

PAGE
2 of 2

Depth	No.	Range (ft.)	Sample Blows	Recovery (ft.)	PID* (ppm)	Water Table	Interval (ft.)	Sample Description	Stratigraphic Description
18.0	11	18-20	36	1.2	0		18.0-18.8	Void	NATIVE
			23				18.8-19.2	Same As 17.2-18.0 feet.	
			20				19.2-20.0	Dark grey, MEDIUM SAND and GRAVEL,	
20.0			19				20.0-20.8	Void	
	12	20-22	17	1.2	ns		20.8-22.0	Dark grey, FINE SAND TO GRAVEL,	
			18					loose, wet, brackish odor.	
			10				22.0-23.1	Same As 20.8-22.0 feet.	
22.0			27				23.1-24.0	Light grey, FINE SAND, little-trace silt,	
	13	22-24	20	2.0	ns			slightly firm.	
			14						
			18						
24.0			35						
									End of Boring

*PID calibrated with isobutylene. To read as benzene, multiply by 0.6 *5 = Driller failed to keep count. Split-spoon went in readily.

METCALF & EDDY
30 Harvard Mill Square
Wakefield, MA 01880
(781)-246-5200

SITE LOCATION
Oxford Paper Mill
Corner of Canal Street and Marston Street
Lawrence, Massachusetts

BORING NUMBER

SB - 2

CONTRACTOR: TDS, Inc.
DRILLER: Scott Lombard
INSPECTOR: William Abrahams-Dematte
START DATE: 3/11/03
FINISH DATE: 3/11/03

DRILLING METHOD: Hollow Stem Auger
WELL INSTALLED: No
SAMPLING METHOD: Split-spoons
SIZE I.D.: 2 Inch
TOTAL DEPTH: 15 ft.

PAGE

1 of 1

Depth	No.	Range (ft.)	Sample Blows	Recovery (ft.)	PID* (ppm)	Water Table	Interval (ft.)	Sample Description	Stratigraphic Description
0.0 1.0	1	0-1	14 11	0.5	ns		0.0-0.5 0.5-0.7 0.7-1.0	Void Ice, wood, gravel. Brown, FINE SANDY LOAM, roots, loose.	FILL TO ~15 FT.
3.0	2	1-3	8 4 7 3	1.0	0		1.0-2.0 2.0-2.4 2.4-3.0	Void Same As 0.7-1.0 plus trace coal. Yellow-brown, MEDIUM SAND, some fine sand, white specs - ACM?	
5.0	3	3-5	13 13 9 8	1.1	0		3.0-3.9 3.9-4.5 4.5-5.0	Void Same As 2.4-3.0 plus trace gravel wood, coal slag/chip, dry. BRICK	
7.0	4	5-7	13 38 25 18	1.3	ns		5.0-5.7 5.7-7.0	Void BRICK, little to trace brown, fine sand, dry.	
9.0	5	7-9	22 19 17 14	1.4	ns		7.0-7.6 7.6-8.1 8.1-8.6 8.6-9.0	Void Brown-dark brown, FINE-MEDIUM SAND trace silt, loose, dry. BRICK Same As 7.6-8.1 feet.	
11.0	6	9-11	18 17 15 12	1.2	0		9.0-9.8 9.8-10.1 10.1-10.3 10.3-10.5 10.5-11.0	Void BRICK and GRANITE STONE. Brown/black, FINE SAND, and STONE CHIPS BRICK Yellow-tan, MEDIUM SAND, little to trace gravel and brick.	
13.0	7	11-13	12 100 for 4" - -	0.5	ns		11.0-11.3 11.3-11.8 11.8-13.0	Void Same As 10.5-11.0 feet, plus, very slightly moist Refusal.	
15.0	8	13-15	82 24 9 11	0.7	ns	Water Table ~14' upper capillary fringe.	13.0-14.3 14.3-14.8 14.8-15.0	Void Same As 11.3-11.8 Concrete with quartz.	EOB 15 ft.

*PID calibrated with isobutylene. To read as benzene, multiply by 0.6.

METCALF & EDDY
30 Harvard Mill Square
Wakefield, MA 01880
(781)-246-5200

SITE LOCATION
Oxford Paper Mill
Corner of Canal Street and Marston Street
Lawrence, Massachusetts

BORING NUMBER
SB-3/MW-3

CONTRACTOR: TDS, Inc.
DRILLER: Scott Lombard
INSPECTOR: William Abrahams-Dematte
START DATE: 3/10/03
FINISH DATE: 3/10/03

DRILLING METHOD: Hollow Stem Auger
WELL INSTALLED: Yes
SAMPLING METHOD: Split-spoons
SIZE I.D.: 2 Inch
TOTAL DEPTH: 22 ft.

PAGE
1 of 2

Depth	No.	Range (ft.)	Sample Blows	Recovery (ft.)	PID* (ppm)	Water Table	Interval (ft.)	Sample Description	Stratigraphic Description
0.0 1.0	1	0-1	17 20	1.0	ns		0.0-0.5 0.5-1.0	BRICK and FINE SAND, tr. silt, loose, dry. BRICK	FILL TO ~15 FT. ↓
3.0	2	1-3	21 24 17 14	1.4	0		1.0-1.6 1.6-2.0 2.0-3.0	Void Brown, FINE SAND, trace medium to coarse sand, brick, loose, dry. Red, BRICK and grey FINE SAND, trace pebble, loose, dry.	
5.0	3	3-5	4 6 7 4	0.9	0		3.0-4.1 4.1-5.0	Void Brown/grey-brown, BRICK and FINE to MEDIUM sand, loose, dry.	
7.0	4	5-7	6 7 5 7	0.5	ns		5.0-6.5 6.5-7.0	Void BRICK	
9.0	5	7-9	7 5 5 5	0.6	0		7.0-8.4 8.4-9.0	Void Brown, FINE SAND, BRICK, COAL ASH, COAL SLAG, loose, very slightly moist.	
11.0	6	9-11	4 4 6 7	0.8	0		9.0-10.2 10.2-10.7 10.7-11.0	Void Tan, FINE to MEDIUM SAND, little brick, trace glass and roots, loose, v. sl. Moist. Grey, FINE to MEDIUM SAND, little brick, loose.	
13.0	7	11-13	5 5 4 3	1.2	0		11.0-11.8 11.8-12.2 12.2-12.5 12.5-13.0	Void Grey-brown, FINE to MEDIUM SAND, little slaty stone, brick, concrete, loose, dry. Light tan, MEDIUM SAND, loose, dry. Light brown, FINE to MEDIUM SAND, loose, dry.	
15.0	8	13-15	3 2 2 5	1.4	0	Water Table ~14.3'	13.0-13.6 13.6-13.9 13.9-14.2 14.2-15.0	Void Yellow-brown, FINE to MEDIUM SAND, little coal chip, loose, dry. Brown, FINE SAND, sl. firm, v. sl. moist. Grey-brown, FINE SAND, tr. roots, sl. Firm, trace black spots, wet, mottled at depth.	
17.0	9	15-17	17 21 25 24	1.0	0		15.0-16.0 16.0-16.4 16.4-16.7 16.7-17.0	Void Grey-brown, FINE SAND Grey-brown, MEDIUM SAND and GRAVEL. GRAVEL, little coarse sand.	NATIVE? TO DEPTH ↓
19.0	10	17-19	25 100 for 0" - -	0.5	0		17-17.5	Dark brown-black, MEDIUM SAND and GRAVEL, refusal.	

*PID calibrated with isobutylene. To read as benzene, multiply by 0.6 *5 = Driller failed to keep count. Split-spoon went in readily.

METCALF & EDDY 30 Harvard Mill Square Wakefield, MA 01880 (781)-246-5200	**SITE LOCATION** Oxford Paper Mill Corner of Canal Street and Marston Street Lawrence, Massachusetts	BORING NUMBER SB-3/MW-3

CONTRACTOR: TDS, Inc.
DRILLER: Scott Lombard
INSPECTOR: William Abrahams-Dematte
START DATE: 3/10/03
FINISH DATE: 3/10/03

DRILLING METHOD: Hollow Stem Auger
WELL INSTALLED: Yes
SAMPLING METHOD: Split-spoons
SIZE I.D.: 2 Inch
TOTAL DEPTH: 22 ft.

PAGE 2 of 2

Depth	No.	Range (ft.)	Sample Blows	Recovery (ft.)	PID* (ppm)	Water Table	Interval (ft.)	Sample Description	Stratigraphic Description
19.0 21.0	11	19-21	- - - -	ns	ns		19.0-22.0	After refusal at 17.5 feet, the augers were advanced with the intention of sampling 19-21 feet. However, the augers encountereda gravelly/rock horizon. A decision was made to go right to 22 feet and set the well.	NATIVE ↓
22.0	12	21-22	- -	ns	ns				EOB 22 ft.

*PID calibrated with isobutylene. To read as benzene, multiply by 0.6.

METCALF & EDDY
30 Harvard Mill Square
Wakefield, MA 01880
(781)-246-5200

SITE LOCATION
Oxford Paper Mill
Corner of Canal Street and Marston Street
Lawrence, Massachusetts

BORING NUMBER
SB - 4

CONTRACTOR: TDS, Inc.
DRILLER: Scott Lombard
INSPECTOR: William Abrahams-Dematte
START DATE: 3/17/03
FINISH DATE: 3/17/03

DRILLING METHOD: Hollow Stem Auger
WELL INSTALLED: No
SAMPLING METHOD: Split-spoons
SIZE I.D.: 2 Inch
TOTAL DEPTH: .17 ft.

PAGE
1 of 1

Depth	No.	Range (ft.)	Sample Blows	Recovery (ft.)	PID* (ppm)	Water Table	Interval (ft.)	Sample Description	Stratigraphic Description
0.0 1.0	1	0-1	38 42	1.0	ns		0.0-0.2 0.2-0.4 0.4-1.0	Brown, FINE SANDY LOAM. BRICK and CONCRETE. Tan, FINE-MEDIUM SAND, little to trace brick and gravel.	FILL TO ~17 FT.
3.0	2	1-3	20 28 26 8	1.6	2.1		1.0-1.4 1.4-2.0 2.0-3.0	Void Brown, FINE SAND, little medium to coarse sand, trace pebble and concrete. BRICK, little to trace tan, medium sand and brown fine to medium sand, coal ash/chip/slag	↓
5.0	3	3-5	18 22 120 for 3" -	0.5	ns		3.0-4.5 4.5-5.0	Void Brown, FINE SAND, loose, brick 4.7-5.0 ft	↓
7.0	4	5-7	4 2 6 6	0.5	2.4		Refusal 5.0-6.5 6.5-7.0	First attempt refused at 5.0 feet. Void MIX: brick, concrete, brown fine sand, trace coal ash at depth. Fine sand nearer top.	↓
9.0	5	7-9	5 3 3 5	0.4	ns		7.0-8.6 8.6-9.0	Void Brown, FINE SAND, little to trace medium sand, trace coal slag and ash.	↓
11.0	6	9-11	24 10 8 8	0.9	4.4		9.0-10.1 10.1-10.4 10.4-11.0	Void Grey-brown, FINE SAND, some possibly woody substance and concrete, loose, dry. Weathered CONCRETE, trace grey medium sand, dry.	↓
13.0	7	11-13	8 12 4 6	1.4	4.0		11.0-11.6 11.6-11.8 11.8-12.2 12.2-12.5 12.5-13.0	Void Brown, FINE-COARSE SAND, trace gravel, concrete and brick, dry. Grey, MEDIUM SAND, little fine sand, trace gravel, dry. Red-tan, FINE-MEDIUM SAND, trace gravel Dark brown, FINE SAND.	↓
15.0	8	13-15	3 5 5 4	2.0	4.7		13.0-13.4 13.4-15.0	Green-grey, FINE-MEDIUM SAND, tr. grav. Dark brown-black, FINE SAND, little to trace silt, dry. Strong, weathered HC odor.	↓
17.0	9	15-17	2 6 6 7	1.3	7.0		15.0-15.7 15.7-17.0	Void Black, FINE SAND, little to trace silt. Strong weathered HC odor; bottom split-spoon become lighter in color and odor becomes less obvious. Top edge water table.	EOB 17 ft.
						Upper Edge Water Table ~17			

*PID calibrated with isobutylene. To read as benzene, multiply by 0.6.

METCALF & EDDY	SITE LOCATION	BORING NUMBER
30 Harvard Mill Square Wakefield, MA 01880 (781)-246-5200	Oxford Paper Mill Corner of Canal Street and Marston Street Lawrence, Massachusetts	SB-5/MW-5

CONTRACTOR: TDS, Inc.
DRILLER: Scott Lombard
INSPECTOR: William Abrahams-Dematte
START DATE: 3/14/03
FINISH DATE: 3/14/03

DRILLING METHOD: Hollow Stem Auger
WELL INSTALLED: Yes
SAMPLING METHOD: Split-spoons
SIZE I.D.: 2 Inch
TOTAL DEPTH: 24 ft.

PAGE
1 of 2

Depth	No.	Range (ft.)	Sample Blows	Recovery (ft.)	PID* (ppm)	Water Table	Interval (ft.)	Sample Description	Stratigraphic Description
0.0	1	0-1	20	1.0	ns		0.0-0.4	White/grey, lime or coal ash; trace brown	
1.0			73					fine sandy loam, m ist.	FILL TO
			100+ for 2"				0.4-0.8	BRICK	~15 FT.
	2	1-3	-	0.15	ns		0.8-1.0	Brown, FINE SAND, trace pebble.	
			-				1.0-1.15	Same As 0.8-1.0	
3.0			-				1.15-3.0	BRICK. Refusal met, halt drilling move 5 ft.	
			13				3.0-4.2	Void	
	3	3-5	7	0.8	0		4.2-4.5	BRICK and Brown FINE SAND.	
			7				4.5-4.7	Black, FINE-MEDIUM SAND texture-coal?	
5.0			21				4.7-4.9	BRICK	
			23				4.9-5.0	Same As 4.5-4.7 feet.	
	4	5-7	8	0.6	0		5.0-6.4	Void	
			8				6.4-6.6	Red-brown, FINE SAND, moist, fall in.	
7.0			11				6.6-7.0	Same As 4.9-5.0 feet, plus trace yellow	
			43					medium sand, dry.	
	5	7-9	15	1.6	0		7.0-7.4	Void	
			13				7.4-7.7	Red-black, with yellow spots, FINE SAND,	
9.0			12					trace coal chips.	
			33				7.7-8.4	Tan, COARSE SAND to FINE GRAVEL.	
	6	9-11	50	1.1	0		8.4-9.0	Black/orange (mottled) FINE to MEDIUM-	
			65					COARSE SAND, trace coal chips and slag,	
11.0			-					moist - likely perched water table.	
12.0			17				9.0-9.9	Void	
	7	11-13	19	0.4	0		9.9-10.0	Black, (coal) sandy textured soil with brick.	
			13				10.0-10.6	Same As 8.4-9.0 feet., less black (coal) sand.	
14.0			8				10.6-11.0	CONCRETE	
			4				11.0-12.0	AUGERED THROUGH REFUSAL.	
	8	13-15	2	1.9	0	Water	12.0-13.6	Void	
			2			Table	13.6-14.0	Orange, FINE to MEDIUM SAND, little to	
16.0			3			~14.8		trace gravel (granite composition).	
			4				14.0-14.1	Void	
	9	15-17	4	2.0	0		14.1-15.0	Brown/grey/black, FINE SAND, sl. moist	
			5				15.0-16.0	Grey to 15.5 ft. green to 16.0 ft, FINE SAND	Native?
18.0			6					very moist.	To Depth
			1				16.0-18.0	Brown-green to black-green, FINE SAND,	
	10	17-19	2	2.0	2.5			little silt.	
			1				18.0-20.0	Green-brown, FINE SAND, little-trace silt,	
20.0			2					wet, marshy odor.	

*PID calibrated with isobutylene. To read as benzene, multiply by 0.6.

METCALF & EDDY
30 Harvard Mill Square
Wakefield, MA 01880
(781)-246-5200

SITE LOCATION
Oxford Paper Mill
Corner of Canal Street and Marston Street
Lawrence, Massachusetts

BORING NUMBER
SB-5/MW-5

CONTRACTOR: TDS, Inc.
DRILLER: Scott Lombard
INSPECTOR: William Abrahams-Dematte
START DATE: 3/14/03
FINISH DATE: 3/14/03

DRILLING METHOD: Hollow Stem Auger
WELL INSTALLED: Yes
SAMPLING METHOD: Split-spoons
SIZE I.D.: 2 Inch
TOTAL DEPTH: 24 ft.

PAGE
2 of 2

Depth	No.	Range (ft.)	Sample Blows	Recovery (ft.)	PID* (ppm)	Water Table	Interval (ft.)	Sample Description	Stratigraphic Description
20.0 22.0	11	18-20	1 1 16 30	1.5	0.9		20.0-20.5 20.5-22.0	Void Dark brown, FINE SAND, little silt, trace pebble, wet (center 0.5 ft. saturated), trace clay at depth.	NATIVE
24.0	12	20-22	37 30 31 39	0.6	1.3		22.0-23.4 23.4-24.0	Void Dark brown-black, COARSE SAND to GRAVEL, saturated. Little to trace fine sand at top.	↓
									End of Boring 24 Feet

*PID calibrated with isobutylene. To read as benzene, multiply by 0.6.

METCALF & EDDY
30 Harvard Mill Square
Wakefield, MA 01880
(781)-246-5200

SITE LOCATION
Oxford Paper Mill
Corner of Canal Street and Marston Street
Lawrence, Massachusetts

BORING NUMBER
SB-6/MW-6

CONTRACTOR: TDS, Inc.
DRILLER: Scott Lombard
INSPECTOR: William Abrahams-Dematte
START DATE: 3/13/03
FINISH DATE: 3/13/03

DRILLING METHOD: Hollow Stem Auger
WELL INSTALLED: Yes
SAMPLING METHOD: Split-spoons
SIZE I.D.: 2 Inch
TOTAL DEPTH: 22 ft.

PAGE
1 of 2

Depth	No.	Range (ft.)	Sample Blows	Recovery (ft.)	PID* (ppm)	Water Table	Interval (ft.)	Sample Description	Stratigraphic Description
0.0	1	0-1	9	0.7	ns		0.0-0.4	Void	
1.0			8				0.4-1.0	Brown, FINE SANDY LOAM and BRICK.	FILL TO ~15-16 FT.
	2	1-3	12	0.8	0		1.0-2.2	Void	
			33				2.2-2.4	Same As 0.4-1.0	
			37				2.4-2.6	BRICK	
3.0			39				2.6-3.0	Brown, FINE SAND, little medium sand and gravel, dense, dry.	
	3	3-5	13	0.6	0				
			8				3.0-3.6	BRICK, little fine sand, brown.	
			8				3.6-5.0	Refusal at concrete floor.	
5.0			10				Refusal	First attempt refused at 3.6 feet.	
	4	5-7	5	0.3	ns		5.0-6.7	Void	
			1				6.7-7.0	Red-brown, FINE SAND, trace silt and brick coal chips and asbestos found at depth.	
			2						
7.0			2				Refusal	Second attempt refused at 7.0 feet.	
	5	7-9	9	0.2	ns		7.0-7.4	Brown-dark brown, FINE SAND, little silt, asbestos, brick, wet.	
			10						
			100+				7.4-9.0	Refusal at concrete floor.	
9.0			-				Refusal	Third attempt refused at 7.5 feet	
10.0	6	10-12	11	0.5	ns		Auger	Fourth attempt augured 8.5-10 feet through concrete floor. Began sampling at 10.0 feet.	
			11						
			16				10.0-11.5	Void	
12.0			14				11.5-12.0	Grey-brown, FINE to COARSE SAND, little angular gravel, brick, dry.	
	7	12-14	3	0	ns				
			1				12.0-14.0	NO RECOVERY.	
			1				14.0-15.0	Brown, FINE SAND, very slightly moist.	
14.0			2			Water Table ~15'	15.0-16.0	Brown-grey, FINE SAND, moist, very wet from 15.6-16.0.	
	8	14-16	2	2.0	0				
			1				16.0-16.5	Void	
			2				16.5-16.8	Brown, FINE SAND, trace silt, wet to moist.	
16.0			1				16.8-17.6	Green-grey, FINE SAND, saturated.	
	9	16-18	1	1.5	0		17.6-17.8	Grey, FINE SAND, wet.	
			1				17.8-18.0	Black, FINE-MEDIUM SAND, little pea gravel, marshy odor, wet.	NATIVE TO DEPTH
			5						
18.0			11				18.0-18.6	Void	
	10	18-20	19	1.4	0		18.6-18.8	Black, FINE SAND, wet.	
			20				18.8-20.0	Black, VERY COARSE SAND and ANGULAR GRAVEL, slight marshy odor, loose, saturated.	
			26						
20.0			33						

*PID calibrated with isobutylene. To read as benzene, multiply by 0.6.

METCALF & EDDY
30 Harvard Mill Square
Wakefield, MA 01880
(781)-246-5200

SITE LOCATION
Oxford Paper Mill
Corner of Canal Street and Marston Street
Lawrence, Massachusetts

BORING NUMBER
SB-6/MW-6

CONTRACTOR: TDS, Inc.
DRILLER: Scott Lombard
INSPECTOR: William Abrahams-Dematte
START DATE: 3/13/03
FINISH DATE: 3/13/03

DRILLING METHOD: Hollow Stem Auger
WELL INSTALLED: Yes
SAMPLING METHOD: Split-spoons
SIZE I.D.: 2 Inch
TOTAL DEPTH: 22 ft.

PAGE
2 of 2

Depth	No.	Range (ft.)	Sample Blows	Recovery (ft.)	PID* (ppm)	Water Table	Interval (ft.)	Sample Description	Stratigraphic Description
20.0			21				20.0-20.9	Void	NATIVE
	11	20-22	55	1.1	0		20.9-22.0	Same As 18.8-20.0 feet, plus brownish-grey coloration at depth.	↓
			27						
22.0			23						
									EOB 22 ft.

*PID calibrated with isobutylene. To read as benzene, multiply by 0.6.

METCALF & EDDY
30 Harvard Mill Square
Wakefield, MA 01880
(781)-246-5200

SITE LOCATION
Oxford Paper Mill
Corner of Canal Street and Marston Street
Lawrence, Massachusetts

BORING NUMBER

SB - 7

CONTRACTOR: TDS, Inc.
DRILLER: Scott Lombard
INSPECTOR: William Abrahams-Dematte
START DATE: 3/13/03
FINISH DATE: 3/14/03

DRILLING METHOD: Hollow Stem Auger
WELL INSTALLED: No
SAMPLING METHOD: Split-spoons
SIZE I.D.: 2 Inch
TOTAL DEPTH: 9.5 ft.

PAGE

1 of 1

Depth	No.	Range (ft.)	Sample Blows	Recovery (ft.)	PID* (ppm)	Water Table	Interval (ft.)	Sample Description	Stratigraphic Description
0.0	1	0-1	33	1.0	ns		0.0-0.1	Ice	
1.0			46				0.1-0.6	BRICK and COAL ASH	FILL TO
			29				0.6-1.0	BRICK	9.5 FT.
	2	1-3	15	1.2	0		1.0-1.8	Void	
			13				1.8-3.0	BRICK, CONCRETE, COAL CHIPS, and	
3.0			18				2.4-3.0	brown FINE SANDY LOAM.	
			9				3.0-4.6	Void	
	3	3-5	11	0.4	0		4.6-4.9	BRICK and COAL ASH	
			14				4.9-5.0	Red-brown, FINE SAND, loose, dry.	
5.0			15				5.0-6.7	Void	
			5				6.7-7.0	BRICK and WOOD.	
	4	5-7	25	0.3	ns		7.0-8.3	Void	
			4				8.3-9.0	YELLOW BRICK (rather than the typical	
7.0			4					red brick) and CONCRETE, trace wood,	
			8					little to trace fine to medium sand.	
	5	7-9	8	0.7	ns		Refusal	First attempt refused at 9.0 ft.	
			10				9.0-9.5	CONCRETE	
9.0			7			Water	9.5-11.0	Refusal.	EOB
			13			Table	Refusal	Second attempt refused at 9.5 f	9.5 ft.
	6	9-11	100+	0.5	ns	> 9.5'			
								A third attempt was made 3/17/03, but met	
11.0								refusal at 9.0 feet too (on concrete floor).	

*PID calibrated with isobutylene. To read as benzene, multiply by 0.6.

METCALF & EDDY	SITE LOCATION	BORING NUMBER
30 Harvard Mill Square Wakefield, MA 01880 (781)-246-5200	Oxford Paper Mill Corner of Canal Street and Marston Street Lawrence, Massachusetts	SB - 8

CONTRACTOR: TDS, Inc.
DRILLER: Scott Lombard
INSPECTOR: William Abrahams-Dematte
START DATE: 3/11/03
FINISH DATE: 3/11/03

DRILLING METHOD: Hollow Stem Auger
WELL INSTALLED: No
SAMPLING METHOD: Split-spoons
SIZE I.D.: 2 Inch
TOTAL DEPTH: 9.5 ft.

PAGE 1 of 1

Depth	No.	Range (ft.)	Sample Blows	Recovery (ft.)	PID* (ppm)	Water Table	Interval (ft.)	Sample Description	Stratigraphic Description
0.0 1.0	1	0-1	6 6	0.6	ns		0.0-0.4 0.4-0.6 0.6-1.0	Void Vegetation Brown, FINE SANDY LOAM, little brick.	FILL TO 9.5 FT.
3.0	2	1-3	7 10 7 14	0.6	ns		1.0-2.4 2.4-3.0	Void Brown/brown-grey, FINE SAND, trace silt, coal ash, and slag.	↓
5.0	3	3-5	7 8 11 9	0.4	ns		3.0-4.6 4.6-5.0	Void Brown, FINE SAND, Grey CONCRETE, and Yellow BRICK, with white grains of unknown material, trace wood.	
7.0	4	5-7	10 17 20 23	1.2	ns		5.0-5.8 5.8-7.0	Void BRICK, some coal ash/chips/slag, trace wood, loose, dry.	
9.0	5	7-9	• • • •	1.0	ns		7.0-8.0 8.0-9.0 Refusal Refusal	Void BRICK and CONCRETE, trace soil. First attempt refused at 9.0 ft. Second attempt refused at 3.5 ft.	
11.0	6	9-11		0.4	ns	Water Table > 9.5'	9.0-9.4 9.4-11.0 Refusal	BRICK Refusal Third attempt refused at 9.5 ft.	EOB 9.5 ft.

*PID calibrated with isobutylene. To read as benzene, multiply by 0.6. • Driller did not take counts for this split spoon.

METCALF & EDDY
30 Harvard Mill Square
Wakefield, MA 01880
(781)-246-5200

SITE LOCATION
Oxford Paper Mill
Corner of Canal Street and Marston Street
Lawrence, Massachusetts

BORING NUMBER
SB - 9

CONTRACTOR: TDS, Inc.
DRILLER: Scott Lombard
INSPECTOR: William Abrahams-Dematte
START DATE: 3/11/03
FINISH DATE: 3/12/03

DRILLING METHOD: Hollow Stem Auger
WELL INSTALLED: No
SAMPLING METHOD: Split-spoons
SIZE I.D.: 2 Inch
TOTAL DEPTH: 15 ft.

PAGE
1 of 1

Depth	No.	Range (ft.)	Sample Blows	Recovery (ft.)	PID* (ppm)	Water Table	Interval (ft.)	Sample Description	Stratigraphic Description
0.0	1	0-1	6	0.6	ns		0.0-0.4	Void	
1.0			8				0.4-1.0	BRICK and white sandy LIME.	FILL TO
	2	1-3	52	1.4	ns		1.0-1.6	Void	15 FT.
			26				1.6-3.0	BRICK, trace soil and coal chips. Brown,	
			18					fine sand, trace silt at depth.	
3.0			48				3.0-4.1	Void	
	3	3-5	17	0.9	ns		4.1-5.0	Same As 1.6-3.0 feet.	
			21				5.0-5.7	Void	
			19				5.7-5.9	Fall in.	
5.0			14				5.9-6.2	BRICK and Brown FINE SAND, trace silt.	
	4	5-7	12	1.3	ns		6.2-6.6	BRICK	
			15				6.6-7.0	BRICK and CONCRETE, trace soil.	
			15				7.0-8.1	Void	
7.0			32				8.1-8.4	Tan, MEDIUM SAND, GRAVEL, BRICK.	
	5	7-9	12	0.9	ns		8.4-9.0	RED BRICK.	
			9				Refusal	First attempt refused at 9.0 ft.	
			15				Refusal	Second attempt refused at 3 ft.	
9.0			18				9.0-10.4	Void	
	6	9-11	4	0.6	3.2		10.4-11.0	Brown-yellow, FINE SAND, trace gravel,	
			4					brick at depth.	
			3				11.0-13.0	Brown-yellow, FINE to MEDIUM SAND,	
11.0			8					loose to slightly firm, small mottles at depth,	
	7	11-13	5	2.0	6.2			dry.	
			5				13.0-13.8	Void	
			6				13.8-15.0	Brown-yellow, FINE SAND, little to trace	
13.0			6			Water		medium sand, trace brick, trace coal chip at	
	8	13-15	7	1.2	4.7	Table		top of split-spoon, loose, dry.	
			6			~13-15 ft.			
			6						EOB
15.0			9						15 ft.

*PID calibrated with isobutylene. To read as benzene, multiply by 0.6.

METCALF & EDDY
30 Harvard Mill Square
Wakefield, MA 01880
(781)-246-5200

SITE LOCATION
Oxford Paper Mill
Corner of Canal Street and Marston Street
Lawrence, Massachusetts

BORING NUMBER
SB-10/MW-10

CONTRACTOR: TDS, Inc.
DRILLER: Scott Lombard
INSPECTOR: William Abrahams-Dematte
START DATE: 3/12/03
FINISH DATE: 3/12/03

DRILLING METHOD: Hollow Stem Auger
WELL INSTALLED: Yes
SAMPLING METHOD: Split-spoons
SIZE I.D.: 2 Inch
TOTAL DEPTH: 17 ft.

PAGE
1 of 1

Depth	No.	Range (ft.)	Sample Blows	Recovery (ft.)	PID* (ppm)	Water Table	Interval (ft.)	Sample Description	Stratigraphic Description
0.0 1.0	1	0-1	10 22	1.0	ns		0.0-0.2 0.2-0.7	Ice BRICK and FINE SANDY LOAM, dry.	FILL TO ~17 FT.
3.0	2	1-3	28 19 22 11	1.0	ns		0.7-1.0 1.0-2.0 2.0-3.0	Brown, FINE SAND, trace silt and medium sand, little brick, loose, dry. Void BRICK and CONCRETE.	
5.0	3	3-5	6 8 7 6	0.5	0		3.0-4.5 4.5-4.7 4.7-5.0	Void Brown, MEDIUM SAND and BRICK. Dark brown, FINE SAND, little to trace silt and slag, loose, very slightly moist.	
7.0	4	5-7	11 4 5 8	1.0	ns	Water Table ~6-7 ft.	5.0-6.0 6.0-6.2 6.2-6.4	Void Yellow-orange, MEDIUM-VERY COARSE SAND, some pebbles, loose, moist. Black, FINE SAND, trace silt and coal chips	
9.0	5	7-9	4 8 16 18	1.0	ns		6.4-6.7 6.7-6.9 6.9-7.0	Light brown, SANDY SILT, trace clay, moist to wet. Pale green, FINE SAND, moist. Same As 6.2-6.4 feet.	
11.0	6	9-11	14 8 7 11	0.6	11.3		7.0-8.0 8.0-8.2 8.2-8.5 8.5-9.0	Void Dark brown, FINE SAND, trace brick, wet. Same As 6.4-6.7 feet, plus lens of black sand. Same As 6.7-6.9 feet, plus a bed (8.7-8.8 ft) of black, fine sand, little silt, trace pea gravel.	
13.0	7	11-13	9 17 16 8	0.4	113		9.0-10.4 10.4-10.7 10.7-11.0	Void Yellow STONE (brick and COARSE SAND. Black FINE SAND and Green STONE, HC odor	
15.0	8	13-15	7 6 6 7	2.0	78.4		11.0-12.6 12.6-13.0	Void Black, FINE SAND, little medium sand, and trace gravel. Very strong HC odor, outside of split spoon coated in viscous oil.	
17.0	9	15-17	10 5 21 14	2.0	131		13.0-14.0 14.0-14.5 14.5-15.0	Sludgy oil, mostly liquid, split-spoon coated. Black, FINE-MEDIUM SAND, oil soaked. Tan/greenish, FINE-MEDIUM SAND, oil coated at edges in contact with split-spoon.	EOB 17 ft.
							15.0-16.1 16.1-16.3 16.3-16.8 16.8-17.0	Black oily sludge, mostly liquidy; like 13'-14' Black FINE SAND and GRAVEL. Gray-black, FINE SAND, oily. Tan, FINE-VC SAND, little gravel, not oily.	

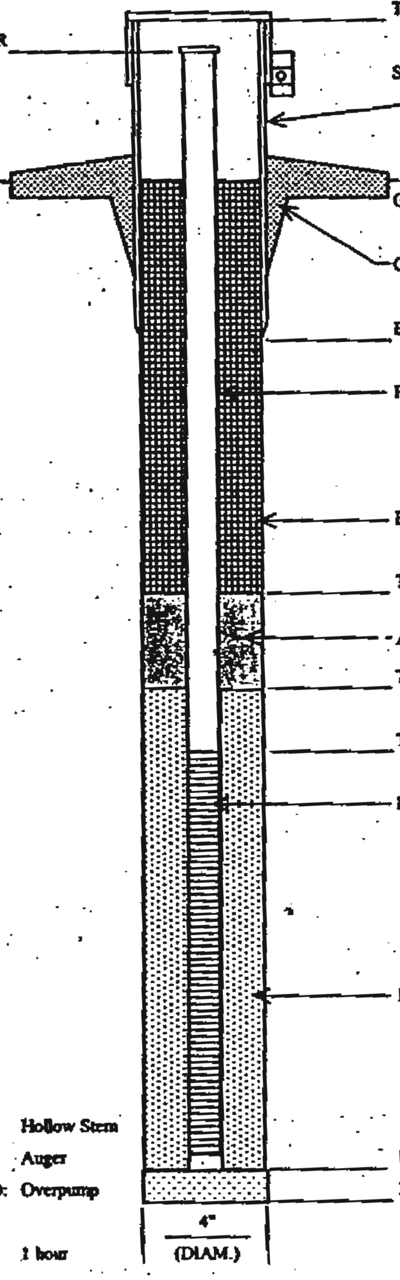
*PID calibrated with isobutylene. To read as benzene, multiply by 0.6.

Appendix F

North Area Monitoring Well Construction Logs

MONITORING WELL INSTALLATION LOG

PROJECT: Oxford Paper Mill, Lawrence, MA	JOB NO. 200299-1-2	WELL NO. **MW-1**
DRILLING CONTRACTOR: TDS, Inc.	COORDINATES:	
BEGUN: 3/10/2003	GEOLOGIST: William Abrahams-Dematte	WATER LEVEL (Depth/Elev.)
FINISHED: 3/10/2003	DRILLER: Scott Lombard	Depth to water 14.15 FT on 3/26/03



GENERALIZED GEOLOGIC LOG
-SEE BORING LOGS

	DEPTH BGS HEIGHT AGS (FT)	ELEV. (FT) NGVD DATUM
TOP OF STEEL CASING	2'	
TOP OF PVC RISER	1.76'	
SURFACE CASING: DIA.: 5" TYPE: Steel		
GROUND SURFACE	0'	
CONCRETE		
BOTTOM OF PROTECTIVE PIPE	3'	
PVC RISER CASING: SCH.: 40 DIAM.: 2-in.		
BACKFILL TYPE: native, sand, cement		
TOP OF ANNULAR SEAL	10'	
ANNULAR SEAL: TYPE: Bentonite Chips		
TOP OF FILTER PACK	12'	
TOP OF WELL SCREEN	13.4'	
PVC SCREEN: SCH.: 40 DIAM.: 2-in. SLOT SIZE: 0.010-in.		
FILTER PACK TYPE: morie sand SIZE: #1		
BOTTOM OF SCREEN	23.4'	
BOTTOM OF HOLE	23.4'	

METHOD DRILLED: Hollow Stem Auger

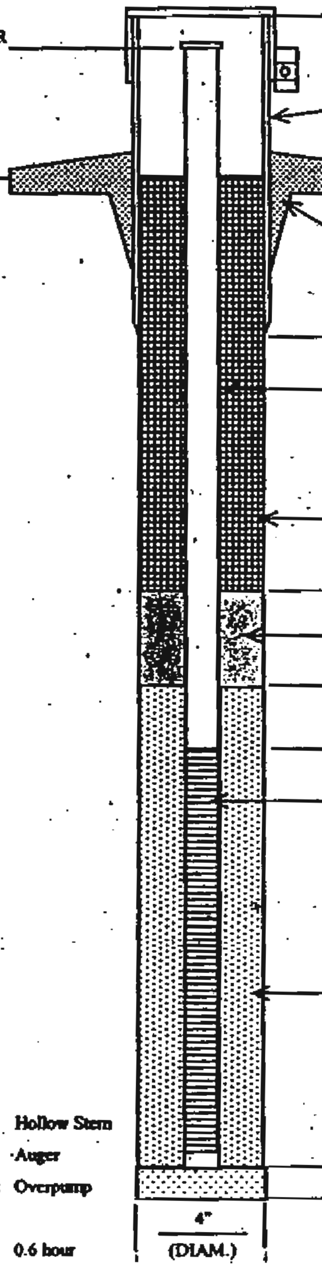
METHOD DEVELOPED: Overpump

TIME DEVELOPED: 1 hour

M&E

MONITORING WELL INSTALLATION LOG

PROJECT: Oxford Paper Mill, Lawrence, MA	JOB NO. 200299-1-2	WELL NO. MW-3
DRILLING CONTRACTOR: TDS, Inc.	COORDINATES:	
BEGUN: 3/10/2003	GEOLOGIST: William Abrahams-Dematte	WATER LEVEL (Depth/Elev.) Depth to water 13.24 FT on 3/26/03
FINISHED: 3/10/2003	DRILLER: Scott Lombard	



GENERALIZED GEOLOGIC LOG
-SEE BORING LOGS

	DEPTH BGS HEIGHT AGS (FT)	ELEV. (FT) NGVD DATUM
TOP OF STEEL CASING	2'	
TOP OF PVC RISER	1.8"	
SURFACE CASINK		
GROUND SURFACE	0'	
CONCRETE		
BOTTOM OF PROTECTIVE PIPE	3'	
PVC RISER CASING:		
BACKFILL TYPE: native, sand, cement		
TOP OF ANNULAR SEAL	8'	
ANNULAR SEAL: TYPE: Bentonite Chips		
TOP OF FILTER PACK	10'	
TOP OF WELL SCREEN	12.6'	
PVC SCREEN:		
FILTER PACK		
BOTTOM OF SCREEN	22.6'	
BOTTOM OF HOLE	22.6'	

SURFACE CASINK
DIA.: 5"
TYPE: Steel

PVC RISER CASING:
SCH.: 40
DIAM.: 2-in.

PVC SCREEN:
SCH.: 40
DIAM.: 2-in.
SLOT SIZE: 0.010-in.

FILTER PACK
TYPE: morie sand
SIZE: #1

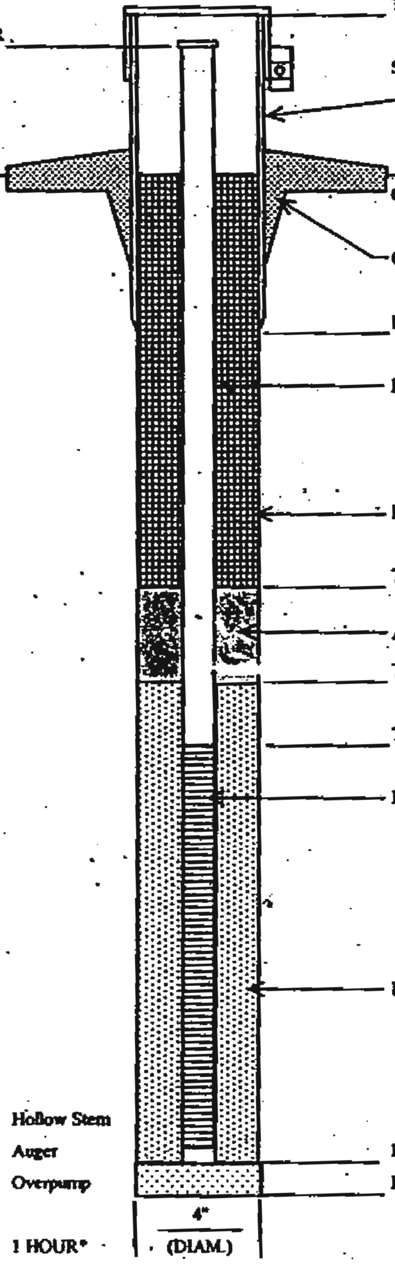
METHOD DRILLED: Hollow Stem Auger
METHOD DEVELOPED: Overpump
TIME DEVELOPED: 0.6 hour

4"
(DIAM.)

M&E

MONITORING WELL INSTALLATION LOG

PROJECT: Oxford Paper Mill, Lawrence, MA	JOB NO. 200299-1-2	WELL NO. MW-5
DRILLING CONTRACTOR: TDS, Inc.	COORDINATES:	
BEGUN: 3/14/2003	GEOLOGIST: William Abrahams-Dematte	WATER LEVEL (Depth/Elev.) Depth to water 16.71 FT on 3/26/03
FINISHED: 3/14/2003	DRILLER: Scott Lombard	



	DEPTH BGS HEIGHT AGS (FT)	ELEV. (FT) NGVD DATUM
TOP OF STEEL CASING	2.3'	
TOP OF PVC RISER	2.1'	
SURFACE CASING: DIA.: 5" TYPE: Steel		
GROUND SURFACE	0'	
CONCRETE		
BOTTOM OF PROTECTIVE PIPE	2.7'	
PVC RISER CASING: SCH.: 40 DIAM.: 2-in.		
BACKFILL TYPE: native, sand, cement		
TOP OF ANNULAR SEAL	10'	
ANNULAR SEAL: TYPE: Bentonite Chips		
TOP OF FILTER PACK	12'	
TOP OF WELL SCREEN	13.6'	
PVC SCREEN: SCH.: 40 DIAM.: 2-in. SLOT SIZE: 0.010-in.		
FILTER PACK TYPE: morie sand SIZE: #1		
BOTTOM OF SCREEN	23.6'	
BOTTOM OF HOLE	23.6'	

GENERALIZED GEOLOGIC LOG
-SEE BORING LOGS

METHOD DRILLED: Hollow Stem Auger

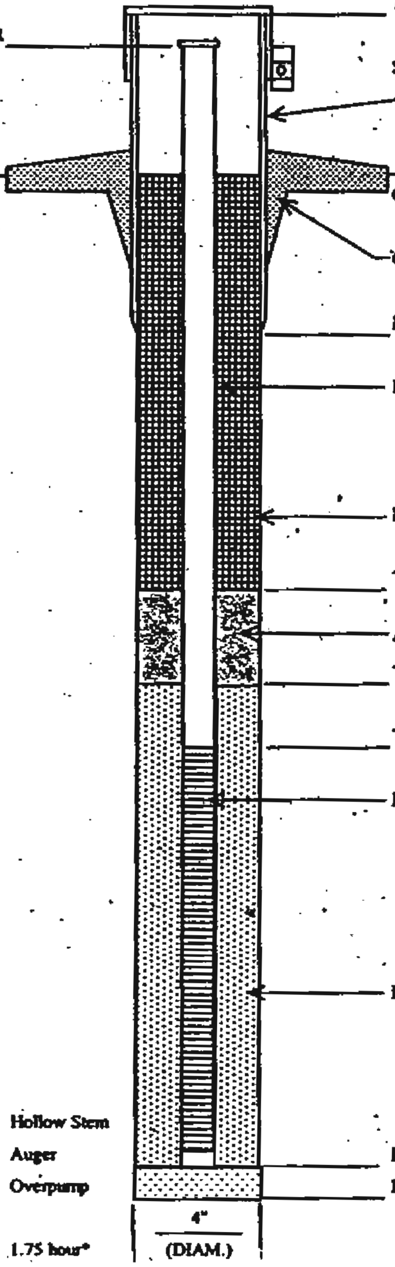
METHOD DEVELOPED: Overpump

TIME DEVELOPED: 1 HOUR*

*Several pauses to allow recharge.

MONITORING WELL INSTALLATION LOG

PROJECT: Oxford Paper Mill, Lawrence, MA	JOB NO. 200299-1-2	WELL NO. MW-6
DRILLING CONTRACTOR: TDS, Inc.	COORDINATES:	
BEGUN: 3/13/2003	GEOLOGIST: William Abrahams-Dematte	WATER LEVEL (Depth/Elev.) Depth to water 14.8 FT on 3/26/03
FINISHED: 3/13/2003	DRILLER: Scott Lombard	



	DEPTH BGS HEIGHT AGS (FT)	ELEV. (FT) NGVD DATUM
TOP OF STEEL CASING	1.9'	
TOP OF PVC RISER	1.4'	
SURFACE CASING: DIA.: 5" TYPE: Steel		
GROUND SURFACE	0'	
CONCRETE		
BOTTOM OF PROTECTIVE PIPE	3.1'	
PVC RISER CASING: SCH.: 40 DIAM.: 2-in.		
BACKFILL TYPE: native, sand, cement		
TOP OF ANNULAR SEAL	8'	
ANNULAR SEAL: TYPE: Bentonite Chips		
TOP OF FILTER PACK	11'	
TOP OF WELL SCREEN	12.6'	
PVC SCREEN: SCH.: 40 DIAM.: 2-in. SLOT SIZE: 0.010-in.		
FILTER PACK TYPE: morie sand SIZE: #1		
BOTTOM OF SCREEN	22.6'	
BOTTOM OF HOLE	22.6'	

GENERALIZED GEOLOGIC LOG
-SEE BORING LOGS

Concrete Floor: 9-10 ft.

METHOD DRILLED: Hollow Stem Auger

METHOD DEVELOPED: Overpump

TIME DEVELOPED: 1.75 hour*

*Stopped several times to allow recharge

MONITORING WELL INSTALLATION LOG

PROJECT: Oxford Paper Mill, Lawrence, MA	JOB NO. 200299-1-2	WELL NO. MW-10
DRILLING CONTRACTOR: TDS, Inc.	COORDINATES:	
BEGUN: 3/12/2003	GEOLOGIST: William Abrahams-Dematte	WATER LEVEL (Depth/Elev.)
FINISHED: 3/12/2003	DRILLER: Scott Lombard	Depth to water 12.64 FT on 3/26/03

GENERALIZED GEOLOGIC LOG
-SEE BORING LOGS

	DEPTH BGS HEIGHT AGS (FT)	ELEV. (FT) NGVD DATUM
TOP OF STEEL CASING	2.6'	
TOP OF PVC RISER	1.35'	
SURFACE CASING: DIA.: 5" TYPE: Steel		
GROUND SURFACE	0'	
CONCRETE		
BOTTOM OF PROTECTIVE PIPE	2.4'	
PVC RISER CASING: SCH.: 40 DIAM.: 2-in.		
BACKFILL TYPE: native, sand, cement		
TOP OF ANNULAR SEAL	3'	
ANNULAR SEAL: TYPE: Bentonite Chips		
TOP OF FILTER PACK	4'	
TOP OF WELL SCREEN	5.4'	
PVC SCREEN: SCH.: 40 DIAM.: 2-in. SLOT SIZE: 0.010-in.		
FILTER PACK TYPE: morie sand SIZE: #1		
BOTTOM OF SCREEN	17.9'	
BOTTOM OF HOLE	17.9'	

METHOD DRILLED: Hollow Stem Auger

METHOD DEVELOPED: Overpump

TIME DEVELOPED: 1.5 hour*

*Stopped several times to clear PVC shavings

M&E

Appendix G

Hazardous Waste Manifests for March 2003 Site Investigation

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF HAZARDOUS MATERIALS
One Winter Street Boston, Massachusetts 02108

Please print or type. (Form designed for use on elite (12-pitch) typewriter)

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. MP9787045801 Manifest Document No. 04124
2. Page 1 of 1
Information in the shaded areas is not required by Federal law.

A. State Manifest Document Number MA Q 404124
B. State Gen...

3. Generator's Name and Mailing Address
CITY OF LAWRENCE
147 HAVERHILL STREET
LAWRENCE MA 01840
4. Generator's Phone (978) 794-6801

5. Transporter 1 Company Name ENPRO Services, Inc.
6. US EPA ID Number MAD980670004

7. Transporter 2 Company Name
8. US EPA ID Number

9. Designated Facility Name and Site Address
GENERAL CHEMICAL
133 LELAND STREET
FRAMINGHAM MA 01701
10. US EPA ID Number MAD019371079

11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol
a. STATE REGULATED OIL WASTE	001	DM	00055	G
b.				
c.				
d.				

J. Additional Descriptions for Materials Listed Above
K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information ENPRO JOB #7003-03
ER CONTACT: ENPRO SERVICES, INC. - 24 HOURS- (800)966-1102

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name Thomas D Schiavone
Signature
Date Month 11 Day 25 Year 03

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name MICHAEL HOLLAND
Signature Michael Holland
Date Month 11 Day 25 Year 03

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name
Signature
Date Month Day Year

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in item 19
Printed/Typed Name
Signature
Date Month Day Year

GENERATOR
TRANSPORTER
FACILITY

MA Q 404124 COPY 8: GENERATOR RETAINS

Form Approved OMB No. 2050-0039.
EPA Form 8700-22 (Rev. 9-88) Previous editions are obsolete.

COMMONWEALTH OF MASS.
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF HAZARDOUS MATERIALS
One Winter Street Boston, Massachusetts 02108

DEP

(Please print or type. (Form designed for use on elite (12-pitch) typewriter)

UNIFORM HAZARDOUS WASTE MANIFEST	1. Generator's US EPA ID No. MC878794589 1	Manifest Document No. 04125	2. Page 1 of	Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
CITY OF LAWRENCE
147 HAVERHILL STREET
LAWRENCE MA 01840
4. Generator's Phone (978) 794-6801

A. State Manifest Document Number MA Q 404125
B. State Gen. ID

5. Transporter 1 Company Name: ENPRO Services, Inc.
6. US EPA ID Number: MAD990670004
7. Transporter 2 Company Name:
8. US EPA ID Number:

9. Designated Facility Name and Site Address
JONES ENVIRONMENTAL SERVICES (NE), INC.
283 HOWARD STREET
LOWELL MA 01852
10. US EPA ID Number: MAD047075733

11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol
a. RQ Asbestos, 9, NA2212, PGIII	003	DF	00600	F
b.				
c.				
d.				

15. Special Handling Instructions and Additional Information: ENPRO JOB #7003-03 ERG#171

ER CONTACT: ENPRO SERVICES, INC. - 24 HOURS- (800)966-1102

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name	Signature	Date Month Day Year
[illegible]		11/25/03

GENERATOR

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Date Month Day Year
MICHAEL HOLLAND		11/25/03

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Date Month Day Year

TRANSPORTER

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in item19

Printed/Typed Name	Signature	Date Month Day Year

FACILITY

Form Approved OMB No. 2050-0039.
EPA Form 8700-22 (Rev. 9-96) Previous editions are obsolete.

MA Q 404125 COPY 8: GENERATOR RETAINS

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF HAZARDOUS MATERIALS
One Winter Street Boston, Massachusetts 02108

Please print or type. (Form designed for use on elite (12-pitch) typewriter)

UNIFORM HAZARDOUS WASTE MANIFEST	1. Generator's US EPA ID No. MP9787945891 Manifest Document No. 04126	2. Page 1 of 1	Information in the shaded areas is not required by Federal law.

A. State Manifest Document Number MA Q 404126

3. Generator's Name and Mailing Address
CITY OF LAWRENCE
147 HAVERHILL STREET
LAWRENCE MA 01840

4. Generator's Phone (978) 794-5891

5. Transporter 1 Company Name: ENPRO Services, Inc.
6. US EPA ID Number: MAD0980670004

7. Transporter 2 Company Name:
8. US EPA ID Number:

9. Designated Facility Name and Site Address
ENPRO SERVICES OF MAINE, INC.
106 MAIN STREET
SOUTH PORTLAND ME 04106

10. US EPA ID Number: MED019051069

11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol
a. NON DOT, NON RCRA REGULATED MATERIAL	001	DM	00055	G
b.				
c.				
d.				

15. Special Handling Instructions and Additional Information: a)ENPRO JOB #7003-03

ER CONTACT: ENPRO SERVICES, INC. - 24 HOURS- (800)966-1102

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name: THOMAS Schiavone
Signature:
Date: Month 11 Day 25 Year 03

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: MICHAEL HOLLAND
Signature: Michael Holland
Date: Month 11 Day 25 Year 03

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name:
Signature:
Date: Month Day Year

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in item19
Printed/Typed Name:
Signature:
Date: Month Day Year

GENERATOR
TRANSPORTER
FACILITY

Form Approved OMB No. 2050-0039.
EPA Form 8700-22 (Rev. 9-96) Previous editions are obsolete.

MA Q 404126 COPY 8: GENERATOR RETAINS

Appendix H

November 2002/August 2003 Soil ACM Laboratory Analytical Reports

Client Name: Stone & Webster Engineering Corporation

Table I
Summary of Bulk Asbestos Analysis Results

08134.0500; Lawrence Oxford Mills; Asbestos

SciLab Sample #	Client Sample# Location	HG Area	Sample Weight (gram)	Heat Sensitive Organic %	Acid Soluble Inorganic %	Insoluble Non-Asbestos Inorganic %	Asbestos by PLM/DS	Asbestos by TEM
01	SS-1 Oxford Mills		----	----	----	----	NVA	NA
02	SS-2 Oxford Mills		----	----	----	----	NVA	NA
03	SS-3 Oxford Mills		----	----	----	----	Chrysotile PRESENT.	NA
04	SS-4 Oxford Mills		----	----	----	----	Amosite PRESENT. Chrysotile PRESENT.	NA
05	SS-5 Oxford Mills		----	----	----	----	NVA	NA
06	SS-6 Oxford Mills		----	----	----	----	Chrysotile PRESENT.	NA
07	SS-7 Oxford Mills		----	----	----	----	Amosite PRESENT. Chrysotile PRESENT.	NA
08	SS-8 Oxford Mills		----	----	----	----	Chrysotile PRESENT.	NA
09	SS-9 Oxford Mills		----	----	----	----	NVA	NA
10	SS-10 Oxford Mills		----	----	----	----	Chrysotile PRESENT.	NA
11	SS-11 Oxford Mills		----	----	----	----	NVA	NA
12	SS-12 Oxford Mills		----	----	----	----	NVA	NA
13	SS-13 Oxford Mills		----	----	----	----	NVA	NA

Table I
Summary of Bulk Asbestos Analysis Results

08134.0500; Lawrence Oxford Mills; Asbestos

SciLab Sample #	Client Sample# Location	HG Area	Sample Weight (gram)	Heat Sensitive Organic %	Acid Soluble Inorganic %	Insoluble Non-Asbestos Inorganic %	Asbestos by PLM/DS	Asbestos by TEM
14	SS-14 Oxford Mills		----	----	----	----	Amosite PRESENT.	NA
15	SS-15 Oxford Mills		----	----	----	----	Chrysotile PRESENT.	NA
16	SS-16 Oxford Mills		----	----	----	----	Chrysotile PRESENT.	NA
17	SS-17 Oxford Mills		----	----	----	----	Chrysotile PRESENT.	NA
18	SS-18 Oxford Mills		----	----	----	----	Amosite PRESENT. Chrysotile PRESENT.	NA
19	SS-19 Oxford Mills		----	----	----	----	NVA	NA
20	SS-20 Oxford Mills		----	----	----	----	Chrysotile PRESENT.	NA
21	SS-21 Oxford Mills		----	----	----	----	NVA	NA
22	SS-22 Oxford Mills		----	----	----	----	Amosite PRESENT. Chrysotile PRESENT.	NA

Client Name: Stone & Webster Engineering Corporation

Table I
Summary of Bulk Asbestos Analysis Results

08134.0500; Lawrence Oxford Mills; Asbestos

SciLab Sample #	Client Sample# Location	HG Area	Sample Weight (gram)	Heat Sensitive Organic %	Acid Soluble Inorganic %	Insoluble Non-Asbestos Inorganic %	Asbestos by PLM/DS	Asbestos by TEM
23	SS-23 Oxford Mills		---	---	---	---	Amosite PRESENT. Chrysotile PRESENT.	NA

Reviewed by:____________; Analyzed By: Paul J. Mucha____________; Date Analyzed: 11/2/02

Qualitative Analysis: Asbestos analysis results of "Present" or "NVA = No Visible Asbestos" represent results for Qualitative PLM or TEM Analysis only (no accreditation coverage available from any regulatory agency for qualitative analyses);

NA = not analyzed; Warning Note: PLM limitation, only TEM will resolve fibers <0.25 micrometers in diameter. Quantitative Analysis (Semi/Full): Bulk Asbestos Analysis - PLM by EPA 600/M4-82-020 per 40 CFR 763 (NVLAP Lab #102079-0); TEM (Semi/Full) by EPA 600/R-93/116 (not covered by NVLAP Bulk accreditation); NAD = no asbestos detected during a quantitative analysis; NA = not analyzed; Trace = <1%; Quantitation for beginning weights of <0.1 grams should be considered as qualitative only; Warning Note: PLM limitation, only TEM will resolve fibers <0.25 micrometers in diameter

SCILAB

SCILAB BOSTON, INC.
8 SCHOOL STREET
WEYMOUTH, MA 02189
TEL: (781) 337-9334 • FAX: (781) 337-7642

PLM Bulk Asbestos Report

Stone & Webster Engineering Corporation
Attn: Jim McComiskey
100 Technology Center Drive
Stoughton, MA 01721

Date Received 10/30/2001 **SciLab Job No.** 502111153
Date Examined 11/12/2002 **P.O. #** 08134.0500
Page 3 **of** 3
RE: 08134.0500; Lawrence Oxford Mill

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
SS-18	502111153-11	*Yes*	1.4 % [1]

Location: Oxford Mills

Description: Brown, Heterogeneous, Soil
Asbestos Types: Chrysotile 1.4 %
Other Material:

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
SS-20	502111153-12	*Yes*	1.3 % [1]

Location: Oxford Mills

Description: , Heterogeneous, Soil
Asbestos Types: Amosite .1 %, Chrysotile 1.1 %, Crocidolite .1 %
Other Material:

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
SS-22	502111153-13	*Yes*	1.3 % [1]

Location: Oxford Mills

Description: Brown, Heterogeneous, Soil
Asbestos Types: Amosite .1 %, Chrysotile 1.2 %
Other Material:

Reporting Notes:

(1) Although this sample was prepared, analyzed, and quantified per EPA Region I Protocol, it should be noted that this protocol stat that "this protocol is not meant to be used as a quantitative method".

Analyzed by: Steven Grevelis ______ ; Date Analyzed: 11/12/02

*NAD/NSD = no asbestos detected; NA = not analyzed; NA/PS = not analyzed / positive stop; PLM Bulk Asbestos Analysis by EPA 600/M4-82-020 per 40 CFR 763 (NVLAP Lab #102079-0); Note: PLM is not consistently reliable in detecting asbestos in floor coverings and similar non-friable organically bound materials. TEM is currently the only method that can be used to determine if this material can be considered or treated as non-asbestos-containing in New York State (also see EPA Advisory for floor tile, FR 59, 146, 38970, 8/1/94). National Institute of Standards and Technology Accreditation requirements mandate that this report must not be reproduced except in full without the approval of the laboratory. This PLM report relates ONLY to the items tested.

Reviewed By: ______

Relinquished By:

[redacted]

Received By: Sullivan Date/Time: 10800

Relinquished By: Date/Time:

Received By: Date/Time:

School Street
Weymouth, MA 02189
Phone (781) 337-9334 / Fax (781) 337-7642
Toll Free (888) 724-5221 www.scilabs.com

SCILAB

Company Name: Stone & Webster, Inc.

Street Address: 100 Technology Drive

City: Stoughton State: MA Zip: 02072

Phone: (617) 589-5111 Fax: (617) 589-2160

Cell/Page #: Verbal Results: Y / [✓ N]

Results to: Mr. Jim McComiskey Fax Results w/ window w/ PLM

Special Instructions or Comments:

SciLab Job #: P.O. #:

Project Name: Lawrence Oxford Mill Project #: 04134.0500

Project Address:

Analysis: ☐PLM ☑PLM Qualitative ☐Point Count ☐NOB(Prep) ☐TEM

Turnaround Time: 3day Fax Copy By:

Sampled By: JSM Date: 10/17/02

Lab ID	Field ID	Location	Sample Description	Homogenous Area
	SS-1	Oxford Mills	Soil	
	SS-2			
	SS-3			
	SS-4			
	SS-5			
	SS-6			
	SS-7			
	SS-8			
	SS-9			
	SS-10			
	SS-11			
	SS-12			
	SS-13			
	SS-14			
	SS-15			
	SS-16			
	SS-17			
	SS-18			
	SS-19			
	SS-20			

PAGE 1 OF 2

Relinquished By: Date/Time:
Received By: Sullivan Date/Time: 103002
Relinquished By: Date/Time:
Received By: Date/Time:

BULK SAMPLE SHEET

50210147 9

SCILAB

8 SCHOOL STREET
WEYMOUTH, MA 02189
PHONE (781) 337-9334 / FAX (781) 337-7642
TOLL FREE (888) 724-5221 www.scilabs.com

Company Name: Stone & Webster, Inc.
Street Address: 100 Technology Drive
City: Stoughton State: MA Zip: 02072
Phone: (617) 589-5111 Fax: (617) 589-2160
Cell/Page #: Verbal Results: Y / N
Results to: Mr. Jim McComiskey

SciLab Job #: P.O. #:
Project Name: Project #:
Project Address:
Analysis: ☐PLM ☐PLM Qualitative ☐Point Count ☐NOB(Prep) ☐TEM
Turnaround Time: Fax Copy By:
Sampled By: Date:

Special Instructions or Comments:

Lab ID	Field ID	Location	Sample Description	Homogenous Area
	SS-21	Oxford Mills	Soil	
	SS-22	↓		
	SS-23			

* EPA Region I Protocol on all samples w/ pos PLM
7-10 TAT

SciLab Job#: 503081238
Client Name: Stone & Webster Engineering Corporation

Table I
Summary of Bulk Asbestos Analysis Results
608134.0500; Lawrence - Oxford Paper Mill

SciLab Sample #	Client Sample# Location	HG Area	Sample Weight (gram)	Heat Sensitive Organic %	Acid Soluble Inorganic %	Insoluble Non-Asbestos Inorganic %	Asbestos by PLM/DS	Asbestos by TEM
01	SS-24 Oxford Paper Mill - North Area		----	----	----	----	Amosite Present Chrysotile Present	NA
02	SS-25 Oxford Paper Mill - North Area		----	----	----	----	NVA	NA
03	SS-26 Oxford Paper Mill - North Area		----	----	----	----	Chrysotile Present Crocidolite Present	NA
04	SS-27 Oxford Paper Mill - North Area		----	----	----	----	Amosite Present	NA
05	SS-28 Oxford Paper Mill - North Area		----	----	----	----	Chrysotile Present	NA
06	SS-29 Oxford Paper Mill - North Area		----	----	----	----	Amosite Present	NA
07	SS-30 Oxford Paper Mill - North Area		----	----	----	----	Chrysotile Present	NA
08	SS-31 Oxford Paper Mill - North Area		----	----	----	----	Amosite Present Chrysotile Present	NA
09	SS-32 Oxford Paper Mill - North Area		----	----	----	----	Amosite Present Chrysotile Present	NA
10	SS-33 Oxford Paper Mill - North Area		----	----	----	----	NVA	NA
11	SS-34 Oxford Paper Mill - North Area		----	----	----	----	NVA	NA

Client Name: Stone & Webster Engineering Corporation

Table I

Summary of Bulk Asbestos Analysis Results

608134.0500; Lawrence - Oxford Paper Mill

SciLab Sample #	Client Sample# Location	HG Area	Sample Weight (gram)	Heat Sensitive Organic %	Acid Soluble Inorganic %	Insoluble Non-Asbestos Inorganic %	Asbestos by PLM/DS	Asbestos by TEM
12	SS-35 Oxford Paper Mill - North Area		---	----	----	----	Amosite Present	NA

Reviewed by:______________________; Analyzed By: Steven Grevelis______________; Date Analyzed: 8/20/03

Qualitative Analysis: Asbestos analysis results of "Present" or "NVA = No Visible Asbestos" represent results for Qualitative PLM or TEM Analysis only (no accreditation coverage available from any regulatory agency for qualitative analyses);

NA = not analyzed; Warning Note: PLM limitation, only TEM will resolve fibers <0.25 micrometers in diameter. Quantitative Analysis (Semi/Full): Bulk Asbestos Analysis - PLM by EPA 600/M4-82-020 per 40 CFR 763 (NVLAP Lab #102079-0); TEM (Semi/Full) by EPA 600/R-93/116 (not covered by NVLAP Bulk accreditation); NAD = no asbestos detected during a quantitative analysis; NA = not analyzed; Trace = <1%; Quantitation for beginning weights of <0.1 grams should be considered as qualitative only; Warning Note: PLM limitation, only TEM will resolve fibers <0.25 micrometers in diameter

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8 SCHOOL STREET
WEYMOUTH, MA 02189
TEL: (781) 337-9334 • FAX: (781) 337-7642

PLM Bulk Asbestos Report

Stone & Webster Engineering Corporation
Attn: Lester Tyrala
100 Technology Center Drive
Stoughton, MA 01721

Date Received 08/15/2003 **SciLab Job No.** 503081303
Date Examined 08/21/2003 **P.O. #** 608134.0500
Page 1 **of** 3
RE: 608134.0500; Lawrence - Oxford Paper Mill

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
SS-24	503081303-01 **Location:** Oxford Paper Mill - North Area **Description:** Brown, Heterogeneous, Soil **Asbestos Types:** Amosite Trace, Chrysotile Trace **Other Material:** Cellulose 1. %, Non-fibrous 99. %	*Yes*	< 1.%[1]
SS-26	503081303-02 **Location:** Oxford Paper Mill - North Area **Description:** Brown, Heterogeneous, Soil **Asbestos Types:** Chrysotile Trace **Other Material:** Cellulose Trace, Non-fibrous 100. %	*Yes*	< 1.%[1]
SS-27	503081303-03.1 **Location:** Oxford Paper Mill - North Area **Description:** Brown, Heterogeneous, Soil **Asbestos Types:** Chrysotile Trace **Other Material:** Cellulose Trace, Non-fibrous 100. %	*Yes*	< 1.%[1]
SS-27	503081303-03.2 **Location:** QC for sample SS-27 **Description:** Brown, Heterogeneous, Soil **Asbestos Types:** Chrysotile Trace **Other Material:** Cellulose Trace, Non-fibrous 100. %	*Yes*	< 1.%[1]
SS-28	503081303-04 **Location:** Oxford Paper Mill - North Area **Description:** Brown, Heterogeneous, Soil **Asbestos Types:** Chrysotile 2.9 % **Other Material:** Cellulose 5. %, Non-fibrous 92.1 %	*Yes*	2.9 %[1]

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SCILAB BOSTON, INC.
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WEYMOUTH, MA 02189
TEL: (781) 337-9334 • FAX: (781) 337-7642

PLM Bulk Asbestos Report

Stone & Webster Engineering Corporation
Attn: Lester Tyrala
100 Technology Center Drive
Stoughton, MA 01721

Date Received 08/15/2003 **SciLab Job No.** 503081303
Date Examined 08/21/2003 **P.O.#** 608134.0500
Page 2 **of** 3
RE: 608134.0500; Lawrence - Oxford Paper Mill

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
SS-29	503081303-05	*Yes*	< 1.%[1]
	Location: Oxford Paper Mill - North Area **Description:** Brown, Heterogeneous, Soil **Asbestos Types:** Chrysotile Trace **Other Material:** Cellulose Trace, Non-fibrous 100. %		
SS-30	503081303-06	*Yes*	< 1.%[1]
	Location: Oxford Paper Mill - North Area **Description:** Brown, Heterogeneous, Soil **Asbestos Types:** Amosite Trace, Chrysotile < 1. **Other Material:** Cellulose Trace, Non-fibrous 100. %		
SS-31	503081303-07	*Yes*	1.5 %[1]
	Location: Oxford Paper Mill - North Area **Description:** Brown, Heterogeneous, Soil **Asbestos Types:** Amosite Trace, Chrysotile 1.4 % **Other Material:** Cellulose 5. %, Non-fibrous 93.6 %		
SS-32	503081303-08	*Yes*	< 1.%[1]
	Location: Oxford Paper Mill - North Area **Description:** Brown, Heterogeneous, Soil **Asbestos Types:** Chrysotile .7 % **Other Material:** Cellulose 3. %, Non-fibrous 96.3 %		
SS-35	503081303-09	*Yes*	< 1.%[1]
	Location: Oxford Paper Mill - North Area **Description:** Brown, Heterogeneous, Soil **Asbestos Types:** Chrysotile Trace **Other Material:** Cellulose 1. %, Non-fibrous 99. %		

SCILAB

SCILAB BOSTON, INC.
8 SCHOOL STREET
WEYMOUTH, MA 02189
TEL: (781) 337-9334 • FAX: (781) 337-7642

PLM Bulk Asbestos Report

Stone & Webster Engineering
Corporation
Attn: Lester Tyrala
100 Technology Center Drive
Stoughton, MA 01721

Date Received 08/15/2003 **SciLab Job No.** 503081303
Date Examined 08/21/2003 **P.O. #** 608134.0500
Page 3 **of** 3
RE: 608134.0500; Lawrence - Oxford Paper Mill

Reporting Notes:

(*) Although this sample was prepared, analyzed, and quantified per EPA Region I Protocol, it should be noted that this protocol states that "this protocol is not meant to be used as a quantitative method".

Analyzed by: John A. Burns ______; Date Analyzed: 8/21/03

*NAD/NSD = no asbestos detected; NVA = no visible asbestos; NA = not analyzed; NA/PS = not analyzed / positive stop; PLM Bulk Asbestos Analysis by EPA 600/M4-82-020 per 40 CFR 763 (NVLAP Lab #102079-0); Note: PLM is not consistently reliable in detecting asbestos in floor coverings and similar non-friable organically bound materials. TEM is currently the only method that can be used to determine if this material can be considered or treated as non-asbestos-containing in New York State (also see EPA Advisory for floor tile, FR 59, 146, 38970, 8/1/94). National Institute of Standards and Technology Accreditation requirements mandate that this report must not be reproduced except in full without the approval of the laboratory. This PLM report relates ONLY to the items tested.

Reviewed By:______

Relinquished By: Date/Time: 8/15/03/1525
Received By: Date/Time: 8/15/03/1525
Relinquished By: Date/Time:
Received By: Date/Time:

BULK SAMPLE SHEET

3 SCHOOL STREET
WEYMOUTH, MA 02189
PHONE (781) 337-9334 / FAX (781) 337-7642
TOLL FREE (800) 724-5221 www.scilabs.com

SCILAB

Company Name: Stone & Webster, Inc.
Street Address: 100 Technology Center Drive
City: Stoughton State: MA Zip: 02072
Phone: (781) 589-7145 Fax: (781) 589-2160
Cell/Page #: 617-851-8013 Verbal Results: Y / [✓ N]
Results to: Mr. Jason Anderson

SciLab Job #: 5080 1238 P.O.#: 203142
Project Name: Lawrence - Oxford Paper Mill Project #: 609134.0500
Project Address:
Analysis: ① ?PLM [✓ ?PLM Qualitative] ?Point Count ?NOB(Prep) ?TEM
Turnaround Time: 5 day Fax Copy By:
Sampled By: Jason Anderson (JGA) Date: 8/15/03

Special Instructions or Comments: email results to – jason.anderson@shawgrp.com (Fax Results when done with PLM Qualitative)

Lab ID	Field ID	Location	Sample Description	Homogenous Area
1	SS-24	Oxford Paper Mill - North Area	Soil	
2	SS-25	↓	↓	
3	SS-26			
4	SS-27			
5	SS-28			
6	SS-29			
7	SS-30			
8	SS-31			
9	SS-32			
10	SS-33			
11	SS-34			
12	SS-35			
(12)				

① Use EPA Region I Protocol on all samples that are positive from PLM Qualitative Analysis – use a 5-day TAT for these samples

PAGE 1 OF 1

** TOTAL PAGE.04 **

Appendix I

May 2002 Site Investigation Laboratory Analytical Reports

Woods Hole Group™
Environmental Laboratories

Rcd 6/6/02

ANALYTICAL REPORT

Prepared for:
Metcalf & Eddy
30 Harvard Mill Square
Wakefield, MA 01880-5371

Project:	Oxford Paper, Lawrence, MA
ETR:	0205050
Report Date:	June 04, 2002

Certifications and Accreditations
Massachusetts MA030
Connecticut PH-0141
New Hampshire 220600B
Rhode Island 64
New Jersey 59015
Maine MA030
New York 11627
Louisiana 03090
Army Corps of Engineers
Department of the Navy

This report shall not be reproduced except in full, without written approval from the laboratory.

CASE NARRATIVE

Woods Hole Group Environmental Laboratories

ETR: 0205050
Project: Oxford Paper, Lawrence, MA

All analyses were performed according to Woods Hole Group's documented Standard Operating Procedures (SOPs), within holding time and with appropriate quality control measures except where noted. Blank correction of results is not performed in the laboratory for any parameter. Soil/sediment samples are reported on a dry weight basis unless otherwise noted.

Extractable Petroleum Hydrocarbons by GC/FID

1. The laboratory control sample (LCS), ES0516L3 had a low recovery of 37% for the compound Naphthalene, which is below the 40% QC acceptance limit. Additionally, this LCS had a recovery of 25% for the non-target compound n-Nonane (C9) and a recovery of 38% for the non-target compound n-Decane (C10), however, the C9-C18 Aliphatic range had a recovery of 64%, which is within QC acceptance limits. The matrix spike for sample 10D (0205050-08) had acceptable recoveries for these compounds indicating that the problem was confined to the laboratory control sample.
2. The Aromatic fraction for samples 6S (0205050-02) and 4D (020505-04) required 1:2 dilutions for all compounds to be within the calibration range of the instrument.
3. The matrix spike for sample 10D (0205050-08) had recoveries above the 140% QC acceptance limits for the compounds Fluoranthene (163%) and Pyrene (168%). This may be due to matrix interference or sample heterogeneity.

Total Metals

Samples associated with this data package were digested according to Method 3050 and analyzed by ICP/MS (Method 6020) for antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium, vanadium and zinc. A separate Method 3050 digestion, with the addition of hydrochloric acid, was used for the preparation of samples analyzed for antimony and silver. Mercury was determined by cold vapor atomic absorption spectroscopy according to Method 7471.

Sample 10D (Lab ID 0205050-08) was digested and analyzed in duplicate with a matrix spike. All QC measures were within acceptance criteria except for the following:

> Antimony: The matrix spike recovery was 24%, which does not meet quality control criteria of 75%-125%. This may be due to sample matrix interference. All results are flagged (N) to indicate this QC failure. The laboratory control sample was within the vendor's acceptance limits. The recovery of a post-digest spike was 98%.
>
> Arsenic: The RPD between duplicates was 89% and exceeds the method acceptance criteria of 20%. This may be due to sample non-homogeneity. All results are flagged (□) to indicate this QC failure.

TCLP Metals

Samples associated with this data package were extracted by Method 1311(TCLP). The extract was digested according to Method 3010 and analyzed by ICP AES (Method 6010) for arsenic, barium, cadmium chromium, lead, selenium and silver. The TCLP extract was analyzed for mercury by cold vapor atomic absorption spectroscopy according to Method 7471.

Samples 4S (Lab ID 0205050-01), 8D (Lab ID 0205050-06) and 8S (Lab ID 0205050-03) were analyzed by ICP MS (Method 6020) due to matrix interference effects on the 6010B analysis resulting in elevated reporting limits.

Sample 10D (Lab ID 0205050-08) was digested and analyzed in duplicate with a matrix spike. All QC measures were within acceptance criteria.

The enclosed results of analyses are representative of the samples as received by the laboratory. Woods Hole Group makes no representations or certifications as to the method of sample collection, sample identification, or transporting/handling procedures used prior to the receipt of samples by Woods Hole Group. To the best of my knowledge, the information contained in this report is accurate and complete.

Approved by: ________________ Date: 06-05-02

Woods Hole Group Environmental Laboratories

Surrogate Recovery
Extractable Petroleum Hydrocarbons by GC/FID

Client:	Metcalf & Eddy		Lab Code: M-MA030
Project:	Oxford Paper, Lawrence, MA		ETR: 0205050
Case: N/A		SDG: N/A	Matrix: Soil

Client ID	Lab ID	5-alpha Androstane	ortho-Terphenyl	Biphenyl	2-Fluorobiphenyl
4S	0205050-01	98	72	86	84
6S	0205050-02	79	56	94	85
8S	0205050-03	78	64	83	82
4D	0205050-04	90	66	91	83
6D	0205050-05	67	42	88	81
8D	0205050-06	97	60	87	82
10S	0205050-07	83	58	85	83
10D	0205050-08	94	73	85	83
12S	0205050-09	109	80	86	85
12D	0205050-10	100	71	92	89
K10D	0205050-11	108	75	90	88
14S	0205050-12	82	49	89	81
14D	0205050-13	83	62	88	84
10D	0205050-08 DUP	101	75	88	87
10D	0205050-08 MS	121	77	89	87
Fractionation Check Solution	FCS0520-1	131	86	81	83
Method Blank	ES0516B3	95	72	90	89
Laboratory Control Sample	ES0516L3	106	69	87	86

N/A - Not Applicable

Surrogate	QC Limits
5-alpha Androstane	40-140
ortho-Terphenyl	40-140
Biphenyl	40-140
2-Fluorobiphenyl	40-140

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Laboratory Control Sample
Extractable Petroleum Hydrocarbons by GC/FID

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
Case:	N/A SDG: N/A	Lab ID:	ES0516L3
Client ID:	Laboratory Control Sample	Associated Blank:	ES0516B3
Matrix:	Soil	Concentration Units:	µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Analyst
N/A	N/A	05/16/02	100	MLB

Parameter	Conc.	% Recovery	% Recovery Limits
C_9-C_{18} Aliphatics [1]	19000	64	40-140
C_{19}-C_{36} Aliphatics [1]	39000	97	40-140
Naphthalene	1900	37*	40-140
2-Methylnaphthalene	2300	45	40-140
Acenaphthylene	2600	53	40-140
Acenaphthene	2700	54	40-140
Fluorene	3100	63	40-140
Phenanthrene	3500	69	40-140
Anthracene	3500	70	40-140
Fluoranthene	3600	72	40-140
Pyrene	3600	72	40-140
Benzo(a)anthracene	3500	69	40-140
Chrysene	3800	76	40-140
Benzo(b)fluoranthene	3500	70	40-140
Benzo(k)fluoranthene	3600	73	40-140
Benzo(a)pyrene	3500	70	40-140
Indeno(1,2,3-cd)pyrene [3]	6900	69	40-140
Dibenzo(a,h)anthracene [3]	6900	69	40-140
Benzo(g,h,i)perylene	3400	68	40-140

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.

[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	106	40-140
ortho-Terphenyl	69	40-140
Fractionation Surrogate		
Biphenyl	87	40-140
2-Fluorobiphenyl	86	40-140

* - Value outside of QC Limits.
N/A - Not Applicable

Concentrations reported as calculated values, which includes rounding for significant figures. Percent recoveries and RPD values are calculated from the unrounded result.

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Extractable Petroleum Hydrocarbons by GC/FID

Client: **Metcalf & Eddy**
Project: **Oxford Paper, Lawrence, MA**
Case: N/A SDG: N/A
Client ID: 10D
Matrix: Soil

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-08
Associated Blank: ES0516B3
Concentration Units: µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Analyst
05/14/02	05/15/02	05/16/02	81.4	MLB

Extractable Petroleum Hydrocarbons	Sample Result	Duplicate Result	RPD	RPD Limit
C_9-C_{18} Aliphatics [1]	3600 U	3600 U	N/A	50
C_{19}-C_{36} Aliphatics [1]	16000	14000	14	50
C_{11}-C_{22} Aromatics [1,2]	33000	35000	5	50
Unadjusted C_{11}-C_{22} Aromatics [1]	49000	58000	17	50

Targeted PAH Analytes	Sample Result	Duplicate Result	RPD	RPD Limit
Naphthalene	600 U	590 U	N/A	50
2-Methylnaphthalene	600 U	590 U	N/A	50
Acenaphthylene	600 U	590 U	N/A	50
Acenaphthene	600 U	590 U	N/A	50
Fluorene	600 U	590 U	N/A	50
Phenanthrene	2000	2700	28	50
Anthracene	630	930	38	50
Fluoranthene	2700	3700	31	50
Pyrene	2600	3600	31	50
Benzo(a)anthracene	1400	1900	30	50
Chrysene	1900	2500	27	50
Benzo(b)fluoranthene	1500	2000	28	50
Benzo(k)fluoranthene	1000	1300	25	50
Benzo(a)pyrene	1400	1800	27	50
Indeno(1,2,3-cd)pyrene [3]	1600	1900	19	50
Dibenzo(a,h)anthracene [3]	1600	1900	19	50
Benzo(g,h,i)perylene	820	1000	20	50

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.
[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.
[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	101	40-140
ortho-Terphenyl	75	40-140
Fractionation Surrogate		
Biphenyl	88	40-140
2-Fluorobiphenyl	87	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

Concentrations reported as calculated values, which includes rounding for significant figures. RPD values are reported based on the unrounded calculated result.

05/22/02 21:20

Matrix Spike
Extractable Petroleum Hydrocarbons by GC/FID

Client: **Metcalf & Eddy**
Project: **Oxford Paper, Lawrence, MA**
Case: N/A SDG: N/A
Client ID: **10D**
Matrix: **Soil**

Lab Code: **M-MA030**
ETR: **0205050**
Lab ID: **See Below**
Associated Blank: **ES0516B3**
Concentration Units: **µg/Kg**

Date Collected	Date Received	Date Extracted	Percent Solid	Analyst
05/14/02	05/15/02	05/16/02	81.4	MLB

Lab ID:	0205050-08		0205050-08		
	Sample		Matrix Spike		% Recovery
Parameter	Conc.		Conc.	% Recovery	Limits
Naphthalene	600	U	4200	69	40-140
2-Methylnaphthalene	600	U	4400	74	40-140
Acenaphthylene	600	U	4600	76	40-140
Acenaphthene	600	U	4800	80	40-140
Fluorene	600	U	5000	83	40-140
Phenanthrene	2000		8200	102	40-140
Anthracene	630		5900	88	40-140
Fluoranthene	2700		13000	163*	40-140
Pyrene	2600		13000	168*	40-140
Benzo(a)anthracene	1400		8600	121	40-140
Chrysene	1900		9400	126	40-140
Benzo(b)fluoranthene	1500		8400	114	40-140
Benzo(k)fluoranthene	1000		7300	105	40-140
Benzo(a)pyrene	1400		8000	111	40-140
Indeno(1,2,3-cd)pyrene [3]	1600		11000	82	40-140
Dibenzo(a,h)anthracene [3]	1600		11000	82	40-140
Benzo(g,h,i)perylene	820		6000	86	40-140
n-Nonane (C9)	600	U	3600	61	40-140
n-Decane (C10)	600	U	4600	77	40-140
n-Dodecane (C12)	600	U	5500	92	40-140
n-Tetradecane (C14)	600	U	6400	107	40-140
n-Hexadecane (C16)	600	U	7200	120	40-140
n-Octadecane (C18)	600	U	7600	127	40-140
n-Nonadecane (C19)	600	U	7500	125	40-140
n-Eicosane (C20)	600	U	7700	128	40-140
n-Docosane (C22)	600	U	7500	126	40-140
n-Tetracosane (C24)	600	U	7300	121	40-140
n-Hexacosane (C26)	600	U	6700	112	40-140
n-Octacosane (C28)	600	U	6000	100	40-140
n-Triacontane (C30)	600	U	5300	89	40-140
n-Hexatriacontane (C36)	600	U	4200	71	40-140

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.
[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	121	40-140
ortho-Terphenyl	77	40-140
Fractionation Surrogate		
Biphenyl	89	40-140
2-Fluorobiphenyl	87	40-140

* - Value outside of QC Limits.
U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

Concentrations reported as calculated values, which includes rounding for significant figures. Percent recoveries and RPD values are calculated from the unrounded result.

05/22/02 21:21

Method Blank Summary
Extractable Petroleum Hydrocarbons by GC/FID

Client: **Metcalf & Eddy**
Project: **Oxford Paper, Lawrence, MA**
Case: N/A SDG: N/A

Lab Code: **M-MA030**
ETR: **0205050**
Lab ID: **ES0516B3**
Date Analyzed: **05/21/02 19:35**

Client ID	Lab ID	Date/Time Analyzed
Laboratory Control Sample	ES0516L3	05/21/02 20:01
4S	0205050-01	05/21/02 23:55
8S	0205050-03	05/22/02 00:48
6D	0205050-05	05/22/02 02:58
8D	0205050-06	05/22/02 03:25
10S	0205050-07	05/22/02 03:51
10D	0205050-08	05/22/02 04:17
10D	0205050-08 DUP	05/22/02 04:43
10D	0205050-08 MS	05/22/02 05:09
12S	0205050-09	05/22/02 05:35
12D	0205050-10	05/22/02 06:01
K10D	0205050-11	05/22/02 06:28
14S	0205050-12	05/22/02 06:54
14D	0205050-13	05/22/02 07:20
6S	0205050-02	05/22/02 18:20
4D	0205050-04	05/22/02 18:46

N/A - Not Applicable

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Woods Hole Group

Extractable Petroleum Hydrocarbons by GC/FID

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
Case:	N/A SDG: N/A	Lab ID:	0205050-01
Client ID:	4S	Associated Blank:	ES0516B3
Matrix:	Soil	Concentration Units:	µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/13/02	05/15/02	05/16/02	79.8	10.14	Aromatic	05/21/02	1	1	MLB
					Aliphatic	05/21/02	1	1	MLB

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	3700	U
C_{19}-C_{36} Aliphatics [1]	5200	
C_{11}-C_{22} Aromatics [1,2]	240000	
Unadjusted C_{11}-C_{22} Aromatics [1]	420000	

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Target PAH Analytes	Result	
Naphthalene	620	U J
2-Methylnaphthalene	620	U
Acenaphthylene	620	U
Acenaphthene	1600	
Fluorene	1600	
Phenanthrene	17000	
Anthracene	4100	
Fluoranthene	30000	
Pyrene	30000	
Benzo(a)anthracene	16000	
Chrysene	18000	
Benzo(b)fluoranthene	17000	
Benzo(k)fluoranthene	9000	
Benzo(a)pyrene	14000	
Indeno(1,2,3-cd)pyrene [3]	13000	
Dibenzo(a,h)anthracene [3]	13000	
Benzo(g,h,i)perylene	8500	

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.
[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.
[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	98	40-140
ortho-Terphenyl	72	40-140
Fractionation Surrogate		
Biphenyl	86	40-140
2-Fluorobiphenyl	84	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 23:18

Extractable Petroleum Hydrocarbons by GC/FID

Client: **Metcalf & Eddy**
Project: **Oxford Paper, Lawrence, MA**
Case: N/A SDG: N/A
Client ID: 6S
Matrix: Soil

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-02
Associated Blank: ES0516B3
Concentration Units: µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/13/02	05/15/02	05/16/02	80.1	10.25	Aromatic	05/22/02	1	2	MLB
					Aliphatic	05/22/02	1	1	MLB

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	3700	U
C_{19}-C_{36} Aliphatics [1]	57000	
C_{11}-C_{22} Aromatics [1,2]	460000	
Unadjusted C_{11}-C_{22} Aromatics [1]	870000	

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Target PAH Analytes	Result	
Naphthalene	2000	J
2-Methylnaphthalene	1400	
Acenaphthylene	1200	U
Acenaphthene	6400	
Fluorene	6300	
Phenanthrene	58000	
Anthracene	14000	
Fluoranthene	74000	
Pyrene	73000	
Benzo(a)anthracene	35000	
Chrysene	38000	
Benzo(b)fluoranthene	35000	
Benzo(k)fluoranthene	12000	
Benzo(a)pyrene	24000	
Indeno(1,2,3-cd)pyrene [3]	22000	
Dibenzo(a,h)anthracene [3]	22000	
Benzo(g,h,i)perylene	13000	

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[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.

[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.

[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	79	40-140
ortho-Terphenyl	56	40-140
Fractionation Surrogate		
Biphenyl	94	40-140
2-Fluorobiphenyl	85	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 21:18

Woods Hole Group

Extractable Petroleum Hydrocarbons by GC/FID

Client:	Metcalf & Eddy			Lab Code: M-MA030
Project:	Oxford Paper, Lawrence, MA			ETR: 0205050
Case:	N/A	SDG:	N/A	Lab ID: 0205050-03
Client ID:	8S			Associated Blank: ES0516B3
Matrix:	Soil			Concentration Units: µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/13/02	05/15/02	05/16/02	69.9	10.15	Aromatic	05/22/02	1	1	MLB
					Aliphatic	05/22/02	1	1	MLB

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	4200	U
C_{19}-C_{36} Aliphatics [1]	9000	
C_{11}-C_{22} Aromatics [1,2]	51000	
Unadjusted C_{11}-C_{22} Aromatics [1]	83000	

7/9/02

Target PAH Analytes	Result	
Naphthalene	700	UJ
2-Methylnaphthalene	700	U
Acenaphthylene	700	U
Acenaphthene	700	U
Fluorene	700	U
Phenanthrene	3400	
Anthracene	1000	
Fluoranthene	5600	
Pyrene	5500	
Benzo(a)anthracene	2900	
Chrysene	3100	
Benzo(b)fluoranthene	2300	
Benzo(k)fluoranthene	2300	
Benzo(a)pyrene	2400	
Indeno(1,2,3-cd)pyrene [3]	2300	
Dibenzo(a,h)anthracene [3]	2300	
Benzo(g,h,i)perylene	1400	

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[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.

[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.

[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	78	40-140
ortho-Terphenyl	64	40-140
Fractionation Surrogate		
Biphenyl	83	40-140
2-Fluorobiphenyl	82	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 21:18

Woods Hole Group

Extractable Petroleum Hydrocarbons by GC/FID

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
Case:	N/A SDG: N/A	Lab ID:	0205050-04
Client ID:	4D	Associated Blank:	ES0516B3
Matrix:	Soil	Concentration Units:	µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/13/02	05/15/02	05/16/02	79.5	10.00	Aromatic	05/22/02	1	2	MLB
					Aliphatic	05/22/02	1	1	MLB

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	3800	U
C_{19}-C_{36} Aliphatics [1]	34000	
C_{11}-C_{22} Aromatics [1,2]	360000	
Unadjusted C_{11}-C_{22} Aromatics [1]	700000	

8U
7/9/02

Target PAH Analytes	Result	
Naphthalene	2400	J
2-Methylnaphthalene	1500	
Acenaphthylene	1300	U
Acenaphthene	6200	
Fluorene	5100	
Phenanthrene	41000	
Anthracene	11000	
Fluoranthene	56000	
Pyrene	56000	
Benzo(a)anthracene	29000	
Chrysene	28000	
Benzo(b)fluoranthene	27000	
Benzo(k)fluoranthene	16000	
Benzo(a)pyrene	21000	
Indeno(1,2,3-cd)pyrene [3]	21000	
Dibenzo(a,h)anthracene [3]	21000	
Benzo(g,h,i)perylene	14000	

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.

[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.

[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	90	40-140
ortho-Terphenyl	66	40-140
Fractionation Surrogate		
Biphenyl	91	40-140
2-Fluorobiphenyl	83	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 21:19

Woods Hole Group

Extractable Petroleum Hydrocarbons by GC/FID

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
Case: N/A	SDG: N/A	Lab ID:	0205050-05
Client ID:	6D	Associated Blank:	ES0516B3
Matrix:	Soil	Concentration Units:	µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/13/02	05/15/02	05/16/02	74.6	10.08	Aromatic	05/22/02	1	1	MLB
					Aliphatic	05/22/02	1	1	MLB

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	4000	U
C_{19}-C_{36} Aliphatics [1]	82000	
C_{11}-C_{22} Aromatics [1,2]	320000	
Unadjusted C_{11}-C_{22} Aromatics [1]	590000	

7/9/02

Target PAH Analytes	Result	
Naphthalene	1300	J
2-Methylnaphthalene	980	
Acenaphthylene	660	U
Acenaphthene	5100	
Fluorene	4500	
Phenanthrene	38000	
Anthracene	9200	
Fluoranthene	44000	
Pyrene	44000	
Benzo(a)anthracene	21000	
Chrysene	24000	
Benzo(b)fluoranthene	23000	
Benzo(k)fluoranthene	8800	
Benzo(a)pyrene	16000	
Indeno(1,2,3-cd)pyrene [3]	16000	
Dibenzo(a,h)anthracene [3]	16000	
Benzo(g,h,i)perylene	10000	

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[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.

[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.

[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	67	40-140
ortho-Terphenyl	42	40-140
Fractionation Surrogate		
Biphenyl	88	40-140
2-Fluorobiphenyl	81	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 21:19

Woods Hole Group

Extractable Petroleum Hydrocarbons by GC/FID

Client: Metcalf & Eddy
Project: Oxford Paper, Lawrence, MA
Case: N/A SDG: N/A
Client ID: 8D
Matrix: Soil

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-06
Associated Blank: ES0516B3
Concentration Units: µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/13/02	05/15/02	05/16/02	72.5	10.39	Aromatic	05/22/02	1	1	MLB
					Aliphatic	05/22/02	1	1	MLB

8U 7/9/02

Extractable Petroleum Hydrocarbons (EPH)	Result
C_9-C_{18} Aliphatics [1]	15000
C_{19}-C_{36} Aliphatics [1]	65000
C_{11}-C_{22} Aromatics [1,2]	250000
Unadjusted C_{11}-C_{22} Aromatics [1]	430000

Target PAH Analytes	Result	
Naphthalene	1300	J
2-Methylnaphthalene	790	
Acenaphthylene	660	U
Acenaphthene	1000	
Fluorene	840	
Phenanthrene	20000	
Anthracene	4300	
Fluoranthene	28000	
Pyrene	29000	
Benzo(a)anthracene	17000	
Chrysene	18000	
Benzo(b)fluoranthene	22000	
Benzo(k)fluoranthene	5500	
Benzo(a)pyrene	13000	
Indeno(1,2,3-cd)pyrene [3]	12000	
Dibenzo(a,h)anthracene [3]	12000	
Benzo(g,h,i)perylene	7400	

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[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.

[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.

[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	97	40-140
ortho-Terphenyl	60	40-140
Fractionation Surrogate		
Biphenyl	87	40-140
2-Fluorobiphenyl	82	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 21:19

Extractable Petroleum Hydrocarbons by GC/FID

Woods Hole Group

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
Case: N/A	SDG: N/A	Lab ID:	0205050-07
Client ID:	10S	Associated Blank:	ES0516B3
Matrix:	Soil	Concentration Units:	µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/14/02	05/15/02	05/16/02	84.4	10.20	Aromatic	05/22/02	1	1	MLB
					Aliphatic	05/22/02	1	1	MLB

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	3500	U
C_{19}-C_{36} Aliphatics [1]	43000	
C_{11}-C_{22} Aromatics [1,2]	74000	
Unadjusted C_{11}-C_{22} Aromatics [1]	110000	

8U 7/9/02

Target PAH Analytes	Result	
Naphthalene	580	UJ
2-Methylnaphthalene	580	U
Acenaphthylene	580	U
Acenaphthene	700	
Fluorene	650	
Phenanthrene	4400	
Anthracene	1300	
Fluoranthene	6300	
Pyrene	6200	
Benzo(a)anthracene	2700	
Chrysene	3100	
Benzo(b)fluoranthene	2700	
Benzo(k)fluoranthene	2100	
Benzo(a)pyrene	2600	
Indeno(1,2,3-cd)pyrene [3]	2500	
Dibenzo(a,h)anthracene [3]	2500	
Benzo(g,h,i)perylene	1500	

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.

[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.

[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	83	40-140
ortho-Terphenyl	58	40-140
Fractionation Surrogate		
Biphenyl	85	40-140
2-Fluorobiphenyl	83	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 21:19

Quality Control Results
Extractable Petroleum Hydrocarbons by GC/FID

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
Case:	N/A SDG: N/A	Lab ID:	0205050-08 DUP
Client ID:	10D	Associated Blank:	ES0516B3
Matrix:	Soil	Concentration Units:	µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/14/02	05/15/02	05/16/02	81.4	10.33	Aromatic	05/22/02	1	1	MLB
					Aliphatic	05/22/02	1	1	MLB

7/9/02

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	3600	U
C_{19}-C_{36} Aliphatics [1]	14000	J
C_{11}-C_{22} Aromatics [1,2]	35000	J
Unadjusted C_{11}-C_{22} Aromatics [1]	58000	J

Target PAH Analytes	Result	
Naphthalene	590	U J
2-Methylnaphthalene	590	U
Acenaphthylene	590	U
Acenaphthene	590	U
Fluorene	590	U
Phenanthrene	2700	J
Anthracene	930	J
Fluoranthene	3700	J
Pyrene	3600	J
Benzo(a)anthracene	1900	J
Chrysene	2500	J
Benzo(b)fluoranthene	2000	J
Benzo(k)fluoranthene	1300	J
Benzo(a)pyrene	1800	J
Indeno(1,2,3-cd)pyrene [3]	1900	J
Dibenzo(a,h)anthracene [3]	1900	J
Benzo(g,h,i)perylene	1000	J

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.

[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.

[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	101	40-140
ortho-Terphenyl	75	40-140
Fractionation Surrogate		
Biphenyl	88	40-140
2-Fluorobiphenyl	87	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 21:32

Woods Hole Group

Extractable Petroleum Hydrocarbons by GC/FID

Client: **Metcalf & Eddy**
Project: **Oxford Paper, Lawrence, MA**
Case: N/A SDG: N/A
Client ID: **10D**
Matrix: Soil

Lab Code: **M-MA030**
ETR: **0205050**
Lab ID: **0205050-08**
Associated Blank: **ES0516B3**
Concentration Units: **µg/Kg**

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/14/02	05/15/02	05/16/02	81.4	10.22	Aromatic	05/22/02	1	1	MLB
					Aliphatic	05/22/02	1	1	MLB

8M
7/9/02

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	3600	U
C_{19}-C_{36} Aliphatics [1]	16000	
C_{11}-C_{22} Aromatics [1,2]	33000	
Unadjusted C_{11}-C_{22} Aromatics [1]	49000	

Target PAH Analytes	Result	
Naphthalene	600	U
2-Methylnaphthalene	600	U
Acenaphthylene	600	U
Acenaphthene	600	U
Fluorene	600	U
Phenanthrene	2000	
Anthracene	630	
Fluoranthene	2700	
Pyrene	2600	
Benzo(a)anthracene	1400	
Chrysene	1900	
Benzo(b)fluoranthene	1500	
Benzo(k)fluoranthene	1000	
Benzo(a)pyrene	1400	
Indeno(1,2,3-cd)pyrene [3]	1600	
Dibenzo(a,h)anthracene [3]	1600	
Benzo(g,h,i)perylene	820	

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[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.
[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.
[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	94	40-140
ortho-Terphenyl	73	40-140
Fractionation Surrogate		
Biphenyl	85	40-140
2-Fluorobiphenyl	83	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 21:19

Extractable Petroleum Hydrocarbons by GC/FID

Client:	Metcalf & Eddy	**Lab Code:**	M-MA030
Project:	Oxford Paper, Lawrence, MA	**ETR:**	0205050
Case:	N/A SDG: N/A	**Lab ID:**	0205050-11
Client ID:	K10D	**Associated Blank:**	ES0516B3
Matrix:	Soil	**Concentration Units:**	µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/14/02	05/15/02	05/16/02	81.5	10.25	Aromatic	05/22/02	1	1	MLB
					Aliphatic	05/22/02	1	1	MLB

SM 7/9/02

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	3600	U
C_{19}-C_{36} Aliphatics [1]	4800	U J
C_{11}-C_{22} Aromatics [1,2]	60000	J
Unadjusted C_{11}-C_{22} Aromatics [1]	110000	J

Target PAH Analytes	Result	
Naphthalene	600	U J
2-Methylnaphthalene	600	U
Acenaphthylene	600	U
Acenaphthene	780	
Fluorene	800	
Phenanthrene	5800	J
Anthracene	1900	J
Fluoranthene	7900	J
Pyrene	7500	J
Benzo(a)anthracene	4300	J
Chrysene	4400	J
Benzo(b)fluoranthene	4500	J
Benzo(k)fluoranthene	1500	J
Benzo(a)pyrene	3500	J
Indeno(1,2,3-cd)pyrene [3]	3300	J
Dibenzo(a,h)anthracene [3]	3300	J
Benzo(g,h,i)perylene	2200	J

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.

[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.

[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	108	40-140
ortho-Terphenyl	75	40-140
Fractionation Surrogate		
Biphenyl	90	40-140
2-Fluorobiphenyl	88	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 21:19

Extractable Petroleum Hydrocarbons by GC/FID

Client: Metcalf & Eddy
Project: Oxford Paper, Lawrence, MA
Case: N/A SDG: N/A
Client ID: 12S
Matrix: Soil

Lab Code: **M-MA030**
ETR: **0205050**
Lab ID: **0205050-09**
Associated Blank: **ES0516B3**
Concentration Units: **µg/Kg**

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/14/02	05/15/02	05/16/02	91.0	10.12	Aromatic	05/22/02	1	1	MLB
					Aliphatic	05/22/02	1	1	MLB

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	3300	U
C_{19}-C_{36} Aliphatics [1]	4300	U
C_{11}-C_{22} Aromatics [1,2]	**16000**	
Unadjusted C_{11}-C_{22} Aromatics [1]	**20000**	

8A
7/9/02

Target PAH Analytes	Result	
Naphthalene	540	U J
2-Methylnaphthalene	540	U
Acenaphthylene	540	U
Acenaphthene	540	U
Fluorene	540	U
Phenanthrene	**660**	
Anthracene	540	U
Fluoranthene	**1000**	
Pyrene	**1000**	
Benzo(a)anthracene	540	U
Chrysene	**660**	
Benzo(b)fluoranthene	540	U
Benzo(k)fluoranthene	540	U
Benzo(a)pyrene	540	U
Indeno(1,2,3-cd)pyrene [3]	**690**	
Dibenzo(a,h)anthracene [3]	**690**	
Benzo(g,h,i)perylene	540	U

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.
[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.
[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	109	40-140
ortho-Terphenyl	80	40-140
Fractionation Surrogate		
Biphenyl	86	40-140
2-Fluorobiphenyl	85	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 21:19

Extractable Petroleum Hydrocarbons by GC/FID

Client: Metcalf & Eddy
Project: Oxford Paper, Lawrence, MA
Case: N/A **SDG:** N/A
Client ID: 12D
Matrix: Soil

Lab Code: **M-MA030**
ETR: **0205050**
Lab ID: **0205050-10**
Associated Blank: **ES0516B3**
Concentration Units: **µg/Kg**

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/14/02	05/15/02	05/16/02	88.0	10.14	Aromatic	05/22/02	1	1	MLB
					Aliphatic	05/22/02	1	1	MLB

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	3400	U
C_{19}-C_{36} Aliphatics [1]	11000	
C_{11}-C_{22} Aromatics [1,2]	90000	
Unadjusted C_{11}-C_{22} Aromatics [1]	160000	

7/9/02

Target PAH Analytes	Result	
Naphthalene	690	J
2-Methylnaphthalene	560	U
Acenaphthylene	560	U
Acenaphthene	1200	
Fluorene	1200	
Phenanthrene	8000	
Anthracene	2400	
Fluoranthene	12000	
Pyrene	12000	
Benzo(a)anthracene	5400	
Chrysene	5700	
Benzo(b)fluoranthene	5700	
Benzo(k)fluoranthene	2800	
Benzo(a)pyrene	4700	
Indeno(1,2,3-cd)pyrene [3]	4400	
Dibenzo(a,h)anthracene [3]	4400	
Benzo(g,h,i)perylene	3000	

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[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.

[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.

[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	100	40-140
ortho-Terphenyl	71	40-140
Fractionation Surrogate		
Biphenyl	92	40-140
2-Fluorobiphenyl	89	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 21:19

Woods Hole Group

Extractable Petroleum Hydrocarbons by GC/FID

Client:	Metcalf & Eddy			Lab Code: M-MA030
Project:	Oxford Paper, Lawrence, MA			ETR: 0205050
Case:	N/A	SDG:	N/A	Lab ID: 0205050-12
Client ID:	14S			Associated Blank: ES0516B3
Matrix:	Soil			Concentration Units: µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/14/02	05/15/02	05/16/02	83.6	10.08	Aromatic	05/22/02	1	1	MLB
					Aliphatic	05/22/02	1	1	MLB

7/9/02

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	3600	U
C_{19}-C_{36} Aliphatics [1]	12000	
C_{11}-C_{22} Aromatics [1,2]	260000	
Unadjusted C_{11}-C_{22} Aromatics [1]	470000	

Target PAH Analytes	Result	
Naphthalene	2000	J
2-Methylnaphthalene	1100	
Acenaphthylene	590	U
Acenaphthene	4200	
Fluorene	4600	
Phenanthrene	32000	
Anthracene	7800	
Fluoranthene	33000	
Pyrene	33000	
Benzo(a)anthracene	16000	
Chrysene	16000	
Benzo(b)fluoranthene	17000	
Benzo(k)fluoranthene	6500	
Benzo(a)pyrene	13000	
Indeno(1,2,3-cd)pyrene [3]	11000	
Dibenzo(a,h)anthracene [3]	11000	
Benzo(g,h,i)perylene	7200	

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.

[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.

[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	82	40-140
ortho-Terphenyl	49	40-140
Fractionation Surrogate		
Biphenyl	89	40-140
2-Fluorobiphenyl	81	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 21:19

Woods Hole Group

Extractable Petroleum Hydrocarbons by GC/FID

Client:	Metcalf & Eddy		
Project:	Oxford Paper, Lawrence, MA		
Case:	N/A	SDG:	N/A
Client ID:	14D		
Matrix:	Soil		

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-13
Associated Blank: ES0516B3
Concentration Units: µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/14/02	05/15/02	05/16/02	85.1	10.11	Aromatic	05/22/02	1	1	MLB
					Aliphatic	05/22/02	1	1	MLB

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	3500	U
C_{19}-C_{36} Aliphatics [1]	35000	
C_{11}-C_{22} Aromatics [1,2]	97000	
Unadjusted C_{11}-C_{22} Aromatics [1]	170000	

SH 7/9/02

Target PAH Analytes	Result	
Naphthalene	800	J
2-Methylnaphthalene	580	U
Acenaphthylene	580	U
Acenaphthene	1500	
Fluorene	1500	
Phenanthrene	9900	
Anthracene	2900	
Fluoranthene	13000	
Pyrene	12000	
Benzo(a)anthracene	5700	
Chrysene	5700	
Benzo(b)fluoranthene	5300	
Benzo(k)fluoranthene	2900	
Benzo(a)pyrene	4700	
Indeno(1,2,3-cd)pyrene [3]	4100	
Dibenzo(a,h)anthracene [3]	4100	
Benzo(g,h,i)perylene	2700	

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.
[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.
[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	83	40-140
ortho-Terphenyl	62	40-140
Fractionation Surrogate		
Biphenyl	88	40-140
2-Fluorobiphenyl	84	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 21:20

Woods Hole Group

Quality Control Results
Extractable Petroleum Hydrocarbons by GC/FID

Client: Metcalf & Eddy		Lab Code: M-MA030
Project: Oxford Paper, Lawrence, MA		ETR: 0205050
Case: N/A	SDG: N/A	Lab ID: ES0516B3
Client ID: Method Blank		Associated Blank: N/A
Matrix: Soil		Concentration Units: µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
N/A	N/A	05/16/02	100	10.00	Aromatic	05/21/02	1	1	MLB
					Aliphatic	05/21/02	1	1	MLB

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	3000	U
C_{19}-C_{36} Aliphatics [1]	4000	U
C_{11}-C_{22} Aromatics [1,2]	8500	U
Unadjusted C_{11}-C_{22} Aromatics [1]	8500	U

Target PAH Analytes	Result	
Naphthalene	500	U
2-Methylnaphthalene	500	U
Acenaphthylene	500	U
Acenaphthene	500	U
Fluorene	500	U
Phenanthrene	500	U
Anthracene	500	U
Fluoranthene	500	U
Pyrene	500	U
Benzo(a)anthracene	500	U
Chrysene	500	U
Benzo(b)fluoranthene	500	U
Benzo(k)fluoranthene	500	U
Benzo(a)pyrene	500	U
Indeno(1,2,3-cd)pyrene [3]	500	U
Dibenzo(a,h)anthracene [3]	500	U
Benzo(g,h,i)perylene	500	U

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.

[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.

[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	95	40-140
ortho-Terphenyl	72	40-140
Fractionation Surrogate		
Biphenyl	90	40-140
2-Fluorobiphenyl	89	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

Quality Control Results
Extractable Petroleum Hydrocarbons by GC/FID

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
Case:	N/A SDG: N/A	Lab ID:	ES0516L3
Client ID:	Laboratory Control Sample	Associated Blank:	ES0516B3
Matrix:	Soil	Concentration Units:	µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
N/A	N/A	05/16/02	100	10.00	Aromatic	05/21/02	1	1	MLB
					Aliphatic	05/21/02	1	1	MLB

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	19000	S
C_{19}-C_{36} Aliphatics [1]	39000	S
C_{11}-C_{22} Aromatics [1,2]	8500	U
Unadjusted C_{11}-C_{22} Aromatics [1]	55000	

Target PAH Analytes	Result	
Naphthalene	1900	S
2-Methylnaphthalene	2300	S
Acenaphthylene	2600	S
Acenaphthene	2700	S
Fluorene	3100	S
Phenanthrene	3500	S
Anthracene	3500	S
Fluoranthene	3600	S
Pyrene	3600	S
Benzo(a)anthracene	3500	S
Chrysene	3800	S
Benzo(b)fluoranthene	3500	S
Benzo(k)fluoranthene	3600	S
Benzo(a)pyrene	3500	S
Indeno(1,2,3-cd)pyrene [3]	6900	S
Dibenzo(a,h)anthracene [3]	6900	S
Benzo(g,h,i)perylene	3400	S

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.

[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.

[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	106	40-140
ortho-Terphenyl	69	40-140
Fractionation Surrogate		
Biphenyl	87	40-140
2-Fluorobiphenyl	86	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
S - Spike compound.
N/A - Not Applicable

05/22/02 21:20

Extractable Petroleum Hydrocarbons by GC/FID

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
Case: N/A	SDG: N/A	Lab ID:	FCS0520-1
Aromatic Analysis Date:	05/21/02	Aliphatic Analysis Date:	05/21/02

Parameter	True Value	Actual Value	Percent Recovery	QC Limits
Naphthalene	50	37	74	40-140
2-Methylnaphthalene	50	36	72	40-140
Acenaphthylene	50	41	83	40-140
Acenaphthene	50	40	80	40-140
Fluorene	50	43	85	40-140
Phenanthrene	50	43	86	40-140
Anthracene	50	45	90	40-140
Fluoranthene	50	42	85	40-140
Pyrene	50	42	84	40-140
Benzo(a)anthracene	50	39	78	40-140
Chrysene	50	43	86	40-140
Benzo(b)fluoranthene	50	37	74	40-140
Benzo(k)fluoranthene	50	43	85	40-140
Benzo(a)pyrene	50	39	79	40-140
Indeno(1,2,3-cd)pyrene [3]	100	77	77	40-140
Dibenzo(a,h)anthracene [3]	100	77	77	40-140
Benzo(g,h,i)perylene	50	38	77	40-140
n-Nonane (C9)	50	49	99	40-140
n-Decane (C10)	50	52	105	40-140
n-Dodecane (C12)	50	54	107	40-140
n-Tetradecane (C14)	50	59	117	40-140
n-Hexadecane (C16)	50	63	126	40-140
n-Octadecane (C18)	50	65	130	40-140
n-Nonadecane (C19)	50	64	128	40-140
n-Eicosane (C20)	50	66	131	40-140
n-Docosane (C22)	50	65	129	40-140
n-Tetracosane (C24)	50	62	125	40-140
n-Hexacosane (C26)	50	59	117	40-140
n-Octacosane (C28)	50	53	106	40-140
n-Triacontane (C30)	50	48	96	40-140
n-Hexatriacontane (C36)	50	39	77	40-140

[3] = Values reported reflect their sum.
N/A - Not Applicable

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	131	40-140
ortho-Terphenyl	86	40-140
Fractionation Surrogate		
Biphenyl	81	40-140
2-Fluorobiphenyl	83	40-140

05/22/02 20:40

Extractable Petroleum Hydrocarbons by GC/FID

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
Case:	N/A SDG: N/A	Lab ID:	-0205050-08 MS
Client ID:	10D	Associated Blank:	ES0516B3
Matrix:	Soil	Concentration Units:	µg/Kg

Date Collected	Date Received	Date Extracted	Percent Solid	Sample Amount (g)	Fraction	Date Analyzed	Final Volume (ml)	Dilution Factor	Analyst
05/14/02	05/15/02	05/16/02	81.4	10.23	Aromatic	05/22/02	1	1	MLB
					Aliphatic	05/22/02	1	1	MLB

Extractable Petroleum Hydrocarbons (EPH)	Result
C_9-C_{18} Aliphatics [1]	35000
C_{19}-C_{36} Aliphatics [1]	53000
C_{11}-C_{22} Aromatics [1,2]	59000
Unadjusted C_{11}-C_{22} Aromatics [1]	180000

Target PAH Analytes	Result	
Naphthalene	4200	S
2-Methylnaphthalene	4400	S
Acenaphthylene	4600	S
Acenaphthene	4800	S
Fluorene	5000	S
Phenanthrene	8200	S
Anthracene	5900	S
Fluoranthene	13000	S
Pyrene	13000	S
Benzo(a)anthracene	8600	S
Chrysene	9400	S
Benzo(b)fluoranthene	8400	S
Benzo(k)fluoranthene	7300	S
Benzo(a)pyrene	8000	S
Indeno(1,2,3-cd)pyrene [3]	11000	S
Dibenzo(a,h)anthracene [3]	11000	S
Benzo(g,h,i)perylene	6000	S

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.
[2] = C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.
[3] = Values reported reflect their sum.

Extraction Surrogate	% Recovery	Acceptance Range (%)
5-alpha Androstane	121	40-140
ortho-Terphenyl	77	40-140
Fractionation Surrogate		
Biphenyl	89	40-140
2-Fluorobiphenyl	87	40-140

S - Spike compound.
N/A - Not Applicable

05/22/02 21:32

Total Metals

Woods Hole Group

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
Case:	N/A SDG: N/A	Lab ID:	0205050-01
Client ID:	4S	Concentration Units:	mg/Kg
Matrix:	Soil	Date Collected:	05/13/02
Percent Solid:	79.8	Date Received:	05/15/02

8A 7/9/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Antimony	0.77	~~N~~ J	0.25	5	05/30/02	05/24/02	6020A	LCP
Arsenic	43	~~¤~~ J	0.046	5	05/29/02	05/24/02	6020A	LMR
Barium	130		0.046	5	05/29/02	05/24/02	6020A	LMR
Beryllium	0.48		0.046	5	05/29/02	05/24/02	6020A	LMR
Cadmium	2.5	J	0.093	5	05/29/02	05/24/02	6020A	LMR
Chromium	32		0.093	5	05/29/02	05/24/02	6020A	LMR
Copper	54		0.093	5	05/29/02	05/24/02	6020A	LMR
Lead	180		0.23	5	05/29/02	05/24/02	6020A	LMR
Mercury	2.0		0.034	5	05/25/02	05/24/02	7471A	CJH
Nickel	79		0.23	5	05/29/02	05/24/02	6020A	LMR
Selenium	0.41	UJ	0.23	5	05/29/02	05/24/02	6020A	LMR
Silver	0.25		0.050	5	05/30/02	05/24/02	6020A	LCP
Thallium	0.46		0.046	5	05/29/02	05/24/02	6020A	LMR
Vanadium	350		0.093	5	05/29/02	05/24/02	6020A	LMR
Zinc	390		0.93	5	05/29/02	05/24/02	6020A	LMR

N - Spike recovery outside control limits.
N/A - Not Applicable
¤ - Duplicate outside control limits.

05/30/02 14:43

Total Metals

Woods Hole Group

Client: Metcalf & Eddy
Project: Oxford Paper, Lawrence, MA
Case: N/A **SDG:** N/A
Client ID: 4D
Matrix: Soil
Percent Solid: 79.5

7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-04
Concentration Units: mg/Kg
Date Collected: 05/13/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Antimony	1.0	~~N~~ J	0.20	5	05/30/02	05/24/02	6020A	LCP
Arsenic	97	~~N~~ J	0.047	5	05/29/02	05/24/02	6020A	LMR
Barium	180		0.047	5	05/29/02	05/24/02	6020A	LMR
Beryllium	0.55		0.047	5	05/29/02	05/24/02	6020A	LMR
Cadmium	2.3	J	0.094	5	05/29/02	05/24/02	6020A	LMR
Chromium	43		0.094	5	05/29/02	05/24/02	6020A	LMR
Copper	85		0.094	5	05/29/02	05/24/02	6020A	LMR
Lead	250		0.23	5	05/29/02	05/24/02	6020A	LMR
Mercury	3.2		0.037	5	05/25/02	05/24/02	7471A	CJH
Nickel	86		0.23	5	05/29/02	05/24/02	6020A	LMR
Selenium	0.82		0.23	5	05/29/02	05/24/02	6020A	LMR
Silver	0.18		0.040	5	05/30/02	05/24/02	6020A	LCP
Thallium	0.71		0.047	5	05/29/02	05/24/02	6020A	LMR
Vanadium	330		0.094	5	05/29/02	05/24/02	6020A	LMR
Zinc	560		0.94	5	05/29/02	05/24/02	6020A	LMR

N - Spike recovery outside control limits.
N/A - Not Applicable
¤ - Duplicate outside control limits.

06/04/02 09:56

Total Metals

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
Case:	N/A SDG: N/A	Lab ID:	0205050-02
Client ID:	6S	Concentration Units:	mg/Kg
Matrix:	Soil	Date Collected:	05/13/02
Percent Solid:	80.1	Date Received:	05/15/02

SU 7/9/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Antimony	1.6	~~N~~ J	0.22	5	05/30/02	05/24/02	6020A	LCP
Arsenic	120	~~¤~~ J	0.048	5	05/29/02	05/24/02	6020A	LMR
Barium	150		0.048	5	05/29/02	05/24/02	6020A	LMR
Beryllium	0.62		0.048	5	05/29/02	05/24/02	6020A	LMR
Cadmium	1.9	J	0.096	5	05/29/02	05/24/02	6020A	LMR
Chromium	46		0.096	5	05/29/02	05/24/02	6020A	LMR
Copper	91		0.096	5	05/29/02	05/24/02	6020A	LMR
Lead	230		0.24	5	05/29/02	05/24/02	6020A	LMR
Mercury	5.3		0.059	10	05/25/02	05/24/02	7471A	CJH
Nickel	130		0.24	5	05/29/02	05/24/02	6020A	LMR
Selenium	0.76		0.24	5	05/29/02	05/24/02	6020A	LMR
Silver	0.33		0.045	5	05/30/02	05/24/02	6020A	LCP
Thallium	1.3		0.048	5	05/29/02	05/24/02	6020A	LMR
Vanadium	520		0.096	5	05/29/02	05/24/02	6020A	LMR
Zinc	300		0.96	5	05/29/02	05/24/02	6020A	LMR

N - Spike recovery outside control limits.
N/A - Not Applicable
¤ - Duplicate outside control limits.

05/30/02 14:43

Total Metals

Client:	Metcalf & Eddy		
Project:	Oxford Paper, Lawrence, MA		
Case:	N/A	SDG:	N/A
Client ID:	6D		
Matrix:	Soil		
Percent Solid:	74.6		

8A 7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-05
Concentration Units: mg/Kg
Date Collected: 05/13/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Antimony	3.8	~~N~~ J	0.21	5	05/30/02	05/24/02	6020A	LCP
Arsenic	84	~~N~~ J	0.060	5	05/29/02	05/24/02	6020A	LMR
Barium	170		0.060	5	05/29/02	05/24/02	6020A	LMR
Beryllium	1.0	J	0.060	5	05/29/02	05/24/02	6020A	LMR
Cadmium	1.6	J	0.12	5	05/29/02	05/24/02	6020A	LMR
Chromium	50		0.12	5	05/29/02	05/24/02	6020A	LMR
Copper	72		0.12	5	05/29/02	05/24/02	6020A	LMR
Lead	210		0.30	5	05/29/02	05/24/02	6020A	LMR
Mercury	17		0.27	40	05/25/02	05/24/02	7471A	CJH
Nickel	83		0.30	5	05/29/02	05/24/02	6020A	LMR
Selenium	0.54	UJ	0.30	5	05/29/02	05/24/02	6020A	LMR
Silver	0.89		0.042	5	05/30/02	05/24/02	6020A	LCP
Thallium	1.0		0.060	5	05/29/02	05/24/02	6020A	LMR
Vanadium	360		0.12	5	05/29/02	05/24/02	6020A	LMR
Zinc	450		1.2	5	05/29/02	05/24/02	6020A	LMR

N - Spike recovery outside control limits.
N/A - Not Applicable
☐ - Duplicate outside control limits.

05/30/02 14:44

Total Metals

Woods Hole Group

Client:	**Metcalf & Eddy**		
Project:	**Oxford Paper, Lawrence, MA**		
Case:	N/A	SDG:	N/A
Client ID:	8S		
Matrix:	Soil		
Percent Solid:	69.9		

8U 7/9/02

Lab Code: **M-MA030**
ETR: **0205050**
Lab ID: **0205050-03**
Concentration Units: **mg/Kg**
Date Collected: **05/13/02**
Date Received: **05/15/02**

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Antimony	0.34	~~N~~ J	0.28	5	05/30/02	05/24/02	6020A	LCP
Arsenic	8.4	~~□~~ J	0.057	5	05/29/02	05/24/02	6020A	LMR
Barium	16		0.057	5	05/29/02	05/24/02	6020A	LMR
Beryllium	0.14		0.057	5	05/29/02	05/24/02	6020A	LMR
Cadmium	0.16	J	0.11	5	05/29/02	05/24/02	6020A	LMR
Chromium	6.8		0.11	5	05/29/02	05/24/02	6020A	LMR
Copper	12		0.11	5	05/29/02	05/24/02	6020A	LMR
Lead	28		0.29	5	05/29/02	05/24/02	6020A	LMR
Mercury	0.85		0.042	5	05/25/02	05/24/02	7471A	CJH
Nickel	26		0.29	5	05/29/02	05/24/02	6020A	LMR
Selenium	0.47	UJ	0.29	5	05/29/02	05/24/02	6020A	LMR
Silver	0.11		0.056	5	05/30/02	05/24/02	6020A	LCP
Thallium	0.063	J	0.057	5	05/29/02	05/24/02	6020A	LMR
Vanadium	80		0.11	5	05/29/02	05/24/02	6020A	LMR
Zinc	35		1.1	5	05/29/02	05/24/02	6020A	LMR

N - Spike recovery outside control limits.
N/A - Not Applicable
□ - Duplicate outside control limits.

06/04/02 09:55

Total Metals

Client:	Metcalf & Eddy		
Project:	Oxford Paper, Lawrence, MA		
Case:	N/A	SDG:	N/A
Client ID:	8D		
Matrix:	Soil		
Percent Solid:	72.5		

8D
7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-06
Concentration Units: mg/Kg
Date Collected: 05/13/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Antimony	0.58	~~N~~ J	0.25	5	05/30/02	05/24/02	6020A	LCP
Arsenic	4.4	~~¤~~ J	0.045	5	05/29/02	05/24/02	6020A	LMR
Barium	300		0.045	5	05/29/02	05/24/02	6020A	LMR
Beryllium	0.52		0.045	5	05/29/02	05/24/02	6020A	LMR
Cadmium	0.79	J	0.090	5	05/29/02	05/24/02	6020A	LMR
Chromium	13		0.090	5	05/29/02	05/24/02	6020A	LMR
Copper	140		0.090	5	05/29/02	05/24/02	6020A	LMR
Lead	140		0.22	5	05/29/02	05/24/02	6020A	LMR
Mercury	1.6		0.033	5	05/25/02	05/24/02	7471A	CJH
Nickel	18		0.22	5	05/29/02	05/24/02	6020A	LMR
Selenium	0.11	UJ	0.22	5	05/29/02	05/24/02	6020A	LMR
Silver	0.13		0.049	5	05/30/02	05/24/02	6020A	LCP
Thallium	0.11		0.045	5	05/29/02	05/24/02	6020A	LMR
Vanadium	27		0.090	5	05/29/02	05/24/02	6020A	LMR
Zinc	300		0.90	5	05/29/02	05/24/02	6020A	LMR

J - Below CRDL, Project DL, or RL but greater than or = MDL.
N - Spike recovery outside control limits.
N/A - Not Applicable
¤ - Duplicate outside control limits.

05/30/02 14:44

Total Metals

Woods Hole Group

Client:	Metcalf & Eddy		
Project:	Oxford Paper, Lawrence, MA		
Case:	N/A	SDG:	N/A
Client ID:	10S		
Matrix:	Soil		
Percent Solid:	84.4		

SU 7/5/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-07
Concentration Units: mg/Kg
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Antimony	0.39	~~N~~J	0.22	5	05/30/02	05/24/02	6020A	LCP
Arsenic	10	~~N~~J	0.045	5	05/29/02	05/24/02	6020A	LMR
Barium	45		0.045	5	05/29/02	05/24/02	6020A	LMR
Beryllium	0.34		0.045	5	05/29/02	05/24/02	6020A	LMR
Cadmium	0.24	J	0.090	5	05/29/02	05/24/02	6020A	LMR
Chromium	15		0.090	5	05/29/02	05/24/02	6020A	LMR
Copper	36		0.090	5	05/29/02	05/24/02	6020A	LMR
Lead	49		0.22	5	05/29/02	05/24/02	6020A	LMR
Mercury	0.14		0.0068	1	05/25/02	05/24/02	7471A	CJH
Nickel	14		0.22	5	05/29/02	05/24/02	6020A	LMR
Selenium	0.22	UJ	0.22	5	05/29/02	05/24/02	6020A	LMR
Silver	0.090	J	0.045	5	05/30/02	05/24/02	6020A	LCP
Thallium	0.11		0.045	5	05/29/02	05/24/02	6020A	LMR
Vanadium	36		0.090	5	05/29/02	05/24/02	6020A	LMR
Zinc	75		0.90	5	05/29/02	05/24/02	6020A	LMR

J - Below CRDL, Project DL, or RL but greater than or = MDL.
N - Spike recovery outside control limits.
N/A - Not Applicable
◻ - Duplicate outside control limits.

05/30/02 14:43

Woods Hole Group

Total Metals

Client:	Metcalf & Eddy		
Project:	Oxford Paper, Lawrence, MA		
Case:	N/A	SDG:	N/A
Client ID:	10D		
Matrix:	Soil		
Percent Solid:	81.4		

8A 7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-08
Concentration Units: mg/Kg
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Antimony	0.33	~~N~~ J	0.16	5	05/30/02	05/24/02	6020A	LCP
Arsenic	15	J	0.041	5	05/29/02	05/24/02	6020A	LMR
Barium	29		0.041	5	05/29/02	05/24/02	6020A	LMR
Beryllium	0.44		0.041	5	05/29/02	05/24/02	6020A	LMR
Cadmium	0.13	J	0.081	5	05/29/02	05/24/02	6020A	LMR
Chromium	18		0.081	5	05/29/02	05/24/02	6020A	LMR
Copper	32		0.081	5	05/29/02	05/24/02	6020A	LMR
Lead	44		0.20	5	05/29/02	05/24/02	6020A	LMR
Mercury	0.11		0.0066	1	05/25/02	05/24/02	7471A	CJH
Nickel	16		0.20	5	05/29/02	05/24/02	6020A	LMR
Selenium	0.40	U	0.20	5	05/29/02	05/24/02	6020A	LMR
Silver	0.071	J	0.032	5	05/30/02	05/24/02	6020A	LCP
Thallium	0.11		0.041	5	05/29/02	05/24/02	6020A	LMR
Vanadium	51		0.081	5	05/29/02	05/24/02	6020A	LMR
Zinc	65		0.81	5	05/29/02	05/24/02	6020A	LMR

N - Spike recovery outside control limits.
N/A - Not Applicable
¤ - Duplicate outside control limits.

05/30/02 14:41

Total Metals

Woods Hole Group

Client: Metcalf & Eddy
Project: Oxford Paper, Lawrence, MA
Case: N/A SDG: N/A
Client ID: K10D
Matrix: Soil
Percent Solid: 81.5

SM 7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-11
Concentration Units: mg/Kg
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Antimony	0.62	~~N~~ J	0.23	5	05/30/02	05/24/02	6020A	LCP
Arsenic	7.7	J	0.048	5	05/29/02	05/24/02	6020A	LMR
Barium	39		0.048	5	05/29/02	05/24/02	6020A	LMR
Beryllium	0.59		0.048	5	05/29/02	05/24/02	6020A	LMR
Cadmium	0.14	J	0.096	5	05/29/02	05/24/02	6020A	LMR
Chromium	19		0.096	5	05/29/02	05/24/02	6020A	LMR
Copper	33		0.096	5	05/29/02	05/24/02	6020A	LMR
Lead	52		0.24	5	05/29/02	05/24/02	6020A	LMR
Mercury	0.11		0.0063	1	05/25/02	05/24/02	7471A	CJH
Nickel	19		0.24	5	05/29/02	05/24/02	6020A	LMR
Selenium	0.37	UJ	0.24	5	05/29/02	05/24/02	6020A	LMR
Silver	0.095		0.045	5	05/30/02	05/24/02	6020A	LCP
Thallium	0.13		0.048	5	05/29/02	05/24/02	6020A	LMR
Vanadium	83		0.096	5	05/29/02	05/24/02	6020A	LMR
Zinc	75		0.96	5	05/29/02	05/24/02	6020A	LMR

N - Spike recovery outside control limits.
N/A - Not Applicable
□ - Duplicate outside control limits.

05/30/02 14:45

Total Metals

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
Case:	N/A SDG: N/A	Lab ID:	0205050-09
Client ID:	12S	Concentration Units:	mg/Kg
Matrix:	Soil	Date Collected:	05/14/02
Percent Solid:	91.0	Date Received:	05/15/02

7/9/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Antimony	0.22	~~N~~ J	0.20	5	05/30/02	05/24/02	6020A	LCP
Arsenic	9.3	~~*~~ J	0.030	5	05/29/02	05/24/02	6020A	LMR
Barium	36		0.030	5	05/29/02	05/24/02	6020A	LMR
Beryllium	0.34		0.030	5	05/29/02	05/24/02	6020A	LMR
Cadmium	0.24	J	0.060	5	05/29/02	05/24/02	6020A	LMR
Chromium	26		0.060	5	05/29/02	05/24/02	6020A	LMR
Copper	14		0.060	5	05/29/02	05/24/02	6020A	LMR
Lead	26		0.15	5	05/29/02	05/24/02	6020A	LMR
Mercury	0.073		0.0065	1	05/25/02	05/24/02	7471A	CJH
Nickel	19		0.15	5	05/29/02	05/24/02	6020A	LMR
Selenium	0.22	UJ	0.15	5	05/29/02	05/24/02	6020A	LMR
Silver	0.040	J	0.040	5	05/30/02	05/24/02	6020A	LCP
Thallium	0.16		0.030	5	05/29/02	05/24/02	6020A	LMR
Vanadium	21		0.060	5	05/29/02	05/24/02	6020A	LMR
Zinc	38		0.60	5	05/29/02	05/24/02	6020A	LMR

N - Spike recovery outside control limits.
N/A - Not Applicable
* - Duplicate outside control limits.

05/30/02 14:45

Total Metals

Client: **Metcalf & Eddy**
Project: **Oxford Paper, Lawrence, MA**
Case: N/A SDG: N/A
Client ID: 12D
Matrix: Soil
Percent Solid: 88.0

8A 7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-10
Concentration Units: mg/Kg
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Antimony	0.56	~~N~~ J	0.22	5	05/30/02	05/24/02	6020A	LCP
Arsenic	13	~~N~~ J	0.041	5	05/29/02	05/24/02	6020A	LMR
Barium	79		0.041	5	05/29/02	05/24/02	6020A	LMR
Beryllium	0.33		0.041	5	05/29/02	05/24/02	6020A	LMR
Cadmium	0.52	J	0.083	5	05/29/02	05/24/02	6020A	LMR
Chromium	21		0.083	5	05/29/02	05/24/02	6020A	LMR
Copper	30		0.083	5	05/29/02	05/24/02	6020A	LMR
Lead	65		0.21	5	05/29/02	05/24/02	6020A	LMR
Mercury	0.25		0.0057	1	05/25/02	05/24/02	7471A	CJH
Nickel	25		0.21	5	05/29/02	05/24/02	6020A	LMR
Selenium	0.20	~~J~~ UJ	0.21	5	05/29/02	05/24/02	6020A	LMR
Silver	0.079	J	0.043	5	05/30/02	05/24/02	6020A	LCP
Thallium	0.14		0.041	5	05/29/02	05/24/02	6020A	LMR
Vanadium	80		0.083	5	05/29/02	05/24/02	6020A	LMR
Zinc	100		0.83	5	05/29/02	05/24/02	6020A	LMR

J - Below CRDL, Project DL, or RL but greater than or = MDL.
N - Spike recovery outside control limits.
N/A - Not Applicable
☐ - Duplicate outside control limits.

05/30/02 14:45

Woods Hole Group

Total Metals

Client: **Metcalf & Eddy**
Project: **Oxford Paper, Lawrence, MA**
Case: N/A SDG: N/A
Client ID: 14S
Matrix: Soil
Percent Solid: 83.6

SH 7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-12
Concentration Units: mg/Kg
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Antimony	0.89	~~N~~ J	0.19	5	05/30/02	05/24/02	6020A	LCP
Arsenic	6.6	~~□~~J	0.035	5	05/29/02	05/24/02	6020A	LMR
Barium	140		0.035	5	05/29/02	05/24/02	6020A	LMR
Beryllium	0.28		0.035	5	05/29/02	05/24/02	6020A	LMR
Cadmium	0.81	J	0.070	5	05/29/02	05/24/02	6020A	LMR
Chromium	27		0.070	5	05/29/02	05/24/02	6020A	LMR
Copper	36		0.070	5	05/29/02	05/24/02	6020A	LMR
Lead	53		0.18	5	05/29/02	05/24/02	6020A	LMR
Mercury	0.23		0.0067	1	05/25/02	05/24/02	7471A	CJH
Nickel	28		0.18	5	05/29/02	05/24/02	6020A	LMR
Selenium	0.26	UJ	0.18	5	05/29/02	05/24/02	6020A	LMR
Silver	0.065	J	0.038	5	05/30/02	05/24/02	6020A	LCP
Thallium	0.097		0.035	5	05/29/02	05/24/02	6020A	LMR
Vanadium	20		0.070	5	05/29/02	05/24/02	6020A	LMR
Zinc	130		0.70	5	05/29/02	05/24/02	6020A	LMR

N - Spike recovery outside control limits.
N/A - Not Applicable
□ - Duplicate outside control limits.

05/30/02 14:46

Total Metals

Client:	Metcalf & Eddy		
Project:	Oxford Paper, Lawrence, MA		
Case:	N/A	SDG:	N/A
Client ID:	14D		
Matrix:	Soil		
Percent Solid:	85.1		

8A
7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-13
Concentration Units: mg/Kg
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Antimony	3.0	~~N~~ J	0.18	5	05/30/02	05/24/02	6020A	LCP
Arsenic	7.5	~~□~~ J	0.034	5	05/29/02	05/24/02	6020A	LMR
Barium	71		0.034	5	05/29/02	05/24/02	6020A	LMR
Beryllium	0.32		0.034	5	05/29/02	05/24/02	6020A	LMR
Cadmium	0.82	J	0.068	5	05/29/02	05/24/02	6020A	LMR
Chromium	20		0.068	5	05/29/02	05/24/02	6020A	LMR
Copper	37		0.068	5	05/29/02	05/24/02	6020A	LMR
Lead	70		0.17	5	05/29/02	05/24/02	6020A	LMR
Mercury	0.59		0.0061	1	05/25/02	05/24/02	7471A	CJH
Nickel	19		0.17	5	05/29/02	05/24/02	6020A	LMR
Selenium	0.23	UJ	0.17	5	05/29/02	05/24/02	6020A	LMR
Silver	0.11		0.037	5	05/30/02	05/24/02	6020A	LCP
Thallium	0.14		0.034	5	05/29/02	05/24/02	6020A	LMR
Vanadium	27		0.068	5	05/29/02	05/24/02	6020A	LMR
Zinc	91		0.68	5	05/29/02	05/24/02	6020A	LMR

N - Spike recovery outside control limits.
N/A - Not Applicable
□ - Duplicate outside control limits.

05/30/02 14:46

TCLP Metals

Client:	Metcalf & Eddy		
Project:	Oxford Paper, Lawrence, MA		
Case:	N/A	SDG:	N/A
Client ID:	4S		
Matrix:	Water		

SU
7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-01
Concentration Units: µg/L
Date Collected: 05/13/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Arsenic	94	J	200	1	05/24/02	05/23/02	6010B	DJL
Barium	440	U	200	1	05/24/02	05/23/02	6010B	DJL
Cadmium	13		10	1	05/24/02	05/23/02	6010B	DJL
Chromium	11	J	20	1	05/24/02	05/23/02	6010B	DJL
Lead	29	U	200	1	05/24/02	05/23/02	6010B	DJL
Mercury	0.27	U	0.50	1	05/24/02	05/23/02	7470A	DJL
Selenium	120	U	200	100	06/03/02	05/23/02	6020A	LMR
Silver	150	J	200	10	05/24/02	05/23/02	6010B	DJL

J - Below CRDL, Project DL, or RL but greater than or = MDL.
U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

Woods Hole Group

TCLP Metals

Client: **Metcalf & Eddy**
Project: **Oxford Paper, Lawrence, MA**
Case: N/A SDG: N/A SD 7/9/02
Client ID: 4D
Matrix: Water

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-04
Concentration Units: µg/L
Date Collected: 05/13/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Arsenic	130	J	200	1	05/24/02	05/23/02	6010B	DJL
Barium	120	J UJ	200	1	05/24/02	05/23/02	6010B	DJL
Cadmium	2.0	U	10	1	05/24/02	05/23/02	6010B	DJL
Chromium	11	J	20	1	05/24/02	05/23/02	6010B	DJL
Lead	29	U	200	1	05/24/02	05/23/02	6010B	DJL
Mercury	0.12	U	0.50	1	05/24/02	05/23/02	7470A	DJL
Selenium	41	U	400	1	05/24/02	05/23/02	6010B	DJL
Silver	20	J	20	1	05/24/02	05/23/02	6010B	DJL

J - Below CRDL, Project DL, or RL but greater than or = MDL.
U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/30/02 11:19

Woods Hole Group

TCLP Metals

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
Case:	N/A SDG: N/A	Lab ID:	0205050-02
Client ID:	6S	Concentration Units:	µg/L
Matrix:	Water	Date Collected:	05/13/02
		Date Received:	05/15/02

8A 7/9/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Arsenic	220		200	1	05/24/02	05/23/02	6010B	DJL
Barium	70	~~J~~ UJ	200	1	05/24/02	05/23/02	6010B	DJL
Cadmium	2.0	U	10	1	05/24/02	05/23/02	6010B	DJL
Chromium	9.8	U	20	1	05/24/02	05/23/02	6010B	DJL
Lead	29	U	200	1	05/24/02	05/23/02	6010B	DJL
Mercury	0.12	U	0.50	1	05/24/02	05/23/02	7470A	DJL
Selenium	54	~~J~~ UJ	400	1	05/24/02	05/23/02	6010B	DJL
Silver	20	J	20	1	05/24/02	05/23/02	6010B	DJL

J - Below CRDL, Project DL, or RL but greater than or = MDL.
U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/30/02 11:17

Woods Hole Group

TCLP Metals

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
		Lab ID:	0205050-05
Case:	N/A SDG: N/A	Concentration Units:	µg/L
Client ID:	6D	Date Collected:	05/13/02
Matrix:	Water	Date Received:	05/15/02

SA 7/9/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Arsenic	250		200	1	05/24/02	05/23/02	6010B	DJL
Barium	120	~~J~~ UJ	200	1	05/24/02	05/23/02	6010B	DJL
Cadmium	4.2	J	10	1	05/24/02	05/23/02	6010B	DJL
Chromium	15	J	20	1	05/24/02	05/23/02	6010B	DJL
Lead	29	U	200	1	05/24/02	05/23/02	6010B	DJL
Mercury	0.50		0.50	1	05/24/02	05/23/02	7470A	DJL
Selenium	52	~~J~~ UJ	400	1	05/24/02	05/23/02	6010B	DJL
Silver	29		20	1	05/24/02	05/23/02	6010B	DJL

J - Below CRDL, Project DL, or RL but greater than or = MDL.
U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/30/02 11:19

Woods Hole Group

TCLP Metals

Client: Metcalf & Eddy
Project: Oxford Paper, Lawrence, MA
Case: N/A **SDG:** N/A
Client ID: 8S
Matrix: Water

8U
7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-03
Concentration Units: µg/L
Date Collected: 05/13/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Arsenic	29	J	200	1	05/24/02	05/23/02	6010B	DJL
Barium	180	J UJ	200	1	05/24/02	05/23/02	6010B	DJL
Cadmium	2.0	U	10	1	05/24/02	05/23/02	6010B	DJL
Chromium	9.8	U	20	1	05/24/02	05/23/02	6010B	DJL
Lead	29	U	200	1	05/24/02	05/23/02	6010B	DJL
Mercury	0.27	U	0.50	1	05/24/02	05/23/02	7470A	DJL
Selenium	120	U	200	100	06/03/02	05/23/02	6020A	LMR
Silver	170	J	200	10	05/24/02	05/23/02	6010B	DJL

J - Below CRDL, Project DL, or RL but greater than or = MDL.
U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

06/04/02 09:39

TCLP Metals

Woods Hole Group

Client: Metcalf & Eddy
Project: Oxford Paper, Lawrence, MA
Case: N/A **SDG:** N/A
Client ID: 8D
Matrix: Water

SA
7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-06
Concentration Units: µg/L
Date Collected: 05/13/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Arsenic	27	U	200	1	05/24/02	05/23/02	6010B	DJL
Barium	450	U	200	1	05/24/02	05/23/02	6010B	DJL
Cadmium	2.0	U	10	1	05/24/02	05/23/02	6010B	DJL
Chromium	9.8	U	20	1	05/24/02	05/23/02	6010B	DJL
Lead	230		200	1	05/24/02	05/23/02	6010B	DJL
Mercury	0.27	U	0.50	1	05/24/02	05/23/02	7470A	DJL
Selenium	120	U	200	100	06/03/02	05/23/02	6020A	LMR
Silver	160	J	200	10	05/24/02	05/23/02	6010B	DJL

J - Below CRDL, Project DL, or RL but greater than or = MDL.
U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

06/04/02 09:40

TCLP Metals

Client: Metcalf & Eddy
Project: Oxford Paper, Lawrence, MA
Case: N/A **SDG:** N/A
Client ID: 10S
Matrix: Water

8A 7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-07
Concentration Units: µg/L
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Arsenic	27	U	200	1	05/24/02	05/23/02	6010B	DJL
Barium	430	U	200	1	05/24/02	05/23/02	6010B	DJL
Cadmium	2.0	U	10	1	05/24/02	05/23/02	6010B	DJL
Chromium	9.8	U	20	1	05/24/02	05/23/02	6010B	DJL
Lead	33	UJ	200	1	05/24/02	05/23/02	6010B	DJL
Mercury	0.12	U	0.50	1	05/24/02	05/23/02	7470A	DJL
Selenium	41	U	400	1	05/24/02	05/23/02	6010B	DJL
Silver	42		20	1	05/24/02	05/23/02	6010B	DJL

J - Below CRDL, Project DL, or RL but greater than or = MDL.
U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/30/02 11:20

TCLP Metals

Client:	**Metcalf & Eddy**		
Project:	**Oxford Paper, Lawrence, MA**		
Case:	**N/A**	**SDG:**	**N/A**
Client ID:	**10D**		
Matrix:	**Water**		

8U 7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-08
Concentration Units: µg/L
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Arsenic	27	U	200	1	05/24/02	05/23/02	6010B	DJL
Barium	360	U	200	1	05/24/02	05/23/02	6010B	DJL
Cadmium	2.0	U	10	1	05/24/02	05/23/02	6010B	DJL
Chromium	9.8	U	20	1	05/24/02	05/23/02	6010B	DJL
Lead	42	~~J~~ UJ	200	1	05/24/02	05/23/02	6010B	DJL
Mercury	0.12	U	0.50	1	05/24/02	05/23/02	7470A	DJL
Selenium	41	~~J~~ UJ	400	1	05/24/02	05/23/02	6010B	DJL
Silver	27		20	1	05/24/02	05/23/02	6010B	DJL

J - Below CRDL, Project DL, or RL but greater than or = MDL.
U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/30/02 11:30

TCLP Metals

Client: Metcalf & Eddy
Project: Oxford Paper, Lawrence, MA
Case: N/A **SDG:** N/A
Client ID: K10D
Matrix: Water

SB 7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-11
Concentration Units: µg/L
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Arsenic	27	U	200	1	05/24/02	05/23/02	6010B	DJL
Barium	270	u	200	1	05/24/02	05/23/02	6010B	DJL
Cadmium	2.0	U	10	1	05/24/02	05/23/02	6010B	DJL
Chromium	9.8	U	20	1	05/24/02	05/23/02	6010B	DJL
Lead	29	U	200	1	05/24/02	05/23/02	6010B	DJL
Mercury	0.12	U	0.50	1	05/24/02	05/23/02	7470A	DJL
Selenium	41	U	400	1	05/24/02	05/23/02	6010B	DJL
Silver	25		20	1	05/24/02	05/23/02	6010B	DJL

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/30/02 11:21

TCLP Metals

Woods Hole Group

Client:	Metcalf & Eddy		
Project:	Oxford Paper, Lawrence, MA		
Case:	N/A	SDG:	N/A
Client ID:	12S		
Matrix:	Water		

SM 7/19/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-09
Concentration Units: µg/L
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Arsenic	27	U	200	1	05/24/02	05/23/02	6010B	DJL
Barium	480	U	200	1	05/24/02	05/23/02	6010B	DJL
Cadmium	2.4	J	10	1	05/24/02	05/23/02	6010B	DJL
Chromium	9.8	U	20	1	05/24/02	05/23/02	6010B	DJL
Lead	65	~~J~~ UJ	200	1	05/24/02	05/23/02	6010B	DJL
Mercury	0.12	U	0.50	1	05/24/02	05/23/02	7470A	DJL
Selenium	41	U	400	1	05/24/02	05/23/02	6010B	DJL
Silver	1.9	U	20	1	05/24/02	05/23/02	6010B	DJL

J - Below CRDL, Project DL, or RL but greater than or = MDL.
U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/30/02 11:20

Woods Hole Group

TCLP Metals

Client: **Metcalf & Eddy**
Project: **Oxford Paper, Lawrence, MA**
Case: N/A SDG: N/A
Client ID: 12D
Matrix: Water

SA 7/9/02

Lab Code: **M-MA030**
ETR: **0205050**
Lab ID: **0205050-10**
Concentration Units: **µg/L**
Date Collected: **05/14/02**
Date Received: **05/15/02**

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Arsenic	28	J	200	1	05/24/02	05/23/02	6010B	DJL
Barium	460	U	200	1	05/24/02	05/23/02	6010B	DJL
Cadmium	7.5	J	10	1	05/24/02	05/23/02	6010B	DJL
Chromium	10	J	20	1	05/24/02	05/23/02	6010B	DJL
Lead	31	~~J~~ UJ	200	1	05/24/02	05/23/02	6010B	DJL
Mercury	0.12	U	0.50	1	05/24/02	05/23/02	7470A	DJL
Selenium	64	~~J~~ UJ	400	1	05/24/02	05/23/02	6010B	DJL
Silver	46		20	1	05/24/02	05/23/02	6010B	DJL

J - Below CRDL, Project DL, or RL but greater than or = MDL.
U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

TCLP Metals

Client: **Metcalf & Eddy**
Project: **Oxford Paper, Lawrence, MA**
Case: N/A SDG: N/A
Client ID: 14S
Matrix: Water

7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-12
Concentration Units: µg/L
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Arsenic	29	J	200	1	05/24/02	05/23/02	6010B	DJL
Barium	890		200	1	05/24/02	05/23/02	6010B	DJL
Cadmium	16		10	1	05/24/02	05/23/02	6010B	DJL
Chromium	13	J	20	1	05/24/02	05/23/02	6010B	DJL
Lead	91	~~J~~ UJ	200	1	05/24/02	05/23/02	6010B	DJL
Mercury	0.12	U	0.50	1	05/24/02	05/23/02	7470A	DJL
Selenium	41	U	400	1	05/24/02	05/23/02	6010B	DJL
Silver	34		20	1	05/24/02	05/23/02	6010B	DJL

J - Below CRDL, Project DL, or RL but greater than or = MDL.
U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/30/02 11:22

TCLP Metals

Woods Hole Group

Client:	Metcalf & Eddy		
Project:	Oxford Paper, Lawrence, MA		
Case:	N/A	SDG:	N/A
Client ID:	14D		
Matrix:	Water		

SW 7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-13
Concentration Units: µg/L
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Date Prepared	Analytical Method	Analyst
Arsenic	27	U	200	1	05/24/02	05/23/02	6010B	DJL
Barium	630	U	200	1	05/24/02	05/23/02	6010B	DJL
Cadmium	15		10	1	05/24/02	05/23/02	6010B	DJL
Chromium	9.8	U	20	1	05/24/02	05/23/02	6010B	DJL
Lead	72	~~J~~ UJ	200	1	05/24/02	05/23/02	6010B	DJL
Mercury	0.12	U	0.50	1	05/24/02	05/23/02	7470A	DJL
Selenium	41	U	400	1	05/24/02	05/23/02	6010B	DJL
Silver	17	J	20	1	05/24/02	05/23/02	6010B	DJL

J - Below CRDL, Project DL, or RL but greater than or = MDL.
U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/30/02 11:23

Woods Hole Group

Client: Metcalf & Eddy
Project: Oxford Paper, Lawrence, MA
Case: N/A SDG: N/A
Client ID: 4S
Matrix: Soil
Percent Solid: 79.8

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-01
Date Collected: 05/13/02
Date Received: 05/15/02

8D 7/9/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Unit	Analytical Method	Analyst
Reactive Sulfide	25	U	25	1	05/24/02	mg/Kg	Ch.7/376.2	MP

N/A - Not Applicable
U - The analyte was analyzed for but not detected at the sample specific level reported.

05/28/02 10:03

Client: Metcalf & Eddy
Project: Oxford Paper, Lawrence, MA
Case: N/A **SDG:** N/A
Client ID: 4D
Matrix: Soil
Percent Solid: 79.5

SH 7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-04
Date Collected: 05/13/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Unit	Analytical Method	Analyst
Reactive Sulfide	25	U	25	1	05/24/02	mg/Kg	Ch.7/376.2	MP

N/A - Not Applicable
U - The analyte was analyzed for but not detected at the sample specific level reported.

05/28/02 10:05

Woods Hole Group

Client:	Metcalf & Eddy	Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA	ETR:	0205050
		Lab ID:	0205050-02
Case:	N/A SDG: N/A	Date Collected:	05/13/02
Client ID:	6S	Date Received:	05/15/02
Matrix:	Soil		
Percent Solid:	80.1		

SM 7/9/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Unit	Analytical Method	Analyst
Reactive Sulfide	25	U	25	1	05/24/02	mg/Kg	Ch.7/376.2	MP

N/A - Not Applicable
U - The analyte was analyzed for but not detected at the sample specific level reported.

05/28/02 10:03

Woods Hole Group

Client:	**Metcalf & Eddy**		
Project:	**Oxford Paper, Lawrence, MA**		
Case:	**N/A**	**SDG:**	**N/A**
Client ID:	**6D**		
Matrix:	**Soil**		
Percent Solid:	**74.6**		

SD 7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-05
Date Collected: 05/13/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Unit	Analytical Method	Analyst
Reactive Sulfide	25	U	25	1	05/24/02	mg/Kg	Ch.7/376.2	MP

N/A - Not Applicable
U - The analyte was analyzed for but not detected at the sample specific level reported.

05/28/02 10:03

Client: **Metcalf & Eddy**
Project: **Oxford Paper, Lawrence, MA**
Case: **N/A** SDG: **N/A**
Client ID: **8S**
Matrix: **Soil**
Percent Solid: **69.9**

Lab Code: **M-MA030**
ETR: **0205050**
Lab ID: **0205050-03**
Date Collected: **05/13/02**
Date Received: **05/15/02**

8A 7/9/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Unit	Analytical Method	Analyst
Reactive Sulfide	25	U	25	1	05/24/02	mg/Kg	Ch.7/376.2	MP

N/A - Not Applicable
U - The analyte was analyzed for but not detected at the sample specific level reported.

05/28/02 10:03

Woods Hole Group

Client:	Metcalf & Eddy		
Project:	Oxford Paper, Lawrence, MA		
Case:	N/A	SDG:	N/A
Client ID:	8D		
Matrix:	Soil		
Percent Solid:	72.5		

8A
7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-06
Date Collected: 05/13/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Unit	Analytical Method	Analyst
Reactive Sulfide	25	U	25	1	05/24/02	mg/Kg	Ch.7/376.2	MP

N/A - Not Applicable
U - The analyte was analyzed for but not detected at the sample specific level reported.

05/28/02 10:05

Woods Hole Group

Client:	Metcalf & Eddy		
Project:	Oxford Paper, Lawrence, MA		
Case:	N/A	SDG:	N/A
Client ID:	10S		
Matrix:	Soil		
Percent Solid:	84.4		

7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-07
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Unit	Analytical Method	Analyst
Reactive Sulfide	25	U	25	1	05/24/02	mg/Kg	Ch.7/376.2	MP

N/A - Not Applicable
U - The analyte was analyzed for but not detected at the sample specific level reported.

05/28/02 10:03

Woods Hole Group

Client: Metcalf & Eddy
Project: Oxford Paper, Lawrence, MA
Case: N/A **SDG:** N/A
Client ID: 10D
Matrix: Soil
Percent Solid: 81.4

8D 7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-08
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Unit	Analytical Method	Analyst
Reactive Sulfide	25	U	25	1	05/24/02	mg/Kg	Ch.7/376.2	MP

N/A - Not Applicable
U - The analyte was analyzed for but not detected at the sample specific level reported.

05/28/02 10:03

Woods Hole Group

Client: **Metcalf & Eddy**
Project: **Oxford Paper, Lawrence, MA**
Case: N/A SDG: N/A
Client ID: **K10D**
Matrix: **Soil**
Percent Solid: **81.5**

Lab Code: **M-MA030**
ETR: **0205050**
Lab ID: **0205050-11**
Date Collected: **05/14/02**
Date Received: **05/15/02**

8u 7/9/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Unit	Analytical Method	Analyst
Reactive Sulfide	25	U	25	1	05/24/02	mg/Kg	Ch.7/376.2	MP

N/A - Not Applicable
U - The analyte was analyzed for but not detected at the sample specific level reported.

Woods Hole Group

Client:	Metcalf & Eddy		
Project:	Oxford Paper, Lawrence, MA		
Case:	N/A	SDG:	N/A
Client ID:	12S		
Matrix:	Soil		
Percent Solid:	91		

SH 7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-09
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Unit	Analytical Method	Analyst
Reactive Sulfide	25	U	25	1	05/24/02	mg/Kg	Ch.7/376.2	MP

N/A - Not Applicable
U - The analyte was analyzed for but not detected at the sample specific level reported.

Woods Hole Group

Client: Metcalf & Eddy
Project: Oxford Paper, Lawrence, MA
Case: N/A SDG: N/A
Client ID: 12D
Matrix: Soil
Percent Solid: 88

8W 7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-10
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Unit	Analytical Method	Analyst
Reactive Sulfide	25	U	25	1	05/24/02	mg/Kg	Ch.7/376.2	MP

N/A - Not Applicable
U - The analyte was analyzed for but not detected at the sample specific level reported.

05/28/02 10:03

Woods Hole Group

Client: **Metcalf & Eddy**
Project: **Oxford Paper, Lawrence, MA**
Case: N/A SDG: N/A
Client ID: 14S
Matrix: Soil
Percent Solid: 83.6

SH 7/5/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-12
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Unit	Analytical Method	Analyst
Reactive Sulfide	25	U	25	1	05/24/02	mg/Kg	Ch.7/376.2	MP

N/A - Not Applicable
U - The analyte was analyzed for but not detected at the sample specific level reported.

Woods Hole Group

Client: Metcalf & Eddy
Project: Oxford Paper, Lawrence, MA
Case: N/A **SDG:** N/A
Client ID: 14D
Matrix: Soil
Percent Solid: 85.1

7/9/02

Lab Code: M-MA030
ETR: 0205050
Lab ID: 0205050-13
Date Collected: 05/14/02
Date Received: 05/15/02

Parameter	Result	Qualifier	Reporting Limit	Dilution	Date Analyzed	Unit	Analytical Method	Analyst
Reactive Sulfide	25	U	25	1	05/24/02	mg/Kg	Ch.7/376.2	MP

N/A - Not Applicable
U - The analyte was analyzed for but not detected at the sample specific level reported.

05/28/02 10:03

Extractable Petroleum Hydrocarbons by GC/FID

Client: **Metcalf & Eddy**
Project: **Oxford Paper, Lawrence, MA**
Case: N/A SDG: N/A
Client ID: **7E water**
Matrix: **Water**

Lab Code: **M-MA030**
ETR: **0205066**
Lab ID: **0205066-01**
Associated Blank: **EW0520B1**
Concentration Units: **µg/L**

Date Collected	Date Received	Date Extracted	Sample Amount (ml)	Final Volume (ml)	Fraction	Date Analyzed	Dilution Factor	Analyst
05/15/02	05/17/02	05/20/02	1000	1	Aromatic	05/22/02	1	MLB
					Aliphatic	05/22/02	1	MLB

Extractable Petroleum Hydrocarbons (EPH)	Result	
C_9-C_{18} Aliphatics [1]	30	U
C_{19}-C_{36} Aliphatics [1]	40	U
C_{11}-C_{22} Aromatics [1,2]	85	U
Unadjusted C_{11}-C_{22} Aromatics [1]	110	

Target PAH Analytes	Result	
Naphthalene	6.2	
2-Methylnaphthalene	5.0	U
Acenaphthylene	5.0	U
Acenaphthene	5.0	U
Fluorene	5.0	U
Phenanthrene	16	
Anthracene	5.0	U
Fluoranthene	6.9	
Pyrene	6.0	
Benzo(a)anthracene	5.0	U
Chrysene	5.0	U
Benzo(b)fluoranthene	5.0	U
Benzo(k)fluoranthene	5.0	U
Benzo(a)pyrene	5.0	U
Indeno(1,2,3-cd)pyrene [3]	5.0	U
Dibenzo(a,h)anthracene [3]	5.0	U
Benzo(g,h,i)perylene	5.0	U

[1] = Range concentration excludes the concentration of any surrogate(s) and/or internal standards eluting in that range.
= C11-C22 Aromatic Hydrocarbons exclude the concentration of Target PAH Analytes.
= Values reported reflect their sum.

xtraction Surrogate	% Recovery	Acceptance Range (%)
alpha Androstane	109	40-140
ortho-Terphenyl	76	40-140
Fractionation Surrogate		
phenyl	92	40-140
Fluorobiphenyl	90	40-140

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 20:43

Polychlorinated Biphenyls by 8082-MCP

Woods Hole Group

Client:	Metcalf & Eddy			Lab Code:	M-MA030
Project:	Oxford Paper, Lawrence, MA			ETR:	0205066
Case:	N/A	SDG:	N/A	Lab ID:	0205066-01
Client ID:	7E water			Associated Blank:	PW0520B1
Matrix:	Water			Concentration Units:	µg/L

Date Collected	Date Received	Date Extracted	Date Analyzed	Sample Amount (ml)	Final Volume (ml)	Dilution Factor	Analyst
05/15/02	05/17/02	05/20/02	05/21/02	970	10	1	DMB

Parameter	Result
Aroclor 1016	1.0 U
Aroclor 1221	1.0 U
Aroclor 1232	1.0 U
Aroclor 1242	1.0 U
Aroclor 1248	1.0 U
Aroclor 1254	1.0 U
Aroclor 1260	1.0 U
Aroclor 1262	1.0 U
Aroclor 1268	1.0 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	90	30-150
Decachlorobiphenyl	70	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/22/02 11 23

M&E Metcalf & Eddy

CHAIN OF CUSTODY FORM

Job/Project Name: Oxford Paper

Job/Project Location: [illegible]

Job/Project Number: [illegible]

Samplers: (Signatures)

Recorder: (Signature)

Date:

Lab (Samples Sent To): Woods Hole Group

SAMPLING		SAMPLE NUMBER	SAMPLE LOCATION	MATRIX					COMPOSITE/GRAB	PRESERVATIVE (Y/N)	ANALYSIS REQUESTED								Total #	COMMENTS
Date	Time			Water	Soil						[illegible]	[illegible]	[illegible]	[illegible]						
[illegible]	[illegible]	4S	4S		x				C	N	x	x	x	x					1	A,B
[illegible]	[illegible]	6S			x				C		x	x	x	x					1	A,B
[illegible]	[illegible]	8S	[illegible]		x				C		x	x	x	x					1	A,B
[illegible]	[illegible]	4D	4D		x				C		x	x	x	x					1	
[illegible]	[illegible]	6D	6D		x				C		x	x	x	x					1	[illegible]
[illegible]	[illegible]	8D	8D		x				C		x	x	x	x					1	[illegible]
5/14/02	0850	10S	10S		x				C		x	x	x	x					1	A,B
5/14/02	0905	10D	10D		x				C		x	x	x	x					2	10C → 10H
5/14/02	11:15	12S	12S		x				C		x	x	x	x					1	A,B
5/14/02	1140	12D	12D		x				C		x	x	x	x					1	12C - 12H
5/14/02	0905	K10D	K10D		x				C		x	x	x	x					1	10C → 10H
5/14/02	1420	14S	14S		x				C		x	x	x	x					1	A,B

Relinquished By: (Signature)	Date: [illegible]	Time: [illegible]	Received By: (Signature)	Relinquished By: (Signature)	Date: Time:	Received By: (Signature)
Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)	Relinquished By: (Signature)	Date: Time:	Received By: (Signature)
Relinquished By: (Signature)	Date:	Time:	Received for Lab By: (Signature)	Date: Time:	Comments: 10D has Extra volume for MS/MSD	

Method of Shipment: Woods Hole Courier

Distribution: **Original to Lab. Copy 1 to Field Files. Copy 2 to Project Manager**

Page 1 of 2

M&E Metcalf & Eddy

CHAIN OF CUSTODY FORM

Job/Project Name: oxford Paper

Job/Project Location: Lawrence, MA

Job/Project Number: 200100 0006 00063

Samplers: (Signatures)

Recorder: (Signature)

Date: 5/14/02

Lab (Samples Sent To): Woods Hole Group

SAMPLING		SAMPLE NUMBER	SAMPLE LOCATION	MATRIX					COMPOSITE/GRAB	PRESERVATIVE (Y/N)	ANALYSIS REQUESTED								Total #	COMMENTS
Date	Time			Water	Soil						EPH	RCP Metals	Pilrble 60,V	Sulfide React						Samples on Ice
5/14/02	1440	14D	14D		X				C	N	X	X	X	X					1	S→G

Relinquished By: (Signature)	Date: [illegible]	Time: [illegible]	Received By: (Signature)	Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)
Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)	Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)
Relinquished By: (Signature)	Date:	Time:	Received for Lab By: (Signature)	Date:	Time:	Comments: Page 2 of 2 coc complete.	

Method of Shipment: Woods Hole Courier

Distribution: Original to Lab, Copy 1 to Field Files, Copy 2 to Project Manager

EPH/TPH
SAMPLE INFORMATION

Client: METCDA ETR Number: 0205050

Matrix:	☐ Aqueous ☒ Soil ☐ Sediment ☐ Other:
Containers:	☒ Satisfactory ☐ Broken ☐ Leaking
	Aqueous ☐ N/A ☐ pH ≤ 2 ☐ pH > 2
Temperature:	☒ Received on ice ☒ Received at 4°C (± 2°C) ☐ Other:
Extraction Method:	Water: Liq/Liq (3520C) ☐ Sep Funnel (3510C) ☐ Soil: Sonication (3550B) ☐ PFE* (3545) ☒
Comments:	

CERTIFICATION

Were all QA/QC procedures REQUIRED by the EPH Method followed? ☑ Yes ☐ No *

Were all performance/acceptance standards for the required QA/QC procedures achieved? ☐ Yes ☑ No *

Were any significant modifications made to the EPH method, as specified in Section 11.3? ☑ Yes* ☐ No

** - EPH Method Modifications:*

1. *The following soil extraction method may be used: PFE-Pressurized Fluid Extraction, Method 3545 SW846 Final Update III 12/96.*
2. *5-Alpha-androstane is substituted for the aliphatic extraction surrogate chloro-octadecane.*
3. *Biphenyl is substituted for the fractionation surrogate 2-bromonapthalene.*

** See Narrative portion of report for details.*

I attest under the pains and penalties of perjury that based upon my inquiry of those individuals immediately responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete.

SIGNATURE: Dawne E Smart POSITION: QA Specialist

PRINTED NAME: Dawne E. Smart DATE: 5/24/02

M&E
Metcalf & Eddy

Memorandum

PROJECT NO: 0362001.0006.00085
TO: Oxford Paper Site File (BTSA)
FROM: S. Harvey
REVIEWED BY: L. Krowitz
CC: B. Weir, N. Thurber (memo only)

DATE: July 10, 2002
OFFICE: Wakefield
COMPANY: Metcalf & Eddy, Inc.

SUBJECT: Limited QC Review/Modified Tier II-Like Review
EPH, Priority Pollutant Metals, TCLP Metals, and/or Reactive Sulfide
Analytical Results
Woods Hole Group, Raynham, Massachusetts
ETR No. 0205050

On May 13 and 14, 2002, thirteen soil samples were collected at the Oxford Paper Brownfields Targeted Site Assessment (BTSA) site, located in Lawrence, Massachusetts by Metcalf & Eddy, Inc. (M&E) field personnel. The sampling was performed as part of the BTSA Response Action Contract (RAC) Work Assignment (WA) #106-SIBZ-01ZZ. The samples were submitted to Woods Hole Group, located in Raynham, Massachusetts for the analysis of Extractable Petroleum Hydrocarbons (EPH) using the Massachusetts Department of Environmental Protection (MADEP) *Method for the Determination of Extractable Petroleum Hydrocarbons (EPH), January 1998*; Priority Pollutant Metals using EPA SW-846 Methods 3050 and 6020; Toxicity Characteristic Leaching Procedure (TCLP) Metals using SW-846 Methods 1311, 6010B, and 7471A; and/or Reactive Sulfide using SW-846 Method, Chapter 7, Section 7.3.4. All samples were received by the laboratory on May 15, 2002. The data package was received in the M&E office on June 6, 2002.

M&E reviewed the data in accordance with the EPA-approved Final Field Task Work Plan for the site, and the guidance received from EPA Work Assignment Manager, Mr. James Byrne, in a September 17, 1999 letter to former M&E Work Assignment Manager, Barb Wyskowski. The data review included:

*	•	Data Completeness
*	•	Preservation and Technical Holding Times
NA	•	GC/MS and GC/ECD Instrument Performance Check
*	•	Initial and Continuing Calibrations
	•	Blank Analysis Results
*	•	Inductively Coupled Plasma (ICP) Interference Check Sample Results
*	•	Surrogate Compounds
*	•	Internal Standards
	•	Matrix Spike (MS) Recoveries

	•	Laboratory Duplicate Sample Results
	•	Field Duplicate Sample Results
	•	Laboratory Fortified Blank (LFB) and/or Laboratory Control Sample (LCS) Results
NA	•	Furnace Atomic Absorption Results
	•	ICP Serial Dilution Analysis Results
	•	Compound Quantitation and Reported Quantitation Limits
NA	•	Semivolatile and Pesticide/PCB Cleanup
NA	•	Performance Evaluation (PE) Sample Results

• = All criteria met for this parameter
NA = Not applicable and/or no information was provided by the laboratory

Note: Worksheets are not included for parameters that have met criteria or for criteria that are not applicable to the method and/or to the modified Tier II-like review.

Included in Attachment I is a copy of the chain-of-custody (COC) record. Included in Attachment II are the result summary sheets, annotated with qualifiers, if necessary, as detailed in this memorandum. Included in Attachment III are the data validation worksheets.

The Reactive Sulfide results are acceptable for use without qualification.

Blank Analysis Results

Priority Pollutant Metals

A review of laboratory blank analysis results indicates the presence of contamination for the priority pollutant metals analytes in the samples listed below.

Analyte	Max. Conc. (µg/L)	Blank Action Level (BAL) (mg/kg)*	Affected Samples/Action
chromium	0.019	0.0095	None. All sample results are >BAL.
selenium	0.25	0.125	Qualify the reported value as nondetect "U" in priority pollutant metals sample 4S, 6D, 8S, 8D, 10S, 10D, K10D, 12S, 12D, 14S, and 14D.
silver	0.029	0.0145	None. All sample results are >BAL.
thallium	0.096	0.048	None. All sample results are >BAL.
vanadium	0.068	0.034	None. All sample results are >BAL.

* The sample-specific preparation factors, dilutions, and percent solids were taken into account when evaluating blank contamination.

The blank contamination validation actions include:

- concentration ≤ blank action level; qualify the reported value as nondetect (U)
- concentration ≥ blank action level; report the value unqualified.

TCLP Metals

A review of laboratory blank analysis results indicates the presence of contamination for the TCLP metals analytes in the samples listed below.

Analyte	Max. Conc. (µg/L)	Blank Action Level (BAL) (µg/L)	Affected Samples/Action
barium	130	650	Qualify the reported values as nondetect (U) in TCLP Metals samples 4S, 4D, 6S, 6D, 8S, 8D, 10S, 10D, K10D, 12S,12D, and 14D.
lead	44	220	Qualify the reported values as nondetect (U) in TCLP Metals samples 10S, 10D, 12S, 12D, 14S, and 14D.
selenium	60	300	Qualify the reported values as nondetect (U) in TCLP Metals samples 6S, 6D, 10D, and 12D.

The blank contamination validation actions include:

- concentration ≤ blank action level; qualify the reported value as nondetect (U)
- concentration ≥ blank action level; report the value unqualified.

Matrix Spike Recoveries

EPH

The EPH compounds for soil samples that did not meet acceptance criteria of 40-140 percent recovery (%R) in matrix spike sample 10D, indicating possible matrix interference, are summarized in the table below:

Compound	Spiked Sample Result (µg/kg)	Sample Result (µg/kg)	Matrix Spike %R	Affected Samples/Action
fluoranthene	13,000	2,700	163	Estimate (J) positive fluoranthene result in this sample.

Compound	Spiked Sample Result (µg/kg)	Sample Result (µg/kg)	Matrix Spike %R	Affected Samples/Action
pyrene	13,000	2,600	168	Estimate (J) positive pyrene result in this sample.

Priority Pollutant Metals

The low level priority pollutant metals analytes for soil samples that did not meet acceptance criteria of 75-125 percent recovery (%R) in matrix spike sample 10D, indicating possible matrix interference, are summarized in the table below:

Analyte	Spiked Sample Result (mg/kg)	Sample Result (mg/kg)	Matrix Spike %R	Affected Samples/Action
antimony	1.1	0.33	24	Estimate (J) the positive antimony results in all priority pollutant metals samples. Sample results may be biased low.

Laboratory Duplicate Sample Results

Priority Pollutant Metals

The priority pollutant metals analyte that did not meet acceptance criteria of relative percent difference (%RPD)<20 in soil sample 10D is summarized in the following table:

Analyte	Sample Result (mg/kg)	Duplicate Sample Result (mg/kg)	%RPD	Affected Samples/Action
arsenic	15	5.6	89%	Estimate (J) the positive

Field Duplicate Sample Results

Priority Pollutant Metals

The following table summarizes the priority pollutant metals analytes that did not meet acceptance criterion for relative percent difference (RPD) of ≤50% in field duplicate samples 10D and K10D:

Analyte	Sample Result (mg/kg)	Duplicate Sample Result (mg/kg)	%RPD	Affected Samples/Action
arsenic	15	7.7	64%	Estimate the positive arsenic result in all priority pollutant metals samples. A bias could not be determined.

EPH

The following table summarizes the EPH compounds that did not meet acceptance criterion for relative percent difference (RPD) of ≤50% in field duplicate samples 10D and K10D:

Compound	Sample Result (mg/kg)	Duplicate Sample Result (mg/kg)	%RPD	Affected Samples/Action
C_{19}-C_{36} aliphatic	14,000	4,800U	NC	Estimate (J) the positive C_{19}-C_{36} aliphatic result in field duplcate samples 10D and estimate (UJ) the nondetect C_{19}-C_{36} aliphatic result in field duplicate sample K10D. A bias could not be determined.
C_{11}-C_{22} aromatics	35,000	60,000	53%	Estimate (J) the positive C_{11}-C_{22} aromatic result in field duplicate samples 10D and K10D. A bias could not be determined.
unadjusted C_{11}-C_{22} aromatics	58,000	110,000	62%	Estimate (J) the positive unadjusted C_{11}-C_{22} aromatic result in field duplicate samples 10D and K10D. A bias could not be determined.
acenaphthene	780	590U	NC	Estimate (J) the positive acenaphthene result in field duplcate sample 10D and estimate (UJ) the nondetect acenaphthene result in field duplicate sample K10D. A bias could not be determined.
fluorene	800	590U	NC	Estimate (J) the positive acenaphthene result in field duplcate sample 10D and estimate (UJ) the nondetect acenaphthene result in field duplicate sample K10D. A bias could not be determined.
phenanthrene	2,700	5,800	73%	Estimate (J) the positive phenanthrene result in field duplicate samples 10D and K10D. A bias could not be determined.

Compound	Sample Result (mg/kg)	Duplicate Sample Result (mg/kg)	%RPD	Affected Samples/Action
anthracene	930	1,900	69%	Estimate (J) the positive anthracene result in field duplicate samples 10D and K10D. A bias could not be determined.
fluoranthene	3,700	7,900	72%	Estimate (J) the positive fluoranthene result in field duplicate samples 10D and K10D. A bias could not be determined.
pyrene	3,600	7,500	70%	Estimate (J) the positive pyrene result in field duplicate samples 10D and K10D. A bias could not be determined.
benzo(a) anthracene	1,900	4,300	77%	Estimate (J) the positive benzo(a) anthracene result in field duplicate samples 10D and K10D. A bias could not be determined.
chrysene	2,500	4,400	55%	Estimate (J) the positive chrysene result in field duplicate samples 10D and K10D. A bias could not be determined.
benzo(b) fluoranthene	2,000	4,500	77%	Estimate (J) the positive benzo(b) fluoranthene result in field duplicate samples 10D and K10D. A bias could not be determined.
benzo(a) pyrene	1,800	3,500	64%	Estimate (J) the positive benzo(a) pyrene result in field duplicate samples 10D and K10D. A bias could not be determined.
indeno(1,2,3-cd) pyrene	1,900	3,300	54%	Estimate (J) the positive indeno (1,2,3-cd) pyrene result in field duplicate samples 10D and K10D. A bias could not be determined.
dibenzo(a,h) anthracene	1,900	3,300	54%	Estimate (J) the positive dibenzo(a,h) anthracene result in field duplicate samples 10D and K10D. A bias could not be determined.

The positive fluoranthene results in samples 10D and K10D were previously qualified as estimated (J) due to poor matirx spike recovery. Therefore, no further action is taken on the fluoranthene results due to poor field duplicate sample results.

Laboratory Control Sample (LCS) Results

EPH

The following table summarizes the EPH compound that did not meet acceptance criteria of percent recovery (%R) of 40-140%:

Compound	%R	Affected Samples/Action
naphthalene	37%	Estimate (J) positive result in samples 4D, 6S, 6D, 8D, 12D, 14S, and 14D. Estimate (UJ) the nondetect result in samples 4S, 8S, 10S, 10D, K10D, and 12S. Sample results may be biased low.

Compound Quantitation and Reported Quantitation Limits

EPH

The laboratory performed a laboratory duplicate analysis on soil sample 10D. The laboratory duplicate sample results were detected at higher concentrations for all but one EPH compound than those concentrations detected in the original analysis of sample 10D. As a conservative measure, the data validator chose to report the laboratory duplicate sample results instead of the original analysis results of sample 10D.

Priority Pollutant Metals

The following table summarizes the priority pollutant metal results that are less than the sample-specific report limit (RL) but greater than the method detection limit (MDL) and were not previously qualified as estimated (J) due to quality control parameters discussed above. The listed results are qualified as estimated (J) due to uncertainty in the quantitation near the RL:

Analyte	Affected Samples/Action
selenium	8D, 10S, 12D

The positive selenium result in sample 8D, 10S, and 12D were previously qualified as nondetect (U) due to blank contamination. The results are further qualified as estimated, nondetect (UJ) due to blank contamination and uncertainty in quantitation.

TCLP Metals

The following table summarizes the TCLP metal results that are less than the reporting limit (RL) but greater than the method detection limit (MDL) and were not previously qualified as estimated (J) due to quality control parameters discussed above. The listed results are qualified as estimated (J) due to uncertainty in the quantitation:

Analyte	Affected Samples/Action
arsenic	4S, 4D, 8S, 12D, 14S
barium	4D, 6S, 6D, 8S
cadmium	6D, 12S, 12D
chromium	4S, 4D, 6D, 12D, 14S
lead	10S, 10D, 12S, 12D, 14S, 14D
selenium	6S, 6D, 10D, 12D
silver	4S, 4D, 6S, 8S, 8D, 14D

The positive results for barium, lead, and selenium in all samples listed above were previously qualified as nondetect (U) due to blank contamination. These results are further qualified as estimated, nondetect (UJ) due to blank contamination and uncertainty in quantitation.

Data Validation Worksheet Cover Page - Page 1 Reference No. 2001.020d.00085.MA

REGION I ORGANIC DATA VALIDATION

The following data package has been validated:

Lab Name Woods Hole Group
ETR# ~~Case/Project No.~~ 0205050
SDG No.
No. of Samples/Matrix 13/soil

SOW/Method No. EPH
Sampling Date(s) 5/13,14/02
Shipping Date(s) 5/15/02
Date Rec'd by lab 5/15/02

Traffic Report Sample Nos. 4S, 4D, 6S, 6D, 8S, 8D, 10S, 10D, K10D, 12S, 12D, 14S, 14D

Trip Blank No. —
Equipment Blank No. —
Bottle Blank No. —
Field Duplicate Nos. 10D/K10D
PES Nos. none

The Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses, revision ________ was used to evaluate the data and/or approved modifications to the EPA-NE Functional Guidelines were used to evaluate the data and are attached to this cover page: (attach modified criteria from EPA approved QAPjP or amendment to QAPjP).

A Tier II or Tier III evaluation was used to validate the data (circle one). If a Tier II validation with a partial Tier III was used, then identify samples, parameters, etc. that received partial Tier III validation

Modified Tier II MA EPH Method.

EPH The data were evaluated based upon the following parameters:

- ok - Overall Evaluation of Data
- ok - Data Completeness (CSF Audit - Tier I)
- ok - Preservation & Technical Holding Times
- NA - GC/MS & GC/ECD Instrument Performance Check
- ok - Initial & Continuing Calibrations
- ok - Blanks
- ok - Surrogate Compounds
- ok - Internal Standards
- * - Matrix Spike/Matrix Spike Duplicate
- * - Field Duplicates
- * - Sensitivity Check (LCS)
- NA - PE Samples/Accuracy Check
- NA - Target Compound Identification
- * - Compound Quantitation and Reported Quantitation Limits
- NA - TICs
- NA - Semivolatile and Pesticide/PCB Cleanup
- NA - System Performance
- ok - Lab Duplicate

Region I Definitions and Qualifiers:

A - Acceptable Data
J - Numerical value associated with compound is an estimated quantity.
R - The data are rejected as unusable. The R replaces the numerical value or sample quantitation limit.
U - Compound not detected at that numerical sample quantitation limit.
UJ - The sample quantitation limit is an estimated quantity.
TB, BB, EB - Compound detected in aqueous trip blank, aqueous bottle blank, or aqueous equipment blank associated with soil/sediment samples.

Validator's Name Sheila Harvey Company Name M+E, Inc Phone Number 781 246 5200

Date Validation Started 6/16/02 Date Validation Completed 6/19/02

Check if all criteria are met and no hard copy worksheet provided. Indicate NA if worksheet is not applicable to analytical method. Note: there is no standard worksheet for System Performance, however, the validator must document all system performance issues in the Data Validation Memorandum.

EPH ~~VOA/SV~~ worksheets:

VOA/SV-Pest/PCB	COMPLETE SDG FILE (CSF) AUDIT	ok
VOA/SV-Pest/PCB-I	PRESERVATION AND HOLDING TIMES	ok
VOA/SV-II	GC/MS INSTRUMENT PERFORMANCE CHECK (TUNING)	NA
VOA/SV-III	INITIAL CALIBRATION	ok
VOA/SV-IV	CONTINUING CALIBRATION	ok
VOA/SV-Pest/PCB-V-A	BLANK ANALYSIS	ok
VOA/SV-Pest/PCB-V-B	BLANK ANALYSIS	—
VOA-VI	VOA SURROGATE SPIKE RECOVERIES	NA
SV-VI	SV SURROGATE SPIKE RECOVERIES	ok
VOA/SV-VII	INTERNAL STANDARD PERFORMANCE	ok
VOA/SV-Pest/PCB-VIII	MATRIX SPIKE/MATRIX SPIKE DUPLICATE	X
VOA/SV-Pest/PCB-IX	FIELD DUPLICATE PRECISION	X
VOA/SV-Pest/PCB-X	SENSITIVITY CHECK	X
VOA/SV-Pest/PCB-XI	ACCURACY CHECK	NA
VOA/SV-Pest/PCB-XII	TARGET COMPOUND IDENTIFICATION	NA
VOA/SV-Pest/PCB-XIII	SAMPLE QUANTITATION	ok
VOA/SV-XIV	TENTATIVELY IDENTIFIED COMPOUNDS	NO
VOA/SV-XV	SEMIVOLATILE CLEANUP	NA
TABLE II-WORKSHEET	OVERALL EVALUATION OF DATA	ok

Pest/PCB worksheets:

VOA/SV-Pest/PCB	COMPLETE SDG FILE (CSF) AUDIT	
VOA/SV-Pest/PCB-I	PRESERVATION AND HOLDING TIMES	
Pest/PCB-IIA	GC/ECD INSTRUMENT PERFORMANCE CHECK-RESOLUTION	
Pest/PCB-IIB	GC/ECD INSTRUMENT PERFORMANCE CHECK-RETENTION TIMES	
Pest/PCB-IIC	GC/ECD INSTRUMENT PERFORMANCE CHECK-ACCURACY CHECK OF INITIAL CALIBRATION	
Pest/PCB-IID	GC/ECD INSTRUMENT PERFORMANCE CHECK-PESTICIDE DEGRADATION	
Pest/PCB-III	INITIAL CALIBRATION	
Pest/PCB-IV	CONTINUING CALIBRATION	
VOA/SV-Pest/PCB-V-A	BLANK ANALYSIS	
VOA/SV-Pest/PCB-V-B	BLANK ANALYSIS	
Pest/PCB-VI	SURROGATE COMPOUNDS: SPIKE RECOVERIES AND RETENTION TIME SHIFT	
Pest/PCB-VII	PESTICIDE CLEANUP	
VOA/SV-Pest/PCB-VIII	MATRIX SPIKE/MATRIX SPIKE DUPLICATE	
VOA/SV-Pest/PCB-IX	FIELD DUPLICATE PRECISION	
VOA/SV-Pest/PCB-X	SENSITIVITY CHECK	
VOA/SV-Pest/PCB-XI	ACCURACY CHECK	
Pest/PCB-XII	COMPOUND IDENTIFICATION	
VOA/SV-Pest/PCB-XIII	SAMPLE QUANTITATION	
TABLE II-WORKSHEET	OVERALL EVALUATION OF DATA	

I certify that all criteria were met for the worksheets checked above.

Signature: Sheila Harvey

Name: Sheila Harvey, ATG, Inc.

Date: 6/19/02

EPA-NE - Data Validation Worksheet
VOA/SV - Pest/PCB-VIII

VIII. **MATRIX SPIKE/MATRIX SPIKE DUPLICATE** - List all MS/MSD analytes that are outside method QC acceptance criteria.

Use a separate worksheet for each MS/MSD pair.

Sample # 10D

Matrix Soil

Concentration Level low

Parameter	Compound	MS %Rec	MSD %Rec	RPD	Method QC Limits		Concentration			% RSD	Action
					% Rec	RPD	Unspiked Sample	MS	MSD		
PAH	Fluoranthene	163			40-140						J(+) in this sam
	Pyrene	168			"						J(+) in this samp

Validator: Sheila Harvey

Date: 6/19/02

EPA-NE - Data Validation Worksheet
VOA/SV - Pest/PCB-IX

IX. FIELD DUPLICATE PRECISION - List all field duplicate analytes that are outside criteria.

Use a separate worksheet for each field duplicate pair.

Pg 1 of 2

Sample Number 101* Duplicate Sample Number K101 Matrix Soil

Parameter	Compound	Sample Conc.	Sample QL		Duplicate Conc.	Duplicate QL		RPD	QC Acceptance Criteria RPD or NA*	Action
			SQL	2xSQL		SQL	2xSQL			
EPH	C_{19}-C_{36} Aliphatics	14000	3600	7200	4800 U	4800	9600	NC	<50	J(+)/UJ(ND)
	C_{11}-C_{22} Aromatics	35000			60000			53		J(+)
	Unadj C_{11}-C_{22} Aromatics	58000	↓	↓	110000	↓	↓	62		"
	Acenaphthene	780	590	1180	590 U	600	1200	NC		J(+)/UJ(ND)
	Fluorene	800			590 U			NC		J(+)/UJ(ND)
	phenanthrene	2700			5800			73		J(+)
	Anthracene	930			1900			69		J(+)
	Fluoranthene	3700			7900			72		J(+)
	Pyrene	3600			7500			70		J(+)
↓	Benzo(a)anthracene	1900	↓	↓	4300	↓	↓	77	↓	J(+)

* For instances where one duplicate result is ND (or reported less than the sample QL).

Does the MS/MSD data indicate acceptable laboratory precision? Y N

Comments: * Concentrations of EPH compounds reported from the laboratory duplicate analysis of soil sam 100 due to higher concentrations of EPH cmpds detected in the lab duplicate sample vs the original analysis of 100.

Sampler Name: ______ Contractor Name: ______ Date Contacted: ______

Reason for Contact and resolution obtained: ______

Validator: Sheila Harvey Date: 7/2/02

EPA-NE - Data Validation Worksheet
VOA/SV - Pest/PCB-IX

IX. **FIELD DUPLICATE PRECISION** - List all field duplicate analytes that are outside criteria.

Use a separate worksheet for each field duplicate pair.

Pg 2 of 2

Sample Number 10D Duplicate Sample Number K10D Matrix Soil

Parameter	Compound	Sample Conc.	Sample QL		Duplicate Conc.	Duplicate QL		RPD	QC Acceptance Criteria RPD or NA*	Action
			SQL	2xSQL		SQL	2xSQL			
OPH	Chrysene	2500	540	1180	4400	600	1200	55	<50%	J(+)
	benzo(b)fluoranthene	2000			4500			77		J(+)
	benzo(k)fluoranthene	1300			1500			7		OK
	benzo(a)pyrene	1800			3500			64		J(+)
	Indeno(1,2,3-cd)pyrene	1900			3300			54		
	dibenzo(a,h)anthracene	1900			3300			54		
↓	benzo(ghi)perylene	1000	↓	↓	2200	↓	↓	50	↓	↓

* For instances where one duplicate result is ND (or reported less than the sample QL).

Does the MS/MSD data indicate acceptable laboratory precision? Y N

Comments:

Sampler Name: Contractor Name: Date Contacted:

Reason for Contact and resolution obtained:

Validator: Sheila Henry Date: 7/2/02

EPA-NE - Data Validation Worksheet
VOA/SV - Pest/PCB-X

X. ~~SENSITIVITY CHECK~~ (Method Detection Limit Study) Fractionation Check Soln.

List all compounds, surrogates, and internal standards that are outside the MDL criteria. All criteria met

- Has an appropriate MDL study been submitted with seven replicates for each compound and matrix of interest? Y N
- Date of Preparation/Analysis: _______ Within 1 year? Y N
- Instrument I.D.: _______ Same as samples? Y N
- Column I.D.: _______ Same as samples? Y N

Matrix	Compound	MDL > QL	Method QC Limits < 80% or > 120%	IS Outside Area Count and/or RT Criteria	RSD > 20%	Samples Affected	Action

If an MDL study has not been submitted, use only the LFB results to evaluate data.

(Laboratory Fortified Blank) - List all LFB compounds, surrogates and internal standards that are outside criteria.

- Has an appropriate and complete LFB been submitted at the proper frequency? Y N
- Does it contain all target compounds at the method-required QLs? Y N
- Was the LFB spiked with a standard from a source (vendor) independent of the calibration standard? Y N

Matrix	Compound	Method QC Limits < 60% or > 140% Other:	IS Outside Area Count and/or RT Criteria	Samples Affected	Action
Soil	Naphthalene	40-140	37%		

Validator: _______________ Date: 6/19/12

Region I
Data Review Worksheet

Site Name: Targetted Brownfields Site Assessment Oxford Paper, Lawrence, MA
Reference Number: 2001.0006.00085.

REGION I REVIEW OF INORGANIC CONTRACT LABORATORY DATA PACKAGE

The hardcopied (laboratory name) Woods Hole Group data package received at Region I has been reviewed and the quality assurance and performance data summarized. The data review included:

~~Case No.~~ ETR #	0205050	SAS No.		Sampling Date (s)	5/13, 14/02
SDG No.	——	Matrix	Soil	Shipping Date (s)	5/15/02
No. of Samples	13			Date(s) rec'd by lab	5/15/02

Traffic Report Numbers 4$, 6$, 8$, 40, 60, 80, 10$, 10D, 12$, 120, K10D, 14$, 140

Trip Blank No.: ——
Equipment Blank Number: ——
Field Duplicate Numbers: 10D/K10D

SOW No. * requires that specific analytical work be done and that associated reports be provided by the laboratory to the Regions, EMSL-LV, and SMO. The general criteria used to determine the performance were based on an examination of:

✓ -Data Completeness
✓ -Holding Times
✓ -Calibrations
✗ -Blanks
✓ -ICP Interference Check Results
✗ -Matrix Spike Recoveries
✗ -Laboratory Duplicates
✗ -Field Duplicates
✓ -Lab Control Sample Results
NA -Furnace AA results
-ICP Serial Dilution Results
✓ -Detection Limit Results
✗ -Sample Quantitation

Overall Comments: * Priority Pollutant (13) ~~Total~~ Metals (Method 3050/6020 for Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Ni, Se, Ag, Tl, V, Zn). Method 3050/6020 w/ addition of HCl for Sb, As. Mercury analyzed according to 7471.

Definitions and Qualifiers:
A - Acceptable data
J - Approximate data due to quality control criteria
R - Reject data due to quality control criteria
U - Analyte not detected

Reviewer: Sheila Harvey
Date: 6/6/02

IV A. BLANK ANALYSIS RESULTS (Sections 1-3)

List the blank contamination in sections 1 and 2 below. A separate worksheet should be used for soil and water blanks.

1. Laboratory Blanks

Matrix: Soil

DATE:	ICB/CCB#	PREP BL	ANALYTE	CONC./UNITS
	ICB, CCB		Tl	~~0.01~~ 0.075µg/L, 0.039
	CCB		Cr	0.019µg/L
	CCB		Mn	0.068µg/L
	CCB		Tl	0.096µg/L; 0.094µg/L; 0.095µg/L
	CCB		Se	0.23µg/L
	CCB		As	0.029µg/L

2. Equipment/Trip Blanks

DATE:	EQUIP BL #	ANALYTE	CONC./UNITS

3. Frequency Requirements

A. Was a preparation blank analyzed for each matrix, for every 20 samples, and for each digestion batch? [✓ Yes] or No

B. Was a calibration blank run at the beginning of the run, and every 10 samples or every 2 hours whichever is more frequent? Yes or No

If no, the data may be affected. Use professional judgment to determine the severity of the effect and qualify the data accordingly. Discuss any actions below, and list the samples affected:

IV B. BLANK ANALYSIS RESULTS (Section 4)

4. Blank Actions

The Action Level for any analyte is equal to 5X the highest concentration of that analyte found in any blank. (Use 5X the absolute value for any negative blank results). The Action Level for samples which have been concentrated or diluted should be multiplied by the concentration/dilution factor. No positive result should be reported unless the concentration of the analyte in the sample exceeds the Action Level (AL) for that analyte. Specific actions are as follows:

1. When the concentration is greater than the IDL, but less than the Action Level, report the sample concentration detected with a U.

2. When the sample concentration is greater than the Action Level, report the sample concentration unqualified.

Matrix: Soil Matrix: ______

ELEMENT	MAX. CONC. UNITS	AL UNITS µg/L	ELEMENT	MAX. CONC. UNITS	AL UNIT
Cr	0.019 µg/L	0.0095			
Se	0.25 µg/L	0.125			
Ag	0.029 µg/L	0.0145			
Tl	0.096 µg/L	0.048			
Vn	0.068 µg/L	0.034			

NOTE: Blanks analyzed during a soil case must be converted to mg/kg in order to compare them with the sample results.

$$\text{conc. in ug/l} \times \frac{\text{Volume diluted to (200ml)}}{\text{Weight digested (1gram)}} \times \frac{1\text{L}}{1000\text{ml}} \times \frac{1000\text{g}}{1\text{kg}} \times \frac{1\text{mg}}{1000\text{ug}} = \text{mg/kg}$$

Multiplying this result by 5 to arrive at the Action Level gives a final result in mg/kg which can then be compared to sample results

r: none
Se: 8D, 80, 40, 4D, 100, 10D, K10D, 120, 12D, 140, 140
Ag: none
Tl: none
Vn: none

VI. MATRIX SPIKE

TR # 10D

Matrix: Soil

1. Recovery Criteria

List the percent recoveries for analytes which did not meet the required criteria.

Matrix Spike Sample - High
Conc. - all criteria

S - amount of spike added
SSR - spiked sample result
SR - sample result

Low

ANALYTE	SSR	SR	S	%R	ACTION
~~Sb~~	~~0.33~~	~~0 1.1~~ SL			
Sb	1.1	0.33		24	J(L) all samples

Matrix Spike Actions apply to all samples of the same matrix.

ACTIONS:

1. If the sample concentration exceed the spike concentration by a factor of 4 or more, no action is taken.
2. If any analyte does not meet the %R criteria, follow the actions stated below:

	PERCENT RECOVERY		
	< 30%	30%-74%	>125%
Positive Sample Results	J	J	J
Non-detected Results	R	UJ	A

2. Frequency Criteria

A. Was a matrix spike prepared at the required frequency? [✓ Yes] or No

B. Was a post digestion spike analyzed for elements that did not meet the required criteria for matrix spike recovery? [✓ Yes] or No

A separate worksheet should be filled out for each matrix spike pair.

VII. LABORATORY DUPLICATES

List the concentrations of any analyte not meeting the criteria for duplicate precision. For soil duplicates, calculate the CRDL in mg/kg using the sample weight, volume and percent solids data for the sample. Indicate what criteria was used to evaluate precision by circling either the RPD or CRDL for each element.

Matrix: Soil

ELEMENT	CRDL		SAMPLE #	DUPLICATE #	RPD	ACTION
	WATER ug/L	SOIL mg/kg	10D	10D - Dup		
Aluminum	200					
Antimony	60					
Arsenic	10	1	15	5.6	89%	J(+)
Barium	200					
Beryllium	5					
Cadmium	5					
Calcium	5000					
Chromium	10					
Cobalt	50					
Copper	25					
Iron	100					
Lead	5					
Magnesium	5000					
Manganese	15					
Mercury	0.2					
Nickel	40					
Potassium	5000					
Selenium	5					
Silver	10					
Sodium	5000					
Thallium	10					
Vanadium	50					
Zinc	20					
Cyanide	10					

Laboratory duplicate actions should be applied to all other samples of the same matrix type.

ACTION:

1. Estimate (J) positive results for elements which have an RPD > 20% for waters and > 35% for soils.
2. If sample results are less than 5X the CRDL, estimate (J) positive results for elements whose absolute difference is > CRDL (2X CRDL for soils). If both samples are non-detected, the RPD is not calculated (NC).

VIII. FIELD DUPLICATES

List the concentrations of all analytes in the field duplicate pair. For soil duplicates, calculate the CRDL in mg/kg using the sample weight, volume and percent solids data for the sample. Indicate what criteria was used to evaluate precision by circling either the RPD or CRDL for each element.

Matrix: Soil

ELEMENT	CRDL		SAMPLE #	DUPLICATE #	RPD	ACTION
	WATER ug/L	SOIL mg/kg	100	K100		
Aluminum	200	20				
Antimony	50	6	0.33	0.62	NE	
Arsenic	10	1	15	7.7	64%	J(+)
Barium	200	20	29	39	OK	
Beryllium	5	0.5	0.44	0.59	OK	
Cadmium	5	0.5	0.13	0.14	NE	
Calcium	5000	500				
Chromium	10	1	18	19	5%	OK
Cobalt	50	5				
Copper	25	2.5	32	33	3%	OK
Iron	100	10				—
Lead	5	0.5	44	52	16%	OK
Magnesium	5000	500				
Manganese	15	1.5				
Mercury	0.2	0.01	0.11	0.11	0%	OK
Nickel	40	4	16	19		OK
Potassium	5000	500				
Selenium	5	0.5	0.40	0.37	NE	
Silver	10	1	0.071	0.095	NE	
Sodium	5000	500				
Thallium	10	1	0.11	0.13	16%	OK
Vanadium	50	5	51	83	47%	OK
Zinc	20	2	65	75	14%	OK
Cyanide	10	NA	—	—	—	→

Field duplicate actions should be applied to all other samples of the same matrix type.

ACTION:

1. Estimate (J) positive results for elements which have an RPD > 30% for waters and > 50% for soils.
2. If sample results are less than 5X the CRDL, estimate (J) positive results for analytes whose absolute difference is > 2X CRDL (4X CRDL for soils). If both samples are non-detected, the RPD is not calculated (NC).

XI. INDUCTIVELY COUPLED PLASMA (ICP) SERIAL DILUTION ANALYSIS

_____ Serial dilutions were performed for each matrix and results of the diluted sample analysis agreed within ± 10% of the original undiluted analysis. 50 x MDL

_____ Serial dilution was not performed for the following:

_____ Serial dilutions were performed, but analytical results did not agree within ± 10% for analyte concentrations greater than 50X the IDL before dilution.

Report all results below that do not meet the required laboratory criteria for ICP serial dilution analysis

Matrix: Soil Sample (01D)

ELEMENT	MDL µg/L	50X IDL µg/L	SAMPLE RESULT	SERIAL DILUTION	% D	ACTION
Aluminum						
Antimony						
Barium						
Beryllium						
Cadmium	0.11	5.5 (0.48 mg/kg)	0.13	0.25	—	NE
Calcium						
Chromium						
Cobalt						
Copper						
Iron						
Lead						
Magnesium						
Manganese						
Nickel						
Potassium						
Silver	0.027	0.12	0.071	0.055	—	NE
Sodium						
Vanadium						
~~Zinc~~ Thallium	0.015	0.75 → 0.065 mg/kg	0.11	0.15	42	J(+)

Actions apply to all samples of the same matrix

ACTIONS:

1. Estimate (J) all positive results and (UJ) all nondetects if the % D > 15%.

Region I
Inorganic Data Review Worksheets

XIII. SAMPLE QUANTITATION (continued)

List the positive sample results that were reported at concentrations less than ~~2xIDL~~ RL > MDL and have not already been qualified. The positive results have been estimated (J) due to uncertainty in the quantitation ~~near the IDL~~.

Analyte	Samples Affected
Se	8D, 4$, 10$, 6D, 8$, K10D, 12$, 12D, 14$, 14D
Sb	8$, 10$, 12$
Cd	8$, 10D, K10D
Tl	8$
Be	6D
Ag	12$, 12D, 14$, 10$

Region I
Data Review Worksheet

Site Name: Targeted Brownfields Site Assessment
Oxford Paper, Lawrence, MA
Reference Number: 2001.0006.00085

REGION I REVIEW OF INORGANIC CONTRACT LABORATORY DATA PACKAGE

The hardcopied (laboratory name) Woods Hole Group data package received at Region I has been reviewed and the quality assurance and performance data summarized. The data review included:

~~Case No.~~ ETR#	0205050	SAS No.	—	Sampling Date (s)	5/13,14/02
SDG No.	—	Matrix	Soil	Shipping Date (s)	5/15/02
No. of Samples	13			Date(s) rec'd by lab	5/15/02

Traffic Report Numbers: 4$, 4D, 6$, 6D, 8$, 8D, 10$, 10D, K(10D), 12$, 12D, 14$, 14D

Trip Blank No.: —
Equipment Blank Number: —
Field Duplicate Numbers: 10D/K(10D)

SOW No. * requires that specific analytical work be done and that associated reports be provided by the laboratory to the Regions, EMSL-LV, and SMO. The general criteria used to determine the performance were based on an examination of:

- * -Data Completeness
- * -Holding Times
- ✓-Calibrations
- * -Blanks
- ✓-ICP Interference Check Results
- ✓-Matrix Spike Recoveries
- ✓-Laboratory Duplicates
- ✓-Field Duplicates
- ✓-Lab Control Sample Results
- NA-Furnace AA results
- -ICP Serial Dilution Results
- ✓-Detection Limit Results
- * -Sample Quantitation

Overall Comments: * TCLP Metals (method 1311; digestion 3010 analysis by ICP/AES-method 6010) for As, Ba, Cd, Cr, Pb, Se, Ag. Mercury analyzed according to Method 7471. Samples 4$, 8D, and 8$ analyzed by ICP-MS due to matrix interference on the 6010 analysis, resulting in elevated reporting limits.

Definitions and Qualifiers:
A - Acceptable data
J - Approximate data due to quality control criteria
R - Reject data due to quality control criteria
U - Analyte not detected

Reviewer: Sheila Harvey
Date: 6/16/02

IV A. BLANK ANALYSIS RESULTS (Sections 1-3)

List the blank contamination in sections 1 and 2 below. A separate worksheet should be used for soil and water blanks.

1. Laboratory Blanks

Matrix: Soil

DATE	ICB/CCB=	PREP BL	ANALYTE	CONC. UNITS µg/L
	CCB		Se	41
	CCB	✓	Ba	52, 130, 46
		✓	Pb	44
		✓	Se	60

2. Equipment/Trip Blanks

DATE	EQUIP BL =	ANALYTE	CONC. UNITS

3. Frequency Requirements

A. Was a preparation blank analyzed for each matrix, for every 20 samples, and for each digestion batch? [✓ Yes] or No

B. Was a calibration blank run at the beginning of the run, and every 10 samples or every 2 hours whichever is more frequent? [✓ Yes] or No

If no, the data may be affected. Use professional judgment to determine the severity of the effect and qualify the data accordingly. Discuss any actions below, and list the samples affected:

IV B. BLANK ANALYSIS RESULTS (Section 4)

4. Blank Actions

The Action Level for any analyte is equal to 5X the highest concentration of that analyte found in any blank. (Use 5X the absolute value for any negative blank results). The Action Level for samples which have been concentrated or diluted should be multiplied by the concentration/dilution factor. No positive result should be reported unless the concentration of the analyte in the sample exceeds the Action Level (AL) for that analyte. Specific actions are as follows:

1. When the concentration is greater than the IDL but less than the Action Level, report the sample concentration detected with a U.

2. When the sample concentration is greater than the Action Level, report the sample concentration unqualified.

Matrix: Soil

Matrix: ______

ELEMENT	MAX. CONC. UNITS µg/l	AL UNITS µg/L	ELEMENT	MAX. CONC. UNITS	AL UNIT
Ba	130	650			
Pb	44	220			
Se	60	300			

NOTE: Blanks analyzed during a soil case must be converted to mg/kg in order to compare them with the sample results.

$$\text{conc. in ug/l} \times \frac{\text{Volume diluted to (200ml)}}{\text{Weight digested (1gram)}} \times \frac{1L}{1000ml} \times \frac{1000g}{1kg} \times \frac{1mg}{1000ug} = mg/kg$$

Multiplying this result by 5 to arrive at the Action Level gives a final result in mg/kg which can then be compared to sample results

Ba: 4$, 4D, 6$, 6D, 8$, 8D, 10$, 10D, K10D, 12$, 12D, 14D

Se: 6$, 6D, 10D, 12D

Pb: 10$, 10D, 12$, 12D, 14$, 14D

XIII. SAMPLE QUANTITATION (continued)

List the positive sample results that were reported at concentrations less than ~~3xIDL~~ RL > MDL and have not already been qualified. The positive results have been estimated (J) due to uncertainty in the quantitation near the IDL.

Analyte	Samples Affected
As	4$, 4D, 8$, 120, 14$
Ba	4D, 6$, 6D, 8$,
Cd	6D, 12$, 12D,
Cr	4$, 40, 6D, 12D, 14$
Pb	10$, 10D, 12$, 120, 14$, 14D
Se	6$, 6D, 10D, 12D
Ag	4$, 4D, 6$, 6D, 8$, 8D, 14D

Appendix J

March 2003 Site Investigation Laboratory Analytical Reports

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-1/0-1
Lab ID: B0417-01A
Matrix: Soil, 87% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/10/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/2/03 F1, 4/2/03 F2
Dilution: 2.5

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	15,000	8,300
C19 - C36 Aliphatics	150,000	11,000
C11 - C22 Aromatics	120,000	23,000
Target Analytes		
Acenaphthene	ND	1,400
Acenaphthylene	ND	1,400
Anthracene	ND	1,400
Benzo(a)anthracene	2,200	1,400
Benzo(a)pyrene	1,700	1,400
Benzo(b)fluoranthene	2,700	1,400
Benzo(ghi)perylene	ND	1,400
Benzo(k)fluoranthene	ND	1,400
Chrysene	2,300	1,400
Dibenzo(a,h)anthracene	ND	1,400
Fluoranthene	4,900	1,400
Fluorene	ND	1,400
Indeno(1,2,3-cd)pyrene	ND	1,400
Naphthalene	ND	1,400
Phenanthrene	3,700	1,400
Pyrene	4,500	1,400
2-Methylnaphthalene	ND	1,400

SP
5/16/03

QC Batch: MB-6143

Surrogate Recovery (%):	
Chlorooctadecane	65%
o-Terphenyl	74%
2-Fluorobiphenyl	90%
2-Bromonaphthalene	54%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-1/5-7
Lab ID: B0417-02A
Matrix: Soil, 79% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/10/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/2/03 F1, 4/2/03 F2
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	ND	3,500
C19 - C36 Aliphatics	5,500	4,700
C11 - C22 Aromatics	51,000	10,000
Target Analytes		
Acenaphthene	ND	590
Acenaphthylene	ND	590
Anthracene	ND	590
Benzo(a)anthracene	820	590
Benzo(a)pyrene	590	590
Benzo(b)fluoranthene	920	590
Benzo(ghi)perylene	ND	590
Benzo(k)fluoranthene	ND	590
Chrysene	880	590
Dibenzo(a,h)anthracene	ND	590
Fluoranthene	1,800	590
Fluorene	ND	590
Indeno(1,2,3-cd)pyrene	ND	590
Naphthalene	ND	590
Phenanthrene	1,400	590
Pyrene	1,700	590
2-Methylnaphthalene	ND	590

EAP
5/16/03

QC Batch: MB-6143

Surrogate Recovery (%):	
Chlorooctadecane	57%
o-Terphenyl	65%
2-Fluorobiphenyl	102%
2-Bromonaphthalene	100%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-1/17-19
Lab ID: B0417-03A
Matrix: Soil, 80% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/10/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/2/03 F1, 4/2/03 F2
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	5,800	3,600
C19 - C36 Aliphatics	9,400	4,800
C11 - C22 Aromatics	25,000	10,000
Target Analytes		
Acenaphthene	ND	600
Acenaphthylene	ND	600
Anthracene	ND	600
Benzo(a)anthracene	ND	600
Benzo(a)pyrene	ND	600
Benzo(b)fluoranthene	ND	600
Benzo(ghi)perylene	ND	600
Benzo(k)fluoranthene	ND	600
Chrysene	ND	600
Dibenzo(a,h)anthracene	ND	600
Fluoranthene	ND	600
Fluorene	ND	600
Indeno(1,2,3-cd)pyrene	ND	600
Naphthalene	ND	600
Phenanthrene	ND	600
Pyrene	ND	600
2-Methylnaphthalene	ND	600

EAD
5/16/03

QC Batch: MB-6143

Surrogate Recovery (%):	
Chlorooctadecane	63%
o-Terphenyl	69%
2-Fluorobiphenyl	99%
2-Bromonaphthalene	93%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-3/0-1
Lab ID: B0417-04A
Matrix: Soil, 81% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/10/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/2/03 F1, 4/2/03 F2
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	4,300	3,500
C19 - C36 Aliphatics	270,000	4,700
C11 - C22 Aromatics	110,000	9,900
Target Analytes		
Acenaphthene	ND	580
Acenaphthylene	ND	580
Anthracene	580	580
Benzo(a)anthracene	1,300	580
Benzo(a)pyrene	950	580
Benzo(b)fluoranthene	1,700	580
Benzo(ghi)perylene	ND	580
Benzo(k)fluoranthene	640	580
Chrysene	1,400	580
Dibenzo(a,h)anthracene	ND	580
Fluoranthene	2,800	580
Fluorene	ND	580
Indeno(1,2,3-cd)pyrene	ND	580
Naphthalene	740	580
Phenanthrene	1,800	580
Pyrene	2,600	580
2-Methylnaphthalene	ND	580

EAD
5/16/03

Surrogate Recovery (%):	
Chlorooctadecane	54%
o-Terphenyl	55%
2-Fluorobiphenyl	92%
2-Bromonaphthalene	87%

QC Batch: MB-6143

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-3/7-9
Lab ID: B0417-05A
Matrix: Soil, 84% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/10/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/3/03 F1, 4/2/03 F2
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	ND	3,400
C19 - C36 Aliphatics	ND	4,500
C11 - C22 Aromatics	15,000	10,000
Target Analytes		
Acenaphthene	ND	560
Acenaphthylene	ND	560
Anthracene	ND	560
Benzo(a)anthracene	ND	560
Benzo(a)pyrene	ND	560
Benzo(b)fluoranthene	ND	560
Benzo(ghi)perylene	ND	560
Benzo(k)fluoranthene	ND	560
Chrysene	ND	560
Dibenzo(a,h)anthracene	ND	560
Fluoranthene	740	560
Fluorene	ND	560
Indeno(1,2,3-cd)pyrene	ND	560
Naphthalene	ND	560
Phenanthrene	ND	560
Pyrene	630	560
2-Methylnaphthalene	ND	560

SD
5/16/03

QC Batch: MB-6143

Surrogate Recovery (%):	
Chlorooctadecane	41%
o-Terphenyl	40%
2-Fluorobiphenyl	124%
2-Bromonaphthalene	111%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-3/13-15
Lab ID: B0417-06A
Matrix: Soil, 82% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/10/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/2/03 F1, 4/2/03 F2
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	ND	3,400
C19 - C36 Aliphatics	14,000	4,600
C11 - C22 Aromatics	ND	9,800
Target Analytes		
Acenaphthene	ND	580
Acenaphthylene	ND	580
Anthracene	ND	580
Benzo(a)anthracene	ND	580
Benzo(a)pyrene	ND	580
Benzo(b)fluoranthene	ND	580
Benzo(ghi)perylene	ND	580
Benzo(k)fluoranthene	ND	580
Chrysene	ND	580
Dibenzo(a,h)anthracene	ND	580
Fluoranthene	ND	580
Fluorene	ND	580
Indeno(1,2,3-cd)pyrene	ND	580
Naphthalene	ND	580
Phenanthrene	ND	580
Pyrene	ND	580
2-Methylnaphthalene	ND	580

EAD
8/16/03

QC Batch: MB-6143

Surrogate Recovery (%):	
Chlorooctadecane	63%
o-Terphenyl	67%
2-Fluorobiphenyl	88%
2-Bromonaphthalene	88%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-2/0-1
Lab ID: B0417-07A
Matrix: Soil, 75% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/11/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/3/03 F1, 4/3/03 F2
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	4,700	3,900
C19 - C36 Aliphatics	38,000	5,200
C11 - C22 Aromatics	49,000	11,000
Target Analytes		
Acenaphthene	ND	650
Acenaphthylene	ND	650
Anthracene	ND	650
Benzo(a)anthracene	1,300	650
Benzo(a)pyrene	1,100	650
Benzo(b)fluoranthene	1,800	650
Benzo(ghi)perylene	ND	650
Benzo(k)fluoranthene	820	650
Chrysene	1,400	650
Dibenzo(a,h)anthracene	ND	650
Fluoranthene	2,700	650
Fluorene	ND	650
Indeno(1,2,3-cd)pyrene	ND	650
Naphthalene	ND	650
Phenanthrene	1,500	650
Pyrene	2,600	650
2-Methylnaphthalene	ND	650

SAD
8/16/03

QC Batch: MB-6143

Surrogate Recovery (%):	
Chlorooctadecane	49%
o-Terphenyl	53%
2-Fluorobiphenyl	92%
2-Bromonaphthalene	82%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-2/7-9
Lab ID: B0417-08A
Matrix: Soil, 84% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/11/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/3/03 F1, 4/3/03 F2
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	ND	3,400
C19 - C36 Aliphatics	13,000	4,600
C11 - C22 Aromatics	34,000	9,700
Target Analytes		
Acenaphthene	ND	570
Acenaphthylene	ND	570
Anthracene	ND	570
Benzo(a)anthracene	1,200	570
Benzo(a)pyrene	940	570
Benzo(b)fluoranthene	1,500	570
Benzo(ghi)perylene	ND	570
Benzo(k)fluoranthene	610	570
Chrysene	1,300	570
Dibenzo(a,h)anthracene	ND	570
Fluoranthene	2,700	570
Fluorene	ND	570
Indeno(1,2,3-cd)pyrene	ND	570
Naphthalene	ND	570
Phenanthrene	1,600	570
Pyrene	2,500	570
2-Methylnaphthalene	ND	570

EAD
5/16/03

QC Batch: MB-6143

Surrogate Recovery (%):	
Chlorooctadecane	56%
o-Terphenyl	63%
2-Fluorobiphenyl	99%
2-Bromonaphthalene	99%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-2/11-13
Lab ID: B0417-09A
Matrix: Soil, 91% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/11/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/3/03 F1, 4/3/03 F2
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	18,000	3,100
C19 - C36 Aliphatics	23,000	4,200
C11 - C22 Aromatics	52,000	8,900
Target Analytes		
Acenaphthene	ND	520
Acenaphthylene	ND	520
Anthracene	ND	520
Benzo(a)anthracene	710	520
Benzo(a)pyrene	ND	520
Benzo(b)fluoranthene	800	520
Benzo(ghi)perylene	ND	520
Benzo(k)fluoranthene	ND	520
Chrysene	760	520
Dibenzo(a,h)anthracene	ND	520
Fluoranthene	1,800	520
Fluorene	ND	520
Indeno(1,2,3-cd)pyrene	ND	520
Naphthalene	ND	520
Phenanthrene	1,000	520
Pyrene	1,500	520
2-Methylnaphthalene	ND	520

EAD
5/16/03

QC Batch: MB-6143

Surrogate Recovery (%):	
Chlorooctadecane	59%
o-Terphenyl	68%
2-Fluorobiphenyl	96%
2-Bromonaphthalene	94%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-8/0-1
Lab ID: B0417-10A
Matrix: Soil, 84% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/11/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/3/03 F1, 4/3/03 F2
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	4,500	3,500
C19 - C36 Aliphatics	13,000	4,700
C11 - C22 Aromatics	45,000	9,900
Target Analytes		
Acenaphthene	ND	580
Acenaphthylene	ND	580
Anthracene	ND	580
Benzo(a)anthracene	1,400	580
Benzo(a)pyrene	1,100	580
Benzo(b)fluoranthene	1,900	580
Benzo(ghi)perylene	ND	580
Benzo(k)fluoranthene	690	580
Chrysene	1,600	580
Dibenzo(a,h)anthracene	ND	580
Fluoranthene	3,100	580
Fluorene	ND	580
Indeno(1,2,3-cd)pyrene	ND	580
Naphthalene	ND	580
Phenanthrene	2,000	580
Pyrene	2,900	580
2-Methylnaphthalene	ND	580

EAD
5/16/03

QC Batch: MB-6143

Surrogate Recovery (%):	
Chlorooctadecane	50%
o-Terphenyl	57%
2-Fluorobiphenyl	90%
2-Bromonaphthalene	89%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-8/7-9
Lab ID: B0417-11A
Matrix: Soil, 85% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/11/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/3/03 F1, 4/3/03 F2
Dilution: 1

EPH Ranges	Results		Reporting Limits
C9 - C18 Aliphatics	ND	UJ	3,300
C19 - C36 Aliphatics	9,700	J	4,400
C11 - C22 Aromatics	96,000		9,400
Target Analytes			
Acenaphthene	1,900		560
Acenaphthylene	ND		560
Anthracene	2,900		560
Benzo(a)anthracene	5,000		560
Benzo(a)pyrene	3,300		560
Benzo(b)fluoranthene	5,400		560
Benzo(ghi)perylene	1,600		560
Benzo(k)fluoranthene	2,000		560
Chrysene	4,900		560
Dibenzo(a,h)anthracene	610		560
Fluoranthene	13,000		560
Fluorene	1,700		560
Indeno(1,2,3-cd)pyrene	2,100		560
Naphthalene	1,100		560
Phenanthrene	12,000		560
Pyrene	12,000		560
2-Methylnaphthalene	ND		560

EAD
5/16/03

Surrogate Recovery (%):

Chlorooctadecane	35%
o-Terphenyl	40%
2-Fluorobiphenyl	88%
2-Bromonaphthalene	74%

QC Batch: MB-6143

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-8/7-9RE
Lab ID: B0417-11ARE
Matrix: Soil, 85% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/11/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/3/03 F1
Dilution: 1

EPH Ranges	Results	Reporting Limits
~~C9 - C18 Aliphatics~~	~~ND~~	~~3,300~~
~~C19 - C36 Aliphatics~~	~~12,000~~	~~4,400~~

☆ EAD 5/16/03

☆ results reported from original analysis

Surrogate Recovery (%):
Chlorooctadecane 36%

QC Batch: MB-6143

ND= Not Detected

Only the aliphatics fraction was reanalyzed to confirm low surrogate recovery.

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-9/0-1
Lab ID: B0417-12A
Matrix: Soil, 70% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/11/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/3/03 F1, 4/3/03 F2
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	26,000	3,900
C19 - C36 Aliphatics	30,000	5,200
C11 - C22 Aromatics	66,000	11,000
Target Analytes		
Acenaphthene	ND	660
Acenaphthylene	950	660
Anthracene	1,800	660
Benzo(a)anthracene	1,200	660
Benzo(a)pyrene	ND	660
Benzo(b)fluoranthene	1,900	660
Benzo(ghi)perylene	ND	660
Benzo(k)fluoranthene	790	660
Chrysene	1,800	660
Dibenzo(a,h)anthracene	ND	660
Fluoranthene	4,200	660
Fluorene	ND	660
Indeno(1,2,3-cd)pyrene	ND	660
Naphthalene	ND	660
Phenanthrene	3,800	660
Pyrene	3,900	660
2-Methylnaphthalene	ND	660

SAD
5/16/03

Surrogate Recovery (%):	
Chlorooctadecane	61%
o-Terphenyl	63%
2-Fluorobiphenyl	94%
2-Bromonaphthalene	98%

QC Batch: MB-6143

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-9/5-7
Lab ID: B0417-13A
Matrix: Soil, 87% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/11/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/3/03 F1, 4/3/03 F2
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	5,000	3,300
C19 - C36 Aliphatics	17,000	4,500
C11 - C22 Aromatics	58,000	9,500
Target Analytes		
Acenaphthene	640	560
Acenaphthylene	ND	560
Anthracene	1,200	560
Benzo(a)anthracene	2,600	560
Benzo(a)pyrene	1,900	560
Benzo(b)fluoranthene	3,000	560
Benzo(ghi)perylene	ND	560
Benzo(k)fluoranthene	1,200	560
Chrysene	2,600	560
Dibenzo(a,h)anthracene	ND	560
Fluoranthene	6,000	560
Fluorene	570	560
Indeno(1,2,3-cd)pyrene	1,200	560
Naphthalene	ND	560
Phenanthrene	4,400	560
Pyrene	5,600	560
2-Methylnaphthalene	ND	560

EAD
5/16/03

QC Batch: MB-6143

Surrogate Recovery (%):	
Chlorooctadecane	46%
o-Terphenyl	53%
2-Fluorobiphenyl	86%
2-Bromonaphthalene	85%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-10/0-1
Lab ID: B0417-14A
Matrix: Soil, 85% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/12/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/3/03 F1, 4/3/03 F2
Dilution: 2.5

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	20,000	8,500
C19 - C36 Aliphatics	54,000	11,000
C11 - C22 Aromatics	190,000	24,000
Target Analytes		
Acenaphthene	ND	1,400
Acenaphthylene	ND	1,400
Anthracene	2,200	1,400
Benzo(a)anthracene	7,700	1,400
Benzo(a)pyrene	6,100	1,400
Benzo(b)fluoranthene	10,000	1,400
Benzo(ghi)perylene	ND	1,400
Benzo(k)fluoranthene	3,700	1,400
Chrysene	7,800	1,400
Dibenzo(a,h)anthracene	ND	1,400
Fluoranthene	15,000	1,400
Fluorene	ND	1,400
Indeno(1,2,3-cd)pyrene	5,000	1,400
Naphthalene	ND	1,400
Phenanthrene	8,100	1,400
Pyrene	15,000	1,400
2-Methylnaphthalene	ND	1,400

EAD
5/16/03

Surrogate Recovery (%):	
Chlorooctadecane	56%
o-Terphenyl	84%
2-Fluorobiphenyl	91%
2-Bromonaphthalene	63%

QC Batch: MB-6143

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-10/9-11
Lab ID: B0417-15A
Matrix: Soil, 91% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/12/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/3/03 F1, 4/3/03 F2
Dilution: 1

EPH Ranges	Results		Reporting Limits
C9 - C18 Aliphatics	460,000		3,200
C19 - C36 Aliphatics	76,000		4,200
C11 - C22 Aromatics	280,000		9,000
Target Analytes			
Acenaphthene	ND	UJ	530
Acenaphthylene	ND	UJ	530
Anthracene	ND		530
Benzo(a)anthracene	910		530
Benzo(a)pyrene	800		530
Benzo(b)fluoranthene	1,200	J	530
Benzo(ghi)perylene	ND		530
Benzo(k)fluoranthene	ND		530
Chrysene	1,000		530
Dibenzo(a,h)anthracene	ND		530
Fluoranthene	2,200	J	530
Fluorene	2,100		530
Indeno(1,2,3-cd)pyrene	ND		530
Naphthalene	620		530
Phenanthrene	2,500		530
Pyrene	1,900	J	530
2-Methylnaphthalene	960		530

EAD
5/16/03

QC Batch: MB-6143

Surrogate Recovery (%):	
Chlorooctadecane	50%
o-Terphenyl	59%
2-Fluorobiphenyl	103%
2-Bromonaphthalene	64%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.	
Analysis: MADEP EPH 98-1	Date Collected: 3/12/03
Client ID: KSB-10/9-11	Date Received: 3/12/03
Lab ID: B0417-16A	Date Extracted: 3/17/03
Matrix: Soil, 91% Solid	Date Analyzed: 4/3/03 F1, 4/3/03 F2
Concentration in: ug/kg, dry weight basis	Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	380,000	3,200
C19 - C36 Aliphatics	60,000	4,300
C11 - C22 Aromatics	280,000	9,200
Target Analytes		
Acenaphthene	1,200J	540
Acenaphthylene	1,900J	540
Anthracene	ND	540
Benzo(a)anthracene	ND	540
Benzo(a)pyrene	ND	540
Benzo(b)fluoranthene	ND UJ	540
Benzo(ghi)perylene	ND	540
Benzo(k)fluoranthene	ND	540
Chrysene	ND	540
Dibenzo(a,h)anthracene	ND	540
Fluoranthene	ND UJ	540
Fluorene	2,100	540
Indeno(1,2,3-cd)pyrene	ND	540
Naphthalene	850	540
Phenanthrene	1,500	540
Pyrene	ND UJ	540
2-Methylnaphthalene	1,100	540

EAD
5/16/03

QC Batch: MB-6143

Surrogate Recovery (%):	
Chlorooctadecane	40%
o-Terphenyl	54%
2-Fluorobiphenyl	106%
2-Bromonaphthalene	70%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

021R

MITKEM CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-10/13-15
Lab ID: B0417-17A
Matrix: Soil, 85% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/12/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/3/03 F1, 4/3/03 F2
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	150,000	3,400
C19 - C36 Aliphatics	32,000	4,500
C11 - C22 Aromatics	140,000	9,500
Target Analytes		
Acenaphthene	ND	560
Acenaphthylene	970	560
Anthracene	ND	560
Benzo(a)anthracene	ND	560
Benzo(a)pyrene	ND	560
Benzo(b)fluoranthene	ND	560
Benzo(ghi)perylene	ND	560
Benzo(k)fluoranthene	ND	560
Chrysene	ND	560
Dibenzo(a,h)anthracene	ND	560
Fluoranthene	ND	560
Fluorene	1,000	560
Indeno(1,2,3-cd)pyrene	ND	560
Naphthalene	ND	560
Phenanthrene	750	560
Pyrene	ND	560
2-Methylnaphthalene	2,000	560

SAD
5/16/03

QC Batch: MB-6143

Surrogate Recovery (%):	
Chlorooctadecane	51%
o-Terphenyl	65%
2-Fluorobiphenyl	100%
2-Bromonaphthalene	80%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-9/13-15
Lab ID: B0417-18A
Matrix: Soil, 85% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/12/03
Date Received: 3/12/03
Date Extracted: 3/17/03
Date Analyzed: 4/3/03 F1, 4/3/03 F2
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	6,000	3,400
C19 - C36 Aliphatics	ND	4,500
C11 - C22 Aromatics	ND	9,600
Target Analytes		
Acenaphthene	ND	570
Acenaphthylene	ND	570
Anthracene	ND	570
Benzo(a)anthracene	ND	570
Benzo(a)pyrene	ND	570
Benzo(b)fluoranthene	ND	570
Benzo(ghi)perylene	ND	570
Benzo(k)fluoranthene	ND	570
Chrysene	ND	570
Dibenzo(a,h)anthracene	ND	570
Fluoranthene	ND	570
Fluorene	ND	570
Indeno(1,2,3-cd)pyrene	ND	570
Naphthalene	ND	570
Phenanthrene	ND	570
Pyrene	ND	570
2-Methylnaphthalene	ND	570

EAD
5/16/03

QC Batch: MB-6143

Surrogate Recovery (%):	
Chlorooctadecane	67%
o-Terphenyl	74%
2-Fluorobiphenyl	97%
2-Bromonaphthalene	90%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.
SB-1/0-1

Lab Name: MITKEM CORPORATION
Contract:
Lab Code: MITKEM
Case No.:
SAS No.:
SDG No.: B0417
Matrix: (soil/water) SOIL
Lab Sample ID: B0417-01A
Sample wt/vol: 30.4 (g/mL) G
Lab File ID: E1E0184F
% Moisture: 13
decanted: (Y/N) N
Date Received: 03/12/03
Extraction: (SepF/Cont/Sonc) SONC
Date Extracted: 03/24/03
Concentrated Extract Volume: 10000(uL)
Date Analyzed: 03/27/03
Injection Volume: 1.0(uL)
Dilution Factor: 1.0
GPC Cleanup: (Y/N) N
pH: ___
Sulfur Cleanup: (Y/N) Y

5/16/0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	------Aroclor-1016	38	U
11104-28-2	------Aroclor-1221	38	U
11141-16-5	------Aroclor-1232	38	U
53469-21-9	------Aroclor-1242	38	U
12672-29-6	------Aroclor-1248	38	U
11097-69-1	------Aroclor-1254	1800	J
11096-82-5	------Aroclor-1260	38	U J

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-1/5-7

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix: (soil/water) SOIL Lab Sample ID: B0417-02A

Sample wt/vol: 30.4 (g/mL) G Lab File ID: E1E0221F

% Moisture: 21 decanted: (Y/N) N Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/24/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 03/28/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

EAD 5/16/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	42	U
11104-28-2	Aroclor-1221	42	U
11141-16-5	Aroclor-1232	42	U
53469-21-9	Aroclor-1242	42	U
12672-29-6	Aroclor-1248	42	U
11097-69-1	Aroclor-1254	42	U
11096-82-5	Aroclor-1260	42	UJ

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-1/17-19

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix: (soil/water) SOIL Lab Sample ID: B0417-03A

Sample wt/vol: 30.2 (g/mL) G Lab File ID: E1E0222F

% Moisture: 20 decanted: (Y/N) N Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/24/03

Concentrated Extract Volume: 10000 (uL) Date Analyzed: 03/28/03

Injection Volume: 1.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

EAD
5/16/0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	------Aroclor-1016	41	U
11104-28-2	------Aroclor-1221	41	U
11141-16-5	------Aroclor-1232	41	U
53469-21-9	------Aroclor-1242	41	U
12672-29-6	------Aroclor-1248	41	U
11097-69-1	------Aroclor-1254	41	U
11096-82-5	------Aroclor-1260	41	UJ

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-3/0-1

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix: (soil/water) SOIL Lab Sample ID: B0417-04A

Sample wt/vol: 30.4 (g/mL) G Lab File ID: E1E0187F

% Moisture: 19 decanted: (Y/N) N Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/24/03

Concentrated Extract Volume: 10000 (uL) Date Analyzed: 03/27/03

Injection Volume: 1.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2------	Aroclor-1016	41	U
11104-28-2------	Aroclor-1221	41	U
11141-16-5------	Aroclor-1232	41	U
53469-21-9------	Aroclor-1242	41	U
12672-29-6------	Aroclor-1248	41	U
11097-69-1------	Aroclor-1254	95	
11096-82-5------	Aroclor-1260	41	U J

SD
8/16/03

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-3/7-9

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix: (soil/water) SOIL Lab Sample ID: B0417-05A

Sample wt/vol: 30.7 (g/mL) G Lab File ID: E1E0188F

% Moisture: 16 decanted: (Y/N) N Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/24/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 03/27/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

5/16/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	------Aroclor-1016	39	U
11104-28-2	------Aroclor-1221	39	U
11141-16-5	------Aroclor-1232	39	U
53469-21-9	------Aroclor-1242	39	U
12672-29-6	------Aroclor-1248	39	U
11097-69-1	------Aroclor-1254	44	
11096-82-5	------Aroclor-1260	39	UJ

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.
SB-3/13-15

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix: (soil/water) SOIL Lab Sample ID: B0417-06A

Sample wt/vol: 30.3 (g/mL) G Lab File ID: E1E0189F

% Moisture: 18 decanted: (Y/N) N Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/24/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 03/27/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

5/16/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	40	U
11104-28-2	Aroclor-1221	40	U
11141-16-5	Aroclor-1232	40	U
53469-21-9	Aroclor-1242	40	U
12672-29-6	Aroclor-1248	40	U
11097-69-1	Aroclor-1254	40	U J
11096-82-5	Aroclor-1260	40	U J

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-2/0-1

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix: (soil/water) SOIL Lab Sample ID: B0417-07A

Sample wt/vol: 30.3 (g/mL) G Lab File ID: E1E0190F

% Moisture: 25 decanted: (Y/N) N Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/24/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 03/27/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

5/16/0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	44	U
11104-28-2	Aroclor-1221	44	U
11141-16-5	Aroclor-1232	44	U
53469-21-9	Aroclor-1242	44	U
12672-29-6	Aroclor-1248	44	U
11097-69-1	Aroclor-1254	44	U J
11096-82-5	Aroclor-1260	44	U J

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-2/7-9

Lab Name: MITKEM CORPORATION   Contract:

Lab Code: MITKEM   Case No.:   SAS No.:   SDG No.: B0417

Matrix: (soil/water) SOIL   Lab Sample ID: B0417-08A

Sample wt/vol: 30.4 (g/mL) G   Lab File ID: E1E0191F

% Moisture: 16   decanted: (Y/N) N   Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC   Date Extracted: 03/24/03

Concentrated Extract Volume: 10000 (uL)   Date Analyzed: 03/27/03

Injection Volume: 1.0 (uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: ___   Sulfur Cleanup: (Y/N) Y

EAD
8/16/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	------Aroclor-1016	39	U
11104-28-2	------Aroclor-1221	39	U
11141-16-5	------Aroclor-1232	39	U
53469-21-9	------Aroclor-1242	39	U
12672-29-6	------Aroclor-1248	39	U
11097-69-1	------Aroclor-1254	39	UJ
11096-82-5	------Aroclor-1260	39	UJ

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-2/7-9

Lab Name: MITKEM CORPORATION   Contract:

Lab Code: MITKEM   Case No.:   SAS No.:   SDG No.: B0417

Matrix: (soil/water) SOIL   Lab Sample ID: B0417-08A

Sample wt/vol: 30.4 (g/mL) G   Lab File ID: E1E0191F

% Moisture: 16   decanted: (Y/N) N   Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC   Date Extracted: 03/24/03

Concentrated Extract Volume: 10000(uL)   Date Analyzed: 03/27/03

Injection Volume: 1.0(uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: ___   Sulfur Cleanup: (Y/N) Y

EAD
8/16/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	39	U
11104-28-2	Aroclor-1221	39	U
11141-16-5	Aroclor-1232	39	U
53469-21-9	Aroclor-1242	39	U
12672-29-6	Aroclor-1248	39	U
11097-69-1	Aroclor-1254	39	UJ
11096-82-5	Aroclor-1260	39	UJ

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-10/0-1

Lab Name: MITKEM CORPORATION   Contract:

Lab Code: MITKEM   Case No.:   SAS No.:   SDG No.: B0417

Matrix: (soil/water) SOIL   Lab Sample ID: B0417-14A

Sample wt/vol: 30.5 (g/mL) G   Lab File ID: E1E0203F

% Moisture: 15   decanted: (Y/N) N   Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC   Date Extracted: 03/24/03

Concentrated Extract Volume: 10000 (uL)   Date Analyzed: 03/28/03

Injection Volume: 1.0 (uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: ___   Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	38	U
11104-28-2	Aroclor-1221	38	U
11141-16-5	Aroclor-1232	38	U
53469-21-9	Aroclor-1242	38	U
12672-29-6	Aroclor-1248	38	U
11097-69-1	Aroclor-1254	600	
11096-82-5	Aroclor-1260	38	UJ

SAD
8/16/0

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-10/9-11

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix: (soil/water) SOIL Lab Sample ID: B0417-15A

Sample wt/vol: 30.4 (g/mL) G Lab File ID: E1E0223F

% Moisture: 9 decanted: (Y/N) N Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/24/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 03/28/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	36	U
11104-28-2	Aroclor-1221	36	U
11141-16-5	Aroclor-1232	36	U
53469-21-9	Aroclor-1242	36	U
12672-29-6	Aroclor-1248	36	U
11097-69-1	Aroclor-1254	36	U
11096-82-5	Aroclor-1260	36	UJ

SD
5/16/

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

KSB-10/9-11

Lab Name: MITKEM CORPORATION   Contract:

Lab Code: MITKEM   Case No.:   SAS No.:   SDG No.: B0417

Matrix: (soil/water) SOIL   Lab Sample ID: B0417-16A

Sample wt/vol: 30.7 (g/mL) G   Lab File ID: E1B0205F

% Moisture: 9   decanted: (Y/N) N   Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC   Date Extracted: 03/24/03

Concentrated Extract Volume: 10000(uL)   Date Analyzed: 03/28/03

Injection Volume: 1.0(uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: ___   Sulfur Cleanup: (Y/N) Y

SAD 5/16/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	36	U
11104-28-2	Aroclor-1221	36	U
11141-16-5	Aroclor-1232	36	U
53469-21-9	Aroclor-1242	36	U
12672-29-6	Aroclor-1248	36	U
11097-69-1	Aroclor-1254	36	U
11096-82-5	Aroclor-1260	36	U J

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-10/13-15

Lab Name: MITKEM CORPORATION   Contract:

Lab Code: MITKEM   Case No.:   SAS No.:   SDG No.: B0417

Matrix: (soil/water) SOIL   Lab Sample ID: B0417-17A

Sample wt/vol: 30.2 (g/mL) G   Lab File ID: E1E0206F

% Moisture: 15   decanted: (Y/N) N   Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC   Date Extracted: 03/24/03

Concentrated Extract Volume: 10000(uL)   Date Analyzed: 03/28/03

Injection Volume: 1.0(uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: ___   Sulfur Cleanup: (Y/N) Y

5/16/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	39	U
11104-28-2	Aroclor-1221	39	U
11141-16-5	Aroclor-1232	39	U
53469-21-9	Aroclor-1242	39	U
12672-29-6	Aroclor-1248	39	U
11097-69-1	Aroclor-1254	39	U
11096-82-5	Aroclor-1260	39	U J

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-9/13-15

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix: (soil/water) SOIL Lab Sample ID: B0417-18A

Sample wt/vol: 30.6 (g/mL) G Lab File ID: E1E0207F

% Moisture: 15 decanted: (Y/N) N Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/24/03

Concentrated Extract Volume: 10000 (uL) Date Analyzed: 03/28/03

Injection Volume: 1.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	------Aroclor-1016	38	U
11104-28-2	------Aroclor-1221	38	U
11141-16-5	------Aroclor-1232	38	U
53469-21-9	------Aroclor-1242	38	U
12672-29-6	------Aroclor-1248	38	U
11097-69-1	------Aroclor-1254	38	U
11096-82-5	------Aroclor-1260	38	U J

SAD
5/16/03

FORM I PCB

1
INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-1/0-1

Lab Name: MITKEM_CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix (soil/water): SOIL Lab Sample ID: B0417-01A

Level (low/med): MED Date Received: 03/12/03

% Solids: 87.0

Concentration Units (ug/L or mg/kg dry weight): MG/KG

EAD
5/16/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	8.8	J	~~*N~~	P
7440-38-2	Arsenic	9.3	J	~~*~~	P
7440-39-3	Barium	68.4	J	~~E~~	P
7440-41-7	Beryllium	0.98		~~*~~	P
7440-43-9	Cadmium	1.2			P
7440-70-2	Calcium				NR
7440-47-3	Chromium	25.2			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	37.3	J	~~*~~	P
7439-89-6	Iron				NR
7439-92-1	Lead	1970	J	~~E~~*	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.53			CV
7440-02-0	Nickel	22.7	J	~~E~~*	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.45	U		P
7440-22-4	Silver	0.87	J ~~B~~	~~*~~ [illegible]	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1.0 ~~0.34~~	UJ ~~B~~		P
7440-62-2	Vanadium	30.7	J	~~*~~	P
7440-66-6	Zinc	79.2	J	~~E~~	P
	Cyanide				NR

Color Before: Clarity Before: Texture:

Color After: Clarity After: Artifacts:

Comments:

097R

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-9/0-1

Lab Name: MITKEM CORPORATION   Contract:

Lab Code: MITKEM   Case No.:   SAS No.:   SDG No.: B0417

Matrix: (soil/water) SOIL   Lab Sample ID: B0417-12A

Sample wt/vol: 30.3 (g/mL) G   Lab File ID: E1E0201F

% Moisture: 30   decanted: (Y/N) N   Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC   Date Extracted: 03/24/03

Concentrated Extract Volume: 10000(uL)   Date Analyzed: 03/28/03

Injection Volume: 1.0(uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: ___   Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	------Aroclor-1016	47	U
11104-28-2	------Aroclor-1221	47	U
11141-16-5	------Aroclor-1232	47	U
53469-21-9	------Aroclor-1242	47	U
12672-29-6	------Aroclor-1248	47	U
11097-69-1	------Aroclor-1254	170	
11096-82-5	------Aroclor-1260	47	U J

EAD
5/16/03

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-9/5-7

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix: (soil/water) SOIL Lab Sample ID: B0417-13A

Sample wt/vol: 30.3 (g/mL) G Lab File ID: E1B0202F

% Moisture: 13 decanted: (Y/N) N Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/24/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 03/28/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

SAD
5/16/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	------Aroclor-1016	38	U
11104-28-2	------Aroclor-1221	38	U
11141-16-5	------Aroclor-1232	38	U
53469-21-9	------Aroclor-1242	38	U
12672-29-6	------Aroclor-1248	38	U
11097-69-1	------Aroclor-1254	71	
11096-82-5	------Aroclor-1260	38	U J

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-10/0-1

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix: (soil/water) SOIL Lab Sample ID: B0417-14A

Sample wt/vol: 30.5 (g/mL) G Lab File ID: E1E0203F

% Moisture: 15 decanted: (Y/N) N Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/24/03

Concentrated Extract Volume: 10000 (uL) Date Analyzed: 03/28/03

Injection Volume: 1.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	38	U
11104-28-2	Aroclor-1221	38	U
11141-16-5	Aroclor-1232	38	U
53469-21-9	Aroclor-1242	38	U
12672-29-6	Aroclor-1248	38	U
11097-69-1	Aroclor-1254	600	
11096-82-5	Aroclor-1260	38	UJ

SAD
5/16/05

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-10/9-11

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix: (soil/water) SOIL Lab Sample ID: B0417-15A

Sample wt/vol: 30.4 (g/mL) G Lab File ID: E1E0223F

% Moisture: 9 decanted: (Y/N) N Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/24/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 03/28/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	36	U
11104-28-2	Aroclor-1221	36	U
11141-16-5	Aroclor-1232	36	U
53469-21-9	Aroclor-1242	36	U
12672-29-6	Aroclor-1248	36	U
11097-69-1	Aroclor-1254	36	U
11096-82-5	Aroclor-1260	36	UJ

SAD
5/16/3

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

KSB-10/9-11

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix: (soil/water) SOIL Lab Sample ID: B0417-16A

Sample wt/vol: 30.7 (g/mL) G Lab File ID: E1B0205F

% Moisture: 9 decanted: (Y/N) N Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/24/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 03/28/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

SAD
5/16/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	------Aroclor-1016	36	U
11104-28-2	------Aroclor-1221	36	U
11141-16-5	------Aroclor-1232	36	U
53469-21-9	------Aroclor-1242	36	U
12672-29-6	------Aroclor-1248	36	U
11097-69-1	------Aroclor-1254	36	U
11096-82-5	------Aroclor-1260	36	U J

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-10/13-15

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix: (soil/water) SOIL Lab Sample ID: B0417-17A

Sample wt/vol: 30.2 (g/mL) G Lab File ID: E1E0206F

% Moisture: 15 decanted: (Y/N) N Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/24/03

Concentrated Extract Volume: 10000 (uL) Date Analyzed: 03/28/03

Injection Volume: 1.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

SAD
5/16/0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	39	U
11104-28-2	Aroclor-1221	39	U
11141-16-5	Aroclor-1232	39	U
53469-21-9	Aroclor-1242	39	U
12672-29-6	Aroclor-1248	39	U
11097-69-1	Aroclor-1254	39	U
11096-82-5	Aroclor-1260	39	U J

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-9/13-15

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix: (soil/water) SOIL Lab Sample ID: B0417-18A

Sample wt/vol: 30.6 (g/mL) G Lab File ID: E1E0207F

% Moisture: 15 decanted: (Y/N) N Date Received: 03/12/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/24/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 03/28/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

SAD 5/16/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	38	U
11104-28-2	Aroclor-1221	38	U
11141-16-5	Aroclor-1232	38	U
53469-21-9	Aroclor-1242	38	U
12672-29-6	Aroclor-1248	38	U
11097-69-1	Aroclor-1254	38	U
11096-82-5	Aroclor-1260	38	U J

FORM I PCB

U.S. EPA - CLP

1
INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-1/0-1

Lab Name: MITKEM_CORPORATION________ Contract: ________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0417__

Matrix (soil/water): SOIL___ Lab Sample ID: B0417-01A____

Level (low/med): MED___ Date Received: 03/12/03___

% Solids: 87.0____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

EAD
5/16/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	8.8	J	~~*N~~	P
7440-38-2	Arsenic	9.3	J	/	P
7440-39-3	Barium	68.4	J	~~E~~	P
7440-41-7	Beryllium	0.98		/	P
7440-43-9	Cadmium	1.2			P
7440-70-2	Calcium				NR
7440-47-3	Chromium	25.2			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	37.3	J	/	P
7439-89-6	Iron				NR
7439-92-1	Lead	1970	J	~~E*~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.53			CV
7440-02-0	Nickel	22.7	J	~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.45	U		P
7440-22-4	Silver	0.87	J ~~B~~	/ 6(b)	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1.0 ~~0.54~~	UJ ~~B~~		P
7440-62-2	Vanadium	30.7	J	/	P
7440-66-6	Zinc	79.2	J	~~E~~	P
	Cyanide				NR

Color Before: ________ Clarity Before: ________ Texture: ________

Color After: ________ Clarity After: ________ Artifacts: ________

Comments:

FORM I - IN SW846

097R

U.S. EPA - CLP

1
INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-1/5-7

ab Name: MITKEM_CORPORATION________ Contract: __________

ab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0417__

Matrix (soil/water): SOIL___ Lab Sample ID: B0417-02A_____

evel (low/med): MED___ Date Received: 03/12/03____

% Solids: 79.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

EAD
5/16/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	2.1	U J	~~*N~~	P
7440-38-2	Arsenic	9.5	J	~~*~~	P
7440-39-3	Barium	47.8	J	~~E~~	P
7440-41-7	Beryllium	0.83		~~*~~	P
7440-43-9	Cadmium	0.46	U		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	20.4			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	49.8	J	~~*~~	P
7439-89-6	Iron				NR
7439-92-1	Lead	208	J	~~E~~*	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.21			CV
7440-02-0	Nickel	11.8	J	~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.53	U		P
7440-22-4	Silver	0.33	UJ ~~B~~	~~*~~ Eg 5/14/03	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1.2 ~~0.39~~	UJ ~~B~~		P
7440-62-2	Vanadium	14.4	J	~~*~~	P
7440-66-6	Zinc	115	J	~~E~~	P
	Cyanide				NR

Color Before: __________ Clarity Before: ________ Texture: _______

lor After: __________ Clarity After: ________ Artifacts: _______

mments:

FORM I - IN

SW846

U.S. EPA - CLP

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-1/17-19

Lab Name: MITKEM_CORPORATION_______ Contract: __________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0417__

Matrix (soil/water): SOIL____ Lab Sample ID: B0417-03A_____

Level (low/med): MED____ Date Received: 03/12/03____

% Solids: 80.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

EAD
5/16/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	0.25 UJ	~~B~~	*~~N~~	P
7440-38-2	Arsenic	2.3	J	~~*~~	P
7440-39-3	Barium	9.8 J	~~B~~	~~E~~	P
7440-41-7	Beryllium	0.44		~~*~~	P
7440-43-9	Cadmium	0.080 UJ	~~B~~		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	13.5			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	4.8	J	~~*~~	P
7439-89-6	Iron				NR
7439-92-1	Lead	3.5	J	~~E*~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.018	U		CV
7440-02-	Nickel	9.4	J	~~E*~~	P
7440-09-	Potassium				NR
7782-49-2	Selenium	0.48	U		P
7440-22-4	Silver	0.28 UJ	~~B~~	~~*~~ B (1.6x)	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1.1 ~~0.38~~ UJ	~~B~~		P
7440-62-2	Vanadium	7.7	J	~~*~~	P
7440-66-6	Zinc	25.2	J	~~E~~	P
	Cyanide				NR

Color Before: ________ Clarity Before: ________ Texture: ________

Color After: ________ Clarity After: ________ Artifacts: ________

Comments:

FORM I - IN SW846

0912

U.S. EPA - CLP

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-3/0-1

ab Name: MITKEM_CORPORATION________ Contract: __________

ab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0417__

Matrix (soil/water): SOIL____ Lab Sample ID: B0417-04A_____

evel (low/med): MED____ Date Received: 03/12/03____

% Solids: 81.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	1.4 UJ		~~*N~~	P
7440-38-2	Arsenic	14.8	J	~~*~~	P
7440-39-3	Barium	52.1	J	~~E~~	P
7440-41-7	Beryllium	0.75		~~*~~	P
7440-43-9	Cadmium	0.39	U		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	15.4			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	45.9	J	~~*~~	P
7439-89-6	Iron				NR
7439-92-1	Lead	142	J	~~E~~*	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.92			CV
7440-02-0	Nickel	36.2	J	~~E~~*	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.47	U		P
7440-22-4	Silver	0.11	U	~~*~~	P
7440-23-5	Sodium			E 5/16	NR
7440-28-0	Thallium	1.08 ~~0.16~~ UJ	B		P
7440-62-2	Vanadium	128	J	~~*~~	P
7440-66-6	Zinc	65.5	J	~~E~~	P
	Cyanide				NR

ED
5/16/03

olor Before: __________ Clarity Before: ________ Texture: ________

lor After: __________ Clarity After: ________ Artifacts: ________

omments:

FORM I - IN SW846

100p

1
INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-3/7-9

Lab Name: MITKEM_CORPORATION________ Contract: ________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0417__

Matrix (soil/water): SOIL____ Lab Sample ID: B0417-05A_____

Level (low/med): MED____ Date Received: 03/12/03____

% Solids: 84.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	0.36	UJ ~~B~~	~~N~~	P
7440-38-2	Arsenic	13.2	J	~~*~~	P
7440-39-3	Barium	42.7	J	~~E~~	P
7440-41-7	Beryllium	0.58		~~*~~	P
7440-43-9	Cadmium	0.23	UJ ~~B~~		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	11.2			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	12.4	J	~~*~~	P
7439-89-6	Iron				NR
7439-92-1	Lead	28.5	J	~~E*~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.18			CV
7440-02-0	Nickel	27.3	J	~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.53	J ~~B~~		P
7440-22-4	Silver	0.12	U	~~*~~ 5/16/03	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1.2 ~~0.17~~	U		P
7440-62-2	Vanadium	90.1	J	~~*~~	P
7440-66-6	Zinc	23.8	J	~~E~~	P
	Cyanide				NR

5/16/03

Color Before: ________ Clarity Before: ________ Texture: ________

Color After: ________ Clarity After: ________ Artifacts: ________

Comments:

101

U.S. EPA - CLP

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-3/13-15

Lab Name: MITKEM_CORPORATION________ Contract: __________

ab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0417__

Matrix (soil/water): SOIL____ Lab Sample ID: B0417-06A_____

evel (low/med): MED____ Date Received: 03/12/03____

% Solids: 82.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

EAD
5/16/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	0.17	UJ ~~B~~	~~*N~~	P
7440-38-2	Arsenic	2.5	J	~~*~~	P
7440-39-3	Barium	12.9	J	~~E~~	P
7440-41-7	Beryllium	0.54		~~*~~	P
7440-43-9	Cadmium	0.085	UJ ~~B~~		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	13.3			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	2.8	UJ	~~*~~	P
7439-89-6	Iron				NR
7439-92-1	Lead	2.4	J	~~E*~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.016	U		CV
7440-02-0	Nickel	10.3	J	~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.46	U		P
7440-22-4	Silver	0.16	UJ ~~B~~	~~*~~ B 5/16/03	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1.0 ~~0.40~~	UJ ~~B~~		P
7440-62-2	Vanadium	26.1	J	~~*~~	P
7440-66-6	Zinc	14.5	J	~~E~~	P
	Cyanide				NR

Color Before: __________ Clarity Before: ________ Texture: ________

olor After: __________ Clarity After: ________ Artifacts: ________

mments:

FORM I - IN SW846

102R

U.S. EPA - CLP

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-2/0-1

Lab Name: MITKEM_CORPORATION________ Contract: __________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0417__

Matrix (soil/water): SOIL___ Lab Sample ID: B0417-07A_____

Level (low/med): MED___ Date Received: 03/12/03___

% Solids: 75.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

EAD 5/16/03

CAS No	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	0.81	UJ ~~B~~	~~*N~~	P
7440-38-2	Arsenic	19.6	J	/	P
7440-39-3	Barium	67.2	J	~~E~~	P
7440-41-7	Beryllium	0.73		/	P
7440-43-9	Cadmium	0.40	U		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	16.4			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	30.1	J	/	P
7439-89-6	Iron				NR
7439-92-1	Lead	87.2	J	~~E*~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	1.1			CV
7440-02-0	Nickel	41.1	J	~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.54	U		P
7440-22-4	Silver	0.12	U	/ Ce 5/16/03	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1.2 ~~0.18~~	U		P
7440-62-2	Vanadium	148	J	/	P
7440-66-6	Zinc	66.7	J	~~E~~	P
	Cyanide				NR

Color Before: ________ Clarity Before: ________ Texture: ________

Color After: ________ Clarity After: ________ Artifacts: ________

Comments:

103 R

U.S. EPA - CLP

1
INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-2/7-9

Lab Name: MITKEM_CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix (soil/water): SOIL Lab Sample ID: B0417-08A

Level (low/med): MED Date Received: 03/12/03

% Solids: 84.0

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	0.72 UJ	~~B~~	*~~N~~	P
7440-38-2	Arsenic	18.9	J	~~*~~	P
7440-39-3	Barium	42.8	J	~~E~~	P
7440-41-7	Beryllium	0.75		~~*~~	P
7440-43-9	Cadmium	0.31	U		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	15.2			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	32.5	J	~~*~~	P
7439-89-6	Iron				NR
7439-92-1	Lead	163	J	~~E*~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.31			CV
7440-02-0	Nickel	23.9	J	~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.54 J	~~B~~		P
7440-22-4	Silver	0.10	U	~~*~~	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1.0 ~~0.37~~ UJ	~~B~~		P
7440-62-2	Vanadium	95.2	J	~~*~~	P
7440-66-6	Zinc	37.1	J	~~E~~	P
	Cyanide				NR

ED
5/16/03

Color Before: Clarity Before: Texture:

Color After: Clarity After: Artifacts:

Comments:

FORM I - IN SW846

104 R

U.S. EPA - CLP

1
INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-2/11-13

Lab Name: MITKEM_CORPORATION________ Contract: __________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0417___

Matrix (soil/water): SOIL____ Lab Sample ID: B0417-09A_____

Level (low/med): MED____ Date Received: 03/12/03____

% Solids: 91.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

EAD
5/16/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	0.41	UJ ~~B~~	~~*N~~	P
7440-38-2	Arsenic	7.0	J	~~*~~	P
7440-39-3	Barium	25.8	J	~~E~~	P
7440-41-7	Beryllium	0.44		~~*~~	P
7440-43-9	Cadmium	0.16	UJ ~~B~~		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	10.9			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	21.4	J	~~*~~	P
7439-89-6	Iron				NR
7439-92-1	Lead	30.0	J	~~E~~*	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.29			CV
7440-02-0	Nickel	15.2	J	~~E~~*	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.48	U		P
7440-22-4	Silver	0.11	U	~~*~~ Ch 5/16	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1.1 ~~0.16~~	U		P
7440-62-2	Vanadium	45.0	J	~~*~~	P
7440-66-6	Zinc	25.4	J	~~E~~	P
	Cyanide				NR

Color Before: ________ Clarity Before: ________ Texture: ________

Color After: ________ Clarity After: ________ Artifacts: ________

Comments:

FORM I - IN SW846

105R

U.S. EPA - CLP

1
INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-8/0-1

ab Name: MITKEM_CORPORATION________ Contract: __________

ab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0417__

Matrix (soil/water): SOIL____ Lab Sample ID: B0417-10A_____

vel (low/med): MED____ Date Received: 03/12/03____

% Solids: 84.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	0.73	UJ ~~B~~	*~~N~~	P
7440-38-2	Arsenic	16.6	J	~~*~~	P
7440-39-3	Barium	63.4	J	~~E~~	P
7440-41-7	Beryllium	0.74		~~*~~	P
7440-43-9	Cadmium	0.51	U		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	13.4			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	34.8	J	~~*~~	P
7439-89-6	Iron				NR
7439-92-1	Lead	93.1	J	~~E~~*	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.83			CV
7440-02-0	Nickel	36.2	J	~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.96	J ~~B~~		P
7440-22-4	Silver	0.10	U	~~*~~ [illegible]	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1.0 ~~0.15~~	U		P
7440-62-2	Vanadium	159	J	~~*~~	P
7440-66-6	Zinc	72.3	J	~~E~~	P
	Cyanide				NR

EAD
5/16/03

olor Before: __________ Clarity Before: ________ Texture: _______

or After: __________ Clarity After: ________ Artifacts: _______

omments:

FORM I - IN SW846

106R

U.S. EPA - CLP

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-8/7-9

Lab Name: MITKEM_CORPORATION________ Contract: ________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0417__

Matrix (soil/water): SOIL____ Lab Sample ID: B0417-11A_____

Level (low/med): MED____ Date Received: 03/12/03____

% Solids: 85.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	R ~~0.17~~	~~U~~	~~*N~~	P
7440-38-2	Arsenic	12.1	J	~~*~~	P
7440-39-3	Barium	645	J	~~E~~	P
7440-41-7	Beryllium	1.0		~~*~~	P
7440-43-9	Cadmium	0.62	U		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	31.5			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	36.7	J	~~*~~	P
7439-89-6	Iron				NR
7439-92-1	Lead	91.9	J	~~E*~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.95			CV
7440-02-0	Nickel	65.1	J	~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.50	U		P
7440-22-4	Silver	0.11	U	~~*~~ G 5/12/03	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1.1 ~~0.18~~	UJ ~~B~~		P
7440-62-2	Vanadium	247	J	~~*~~	P
7440-66-6	Zinc	429	J	~~E~~	P
	Cyanide				NR

SD
5/16/03

Color Before: ________ Clarity Before: ________ Texture: ________

Color After: ________ Clarity After: ________ Artifacts: ________

Comments:

107 R

1
INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-9/0-1

ab Name: MITKEM_CORPORATION________ Contract: __________

ab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0417__

Matrix (soil/water): SOIL____ Lab Sample ID: B0417-12A_____

evel (low/med): MED____ Date Received: 03/12/03____

% Solids: 70.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	0.64	UJ ~~B~~	~~*N~~	P
7440-38-2	Arsenic	9.4	J	~~*~~	P
7440-39-3	Barium	26.8	J	~~E~~	P
7440-41-7	Beryllium	0.41		~~*~~	P
7440-43-9	Cadmium	0.21	UJ ~~B~~		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	5.8			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	8.7	J	~~*~~	P
7439-89-6	Iron				NR
7439-92-1	Lead	13.2	J	~~E*~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.28			CV
7440-02-0	Nickel	11.8	J	~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	1.6	J ~~B~~		P
7440-22-4	Silver	0.13	U	~~*~~ Ch (HB)	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1.3 ~~0.20~~	U		P
7440-62-2	Vanadium	54.4	J	~~*~~	P
7440-66-6	Zinc	24.1	J	~~E~~	P
	Cyanide				NR

ED
5/16/03

olor Before: ________ Clarity Before: ________ Texture: ________

or After: ________ Clarity After: ________ Artifacts: ________

mments:

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-9/5-7

Lab Name: MITKEM_CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix (soil/water): SOIL Lab Sample ID: B0417-13A

Level (low/med): MED Date Received: 03/12/03

% Solids: 87.0

Concentration Units (ug/L or mg/kg dry weight): MG/KG

5/16/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	0.59	UJ ~~B~~	~~*N~~	P
7440-38-2	Arsenic	21.0	J	~~*~~	P
7440-39-3	Barium	93.6	J	~~E~~	P
7440-41-7	Beryllium	0.61		~~*~~	P
7440-43-9	Cadmium	0.56	U		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	17.3			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	27.5	J	~~*~~	P
7439-89-6	Iron				NR
7439-92-1	Lead	91.6	J	~~E*~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	1.4			CV
7440-02-0	Nickel	65.0	J	~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.44	U		P
7440-22-4	Silver	0.098	U	~~*~~ 5/12/03	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1.0 ~~0.15~~	U		P
7440-62-2	Vanadium	505	J	~~*~~	P
7440-66-6	Zinc	59.9	J	~~E~~	P
	Cyanide				NR

Color Before: Clarity Before: Texture:

Color After: Clarity After: Artifacts:

Comments:

U.S. EPA - CLP

1
INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-10/0-1

Lab Name: MITKEM_CORPORATION________ Contract: __________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0417__

Matrix (soil/water): SOIL____ Lab Sample ID: B0417-14A_____

Level (low/med): MED____ Date Received: 03/12/03____

% Solids: 85.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	1.7	UJ	~~*N~~	P
7440-38-2	Arsenic	19.4	J		P
7440-39-3	Barium	111	J	~~E~~	P
7440-41-7	Beryllium	1.0			P
7440-43-9	Cadmium	4.2			P
7440-70-2	Calcium				NR
7440-47-3	Chromium	38.6			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	43.3	J		P
7439-89-6	Iron				NR
7439-92-1	Lead	120	J	~~E*~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	3.3			CV
7440-02-0	Nickel	41.1	J	~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.44	U		P
7440-22-4	Silver	0.097	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1.0 ~~0.70~~	UJ ~~B~~		P
7440-62-2	Vanadium	54.0	J		P
7440-66-6	Zinc	161	J	~~E~~	P
	Cyanide				NR

EAP
5/16/03

Color Before: __________ Clarity Before: ________ Texture: ________

Color After: __________ Clarity After: ________ Artifacts: ________

Comments:

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FORM I - IN SW846

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U.S. EPA - CLP

1
INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-10/9-11

Lab Name: MITKEM_CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0417

Matrix (soil/water): SOIL Lab Sample ID: B0417-15A

Level (low/med): MED Date Received: 03/12/03

% Solids: 91.0

Concentration Units (ug/L or mg/kg dry weight): MG/KG

EAD
5/16/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	R ~~0.14~~	~~U~~	*~~N~~	P
7440-38-2	Arsenic	3.8	J		P
7440-39-3	Barium	34.4	J	~~E~~	P
7440-41-7	Beryllium	0.77			P
7440-43-9	Cadmium	0.20	UJ ~~B~~		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	26.2			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	16.1	J		P
7439-89-6	Iron				NR
7439-92-1	Lead	15.0	J	~~E~~*	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.048	U		CV
7440-02-0	Nickel	17.7	J	~~E~~*	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.41	U		P
7440-22-4	Silver	0.092	U	Ch 5/12/03	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	0.94 ~~0.82~~	UJ ~~B~~		P
7440-62-2	Vanadium	19.8	J		P
7440-66-6	Zinc	24.2	J	~~E~~	P
	Cyanide				NR

Color Before: Clarity Before: Texture:

Color After: Clarity After: Artifacts:

Comments:

FORM I - IN SW846

111 R

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

KSB-10/9-11

Lab Name: MITKEM_CORPORATION______ Contract: ______

Lab Code: MITKEM Case No.: _____ SAS No.: _____ SDG No.: B0417__

Matrix (soil/water): SOIL____ Lab Sample ID: B0417-16A____

Level (low/med): MED___ Date Received: 03/12/03___

% Solids: 91.0____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	R ~~0.14~~	~~U~~	~~*N~~	P
7440-38-2	Arsenic	4.4	J	~~*~~	P
7440-39-3	Barium	44.0	J	~~E~~	P
7440-41-7	Beryllium	1.0		~~*~~	P
7440-43-9	Cadmium	0.25	U		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	31.3			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	19.7	J	~~*~~	P
7439-89-6	Iron				NR
7439-92-1	Lead	20.4	J	~~E*~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.048	U		CV
7440-02-0	Nickel	21.8	J	~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.42	U		P
7440-22-4	Silver	0.094	U	~~*~~ [illegible] 5/21/03	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	0.96 ~~0.64~~	UJ ~~B~~		P
7440-62-2	Vanadium	23.9	J	~~*~~	P
7440-66-6	Zinc	30.5	J	~~E~~	P
	Cyanide				NR

ED
5/16/03

Color Before: ______ Clarity Before: ______ Texture: ______

Color After: ______ Clarity After: ______ Artifacts: ______

Comments:

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U.S. EPA - CLP

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-10/13-15

Lab Name:	MITKEM_CORPORATION	Contract:			
Lab Code:	MITKEM	Case No.:		SAS No.:		SDG No.: B0417
Matrix (soil/water):	SOIL			Lab Sample ID:	B0417-17A
Level (low/med):	MED			Date Received:	03/12/03
% Solids:	85.0				

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	0.73 UJ	~~B~~	~~*N~~	P
7440-38-2	Arsenic	4.1	J	~~*~~	P
7440-39-3	Barium	34.8	J	~~E~~	P
7440-41-7	Beryllium	0.64		~~*~~	P
7440-43-9	Cadmium	0.12 UJ	~~B~~		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	17.6			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	7.5	J	~~*~~	P
7439-89-6	Iron				NR
7439-92-1	Lead	4.8	J	~~E*~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.030 UJ	~~B~~		CV
7440-02-0	Nickel	11.0	J	~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.46	U		P
7440-22-4	Silver	0.10	U	~~*~~ [illegible] 5/12/03	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	1. ~~0.15~~	U		P
7440-62-2	Vanadium	12.3	J	~~*~~	P
7440-66-6	Zinc	15.6	J	~~E~~	P
	Cyanide				NR

ED
5/16/03

Color Before:		Clarity Before:		Texture:	
Color After:		Clarity After:		Artifacts:	

Comments:

113R

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-9/13-15

ab Name: MITKEM_CORPORATION________ Contract: __________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0417__

atrix (soil/water): SOIL____ Lab Sample ID: B0417-18A_____

vel (low/med): MED____ Date Received: 03/12/03____

% Solids: 85.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

EAD 5/16/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	0.31	UJ ~~B~~	~~*N~~	P
7440-38-2	Arsenic	8.2	J		P
7440-39-3	Barium	24.8	J	~~E~~	P
7440-41-7	Beryllium	0.71			P
7440-43-9	Cadmium	0.15	UJ ~~B~~		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	17.8			P
7440-48-4	Cobalt				NR
7440-50-8	Copper	6.5	J		P
7439-89-6	Iron				NR
7439-92-1	Lead	10.1	J	~~E~~*	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.10	U		CV
7440-02-0	Nickel	13.4	J	~~E~~*	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.43	U		P
7440-22-4	Silver	0.096	U	EB 5/12/03	P
7440-23-5	Sodium				NR
7440-28-0	Thallium	0.98 ~~0.14~~	U		P
7440-62-2	Vanadium	52.2	J		P
7440-66-6	Zinc	17.8	J	~~E~~	P
	Cyanide				NR

olor Before: ________ Clarity Before: ________ Texture: ________

r After: ________ Clarity After: ________ Artifacts: ________

omments:

FORM I - IN SW846

M&E Metcalf & Eddy

CHAIN OF CUSTODY FORM

Pg. 1 of 2

Job/Project Name: Oxford Paper Mill
Job/Project Location: Lawrence, MA
Job/Project Number: 200299-1-2
Samplers: (Signatures)
Recorder: (Signature)
Date: 3/12/03
Lab (Samples Sent To): MIT KEM

SAMPLING Date	SAMPLING Time	SAMPLE NUMBER	SAMPLE LOCATION	MATRIX Water	MATRIX Soil				COMPOSITE/GRAB	PRESERVATIVE (Y/N)	PPMETALS plus BAN, [illegible]EPH	PCB'S							Total #	COMMENTS
3/10/03	0900	SB-1/0-1	SB-1/0-1		X				C	ICE	1	1							2	
↓	0940	SB-1/5-7	SB-1/5-7		↓				↓	↓	↓	↓							↓	
↓	1057	SB-1/17-19	SB-1/17-19		↓				↓	↓	↓	↓							↓	
↓	1300	SB-3/0-1	SB-3/0-1		↓				↓	↓	↓	↓							↓	
↓	1315	SB-3/7-9	SB-3/7-9		↓				↓	↓	↓	↓							↓	
↓	1339	SB-3/13-15	SB-3/13-15		↓				↓	↓	↓	↓							↓	
3/11/03	0937	SB-2/0-1	SB-2/0-1		X				C	ICE	1	1							2	
↓	1006	SB-2/7-9	SB-2/7-9		↓				↓	↓	↓	↓							↓	
↓	1028	SB-2/11-13	SB-2/11-13		↓				↓	↓	↓	↓							↓	
↓	1103	SB-8/0-1	SB-8/0-1		↓				↓	↓	↓	↓							↓	
↓	1130	SB-8/7-9	SB-8/7-9		↓				↓	↓	↓	↓							↓	
↓	1348	SB-9/0-1	SB-9/0-1		↓				↓	↓	↓	↓							↓	

Relinquished By: (Signature)	Date: 3/12/03	Time: 1412	Received By: (Signature)	Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)
Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)	Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)
Relinquished By: (Signature)	Date:	Time:	Received for Lab By: (Signature)	Date:	Time:	Comments:	

Method of Shipment:

Distribution: Original to Lab, Copy 1 to Field Files, Copy 2 to Project Manager

M&E Metcalf & Eddy

CHAIN OF CUSTODY FORM

Pg 2 of 2

Job/Project Name: Oxford Paper Mill	Job/Project Location: Lawrence, MA	Job/Project Number: 299-1-2
Samplers: (Signatures)	Recorder: (Signature)	Date: 3/12/03
Lab (Samples Sent To): MITKEM		

SAMPLING Date	SAMPLING Time	SAMPLE NUMBER	SAMPLE LOCATION	MATRIX Water	MATRIX Soil				COMPOSITE/GRAB	PRESERVATIVE (Y/N)	METALS plus Ba, V, MADEP EPH	PCBS							Total #	COMMENTS
3/11/03	1410	SB-9/5-7	SB-9/5-7		X				C	ice	1	1							2	
3/12/03	0932	SB-10/0-1	SB-10/0-1		X				C	ice	1	1							2	
	1010	SB-10/9-11	SB-10/9-11																	hvy oil/product
	1013	KSB-10/9-11	KSB-10/9-11																	
	1107	SB-10/13-15	SB-10/13-15																	↓ ↓
	1340	SB-9/13-15	SB-9/13-15								↓	↓								
↓	1342	MSB-9/13-15	MSB-9/13-15		↓				↓	↓		2							↓	MS/MSD

Relinquished By: (Signature)	Date: 3/12/03	Time: 1412	Received By: (Signature)	Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)
Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)	Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)
Relinquished By: (Signature)	Date:	Time:	Received for Lab By: (Signature)	Date:	Time:	Comments:	
Method of Shipment:							

Distribution: Original to Lab. Copy 1 to Field Files. Copy 2 to Project Manager

Metcalf & Eddy

Memorandum

PROJECT NO: 036200299.0001.00003 **DATE:** May 16, 2003
TO: Oxford Paper Mill File **OFFICE:** Wakefield
FROM: E. DeCola EAD **COMPANY:** Metcalf & Eddy, Inc.
REVIEWED BY: D. Truini
CC: B. Weir, N. Thurber, D. Laferte (memo only)

SUBJECT: Limited QC Review/Modified Tier II-Like Review
PCB, EPH and Priority Pollutant Metals Analytical Results
Mitkem Corporation, Warwick, Rhode Island
Lab Project # B0417

On March 10, 11, and 12, 2003, 18 soil samples were collected at the Oxford Paper Mill site, located in Lawrence, Massachusetts by Shaw Environmental & Infrastructure, Inc. (Shaw) and Metcalf & Eddy, Inc. (M&E) field personnel. The sampling was performed as part of Shaw's contract with the City of Lawrence, MA and Shaw's contract with M&E (Shaw Project Number 608134, M&E Project Number 200299-0001).

The samples were submitted to Mitkem Corporation, located in Warwick, Rhode Island for the analysis of Polychlorinated Biphenyls (PCB) using EPA SW-846 Method 8082, Extractable Petroleum Hydrocarbons (EPH) using the MADEP *Method for the Determination of Extractable Petroleum Hydrocarbons (EPH) (January 1998)*, and Priority Pollutant Metals using EPA SW-846 Methods 6010B and 7471A. All samples were received by the laboratory on March 12, 2003. The data package was received in the M&E office on April 9, 2003.

In accordance with M&E's contract with Shaw, and the EPA and MADEP-approved work plan for the subject site dated January 2003, M&E reviewed the data using EPA Region I Tier II level guidelines, as modified by M&E/EPA for the Targeted Brownfields Assessment Program (EPA Response Action Contract, Work Assignment Number 106-SIBZ-0100). The data deliverables, and the modified Tier II level data validation guidelines used to evaluate the data, are also consistent with MADEP's Presumptive Certainty guidelines for the usability of analytical data. The data review included:

- Data Completeness
- * Preservation and Technical Holding Times
- NA GC/ECD Instrument Performance Checks
- Initial and Continuing Calibrations
- Blanks
- Surrogate Recoveries and Retention Time Shifts

- * Inductively Coupled Plasma (ICP) Interference Check Sample
- NA Internal Standards
- Matrix Spike/Matrix Spike Duplicate
- Laboratory Duplicates
- Field Duplicates
- ICP Serial Dilution Analysis Results
- NA Sensitivity Check
- * Performance Evaluation Samples/Accuracy Check
- NA Target Compound Identification
- Compound Quantitation and Reported Quantitation Limits
- * System Performance

* = All criteria met for this parameter
NA = Not applicable and/or no information was provided by the laboratory

Note: Worksheets are not included for parameters that have met criteria or for criteria that are not applicable to the method and/or to the modified Tier II-like review.

Included in Attachment I is a copy of the chain-of-custody (COC) record. Included in Attachment II are the result summary sheets, annotated with qualifiers, if necessary, as detailed in this memorandum. Included in Attachment III are the data validation worksheets.

Data Completeness

Priority Pollutant Metals

The following items were missing or incorrectly reported.

1) The laboratory incorrectly identified sample KSB-10-/9-11(lab ID B0417-16A) as SB-10/9-11 in the EPH fraction.
2) Barium and vanadium were not reported for any soil samples as requested on the chain-of-custody.
3) Unspiked analytes were not reported in the ICSA Form 4 for metals.
A resubmital request was sent to Mitkem on April 28, 2003 and a response was received on May 5, 2003 with the revised forms.

The data package was complete for PCB analysis.

Initial and Continuing Calibrations

All initial and continuing calibration criteria was met for EPH and priority pollutants metals. However, it should be noted that the laboratory did not follow method requirements for calculation of the EPH range continuing calibration calibration factors. Per the MADEP method, the range calibration factor is calculated by summation of the peak areas of all component standards in each range fraction against the total mass injected. The laboratory calculated calibration factors for each individual peak rather than a summation. No action was taken since the individual calibration factors were all <25 relative percent difference.

PCB

The following table summarizes the continuing calibration (CC) analysis results that failed to meet the CC criterion of percent difference (%D) ≤15. Note that the 3 peaks used to quantitate the PCB results were averaged to determine %D exceedances.

Instrument/Column	RTXCLP/ pest2	RTXCLP/ pest2	RTXCLP/ pest2
Calibration Date	CC 3/27/03 @ 12:47	CC 3/28/03 @ 00:34	CC 3/28/03 @11:05
Compound	Average %D	Average %D	Average %D
Aroclor-1254	18	-	-
Aroclor- 1260	-	17.6	17.7
Associated Samples and Action.	Estimate (J and UJ) the positive and nondetect Aroclor-1254 results in samples SB-1/0-1, SB-3/13-15, SB-2/0-1 and SB-2/7-9. No actions were taken for samples SB-3/0-1 and SB-3/7-9 since Aroclor-1254 was reported from the other column in both samples.	Estimate (UJ) the nondetect Aroclor-1260 results in all samples except SB-1/5-7, SB-1/17-19, and SB-10/9-11.	Estimate (UJ) the nondetect Aroclor-1260 results for samples SB-1/5-7, SB-1/17-19 and SB-10/9-11. No action was taken for samples, SB2-/11-13, SB-8/0-1, SB-8/7-9, SB-9/0-1, SB-9/5-7, SB-10/0-1, KSB-10/9-11, SB-10/13-15, SB-9/13-15.

Blanks

Priority Pollutant Metals

A review of laboratory blank results indicates the presence of positive and negative laboratory contamination for the analyte listed below.

Analyte	Max. Conc. Contaminant (mg/kg)	BAL (mg/kg)	Affected Samples/Action
antimony	1.047	5.235	Qualify the reported value as "U" in all samples except SB-1/01, SB-8/7-9, SB-10/9-11, and KSB-10/9-11.

Analyte	Max. Conc. Contaminant (mg/kg)	BAL (mg/kg)	Affected Samples/Action
arsenic	-0.355	-1.775	None. All sample results > BAL.
barium	0.923	4.615	None. All sample results >BAL.
beryllium	0.056	0.28	None. All sample results >BAL.
cadmium	0.147	0.735	Qualify the reported value as "U" in all samples except SB-10/0-1 and SB-1/0-1.
chromium	0.096	0.48	None. All sample results >BAL.
copper	0.86	4.3	Qualify the reported value as "U" in sample SB-3/13-15.
mercury	0.033	0.17	Qualify the reported value as "U" in samples SB-10/9-11, KSB-10/9-11, SB-10/13-15 and SB-9/13-15.
silver	0.13	0.65	Qualify the reported value as "U" in samples SB-1/5-7, SB-1/17-19, and SB-3/13-15.
thallium	-0.205 and 0.155	-1.025 and 0.78	Qualify "U" at the negative BAL in samples SB-1/0-1, SB-1/5-7, SB-1/17-19, SB-3/0-1, SB-3/13-15, SB-2/7-9, SB-8/7-9, SB-10/0-1, SB-10/9-11, and KSB-10/9-11. Replace the nondetect value with the negative BAL in samples SB-8/0-1, SB-2/11-13, SB-2/0-1, SB-3/7-9, SB-9/0-1, SB-9/5-7, SB-10/13-15, SB-9/13-15.
vanadium	0.129	0.645	None. All sample results >BAL.
zinc	0.882	4.41	None. All sample results >BAL.

BAL- Blank Action Level

The sample specific preparation factors, dilutions, and percent solids were taken into account when evaluating blank contamination.

Blank actions for analytes associated with positive blank contamination:

- concentration ≤ BAL; report value on summary table as U.
- concentration > BAL; report value unqualified.

Blank actions for analytes associated with negative blank contamination and positive blank contamination where the negative |BAL| is > positive BAL.

- If the sample result was positive and < negative BAL, the result was qualified as nondetect (U) and the detection limit was raised to the negative BAL.
- If the sample result was nondetect, the detection limit was raised to the negative BAL.
- If the sample result was > the positive and negative BALs, qualification of the data was not required.

No blank contamination was detected in the PCB and EPH analyses. However, it should be noted that the laboratory blank corrected the EPH range results for contamination from the solid phase extraction/fractionation cartridges.

Surrogate Recoveries and Retention Time Shifts

EPH

The EPH surrogate compounds that did not meet the acceptance criterion of percent recovery (%R) of 40-140% for chlorooctadecane are summarized in the following table:

Sample ID	chlorooctadecane %	Action
SB-8/7-9	35	Estimate(J and UJ) the positive and nondetect C_9-C_{18} Aliphatic and C_{19}-C_{36} Aliphatic results in sample SB-8/7-9. These results may be biased low.
SB-8/7-9RE	36	None. The results from SB-8/7-9 were reported.

PCB

The PCB surrogate compounds that did not meet the acceptance criterion of percent recovery (%R) of 29-155% for decachlorobiphenyl (DCB) are summarized in the following table:

Sample ID	DCB Column I	Action
SB-8/0-1	161	No action. Only 1 surrogate of 4 was outside of recovery criteria.
SB-8/7-9	430	No action. Only 1 surrogate of 4 was outside of recovery criteria
SB-9/5-7	404	No action. Only 1 surrogate of 4 was outside of recovery criteria
SB-10/0-1	310	No action. Only 1 surrogate of 4 was outside of recovery criteria

Surrogate criteria is not applicable for priority pollutant metals analysis.

Field Duplicates

EPH

The compounds that did not meet acceptance criterion for relative percent difference (RPD) of ≤ 50% in field duplicate samples SB-10-9-11 and KSB-10/9-11 are summarized in the following table:

Compound	Sample Result (µg/kg)	Duplicate Sample Result (µg/kg)	RPD	Affected Samples/Action
acenaphthene	530 U	1200	NC	Estimate (J/UJ) the positive and nondetect result in field duplicate samples SB-10/9-11 and KSB-10/9-11. A bias could not be determined
acenaphthylene	530 U	1900	NC	Estimate (J/UJ) the positive and nondetect result in field duplicate samples SB-10/9-11 and KSB-10/9-11. A bias could not be determined.
benzo(b)fluoranthene	1200	540 U	NC	Estimate (J/UJ) the positive and nondetect result in field duplicate samples SB-10/9-11 and KSB-10/9-11. A bias could not be determined.
fluoranthene	2200	540 U	NC	Estimate (J/UJ) the positive and nondetect result in field duplicate samples SB-10/9-11 and KSB-10/9-11. A bias could not be determined.
pyrene	1900	540 U	NC	Estimate (J/UJ) the positive and nondetect result in field duplicate samples SB-10/9-11 and KSB-10/9-11. A bias could not be determined.

NC- the RPD was not calculated due to the nondetect sample.

All criteria was met for PCB and priority pollutant metals field duplicates.

Matrix Spike/Matrix Spike Duplicate

All criteria was met for PCB and EPH matrix spike/matrix spike duplicates.

Priority Pollutant Metals

The priority pollutant metals analytes for soil samples that did not meet acceptance criteria of 75-125 percent recovery (%R) in matrix spike sample SB-1/0-1, indicating possible matrix interference, are summarized in the table below:

Analyte	Spiked Sample Result (mg/kg)	Sample Result (mg/kg)	Matrix Spike %R	Affected Samples/Action
antimony	8.64	8.77	-0.6	Estimate (J) the positive antimony results in all samples except SB-8/7-9, SB-10/9-11, and KSB-10/9-11. Reject (R) the nondetect antimony results in samples SB-8/7-9, SB-10/9-11, and KSB-10/9-11.
lead	90.06	1967.98	-8258.2	No action since the sample result was >4x the spike added.

The antimony results in all priority pollutant metals samples except SB-1/0-1, SB-8/7-9, SB-10/9-11, and KSB-10/9-11 were previously qualified as nondetect due to laboratory blank contamination.

Laboratory Duplicates

Priority Pollutant Metals

The priority pollutant metals analyte that did not meet acceptance criteria of relative percent difference (%RPD)<20 in soil sample SB-1/0-1 is summarized in the following table:

Analyte	Sample Result (mg/kg)	Duplicate Sample Result (mg/kg)	%RPD	Affected Samples/Action
antimony	8.77	0.15 U	200	Estimate (J) the positive antimony results in all samples.
arsenic	9.29	6.86	30	Estimate (J) the positive arsenic results in all samples.
copper	37.3	26.5	33.6	Estimate (J) the positive copper results in all samples.
nickel	22.7	17.3	26.9	Estimate (J) the positive nickel results in all samples.
lead	1967.98	59.00	188.4	Estimate (J) the positive lead results in all samples.
vanadium	30.7331	23.5681	26.4	Estimate (J) the positive vanadium results in all samples.

No further actions were taken for antimony. The antimony results in all samples except SB-1/0-1, SB-8/7-9, SB-10/9-11 and KSB-10/9-11 were previously qualified as nondetect due to laboratory blank contamination. In addition, all antimony results were further estimated (J) or rejected (R) due to severely low matrix spike recovery.

The copper result in sample SB-3/13-15 was previously estimated for laboratory blank contamination.

ICP Serial Dilution Analysis Results

Barium, lead, nickel and zinc did not meet serial dilution criteria of 10% difference (11.6%, 11.8%, 11.5%, and 12.4%, respectively). Estimate (J) the positive zinc and barium results in all samples due to serial dilution exceedence. No further actions were taken for lead and nickel since these results were previously estimated for laboratory duplicate imprecision.

Laboratory duplicates are not required in EPH and PCB analysis.

Compound Quantitation and Reported Quantitation Limits

EPH

The following samples were diluted (dilution listed in parenthesis) based on results exceeding the calibration range in the original sample analysis:

Sample	Compounds from Dilution Analysis
SB-1/0-1	all compounds (2.5x)
SB-10/0-1	all compounds (2.5x)

Priority Pollutant Metals

The following table summarizes the priority pollutants metal results that are less than the reporting limit (RL) but greater than the instrument detection limit (IDL) and were not previously qualified as estimated (J) due to quality control parameters discussed above. The listed results are qualified as estimated (J) due to uncertainty in the quantitation:

Analyte	Affected Samples/Action
selenium	SB-3/7-9, SB-2/7-9, SB-8/01, and SB-9/0-1
silver	SB-1/0-1, SB-1/5-7, SB-1/17-19, and SB-3/13-15.
thallium	SB-1/0-1, SB-1/5-7, SB-1/17-19, SB-3/0-1, SB-3/13-15, SB-2/7-9, SB-8/7-9, SB-10/0-1, SB-10/9-11, and KSB-10/9-11.

Analyte	Affected Samples/Action
cadmium	SB-1/17-19, SB-3/7-9, SB-3/13-15, SB-2/11-13, SB-10/9-11, SB-9/0-1, SB-10/13-15, and SB-9/13-15.
mercury	SB-10/13-15

The positive results for silver, thallium, mercury, and cadmium in all samples with the exception of silver in SB-1/0-1 listed above were previously qualified as nondetect (U) due to blank contamination. These results are further qualified as estimated, nondetect (UJ) due to blank contamination and uncertainty in quantitation.

All criteria was met for PCB analysis for compound quantitation and reported quantitation limits.

Reference No. MADEP
EPA SW-846

REGION I ORGANIC DATA VALIDATION

The following data package has been validated:

Lab Name Mitkem
Case/Project No. R0917
SDG No. NA
No. of Samples/Matrix 19 / Soil

SOW/Method No. MADEP + EPA SW-846 methods
Sampling Date(s) 3/10/03 - 3/12/03
Shipping Date(s) 3/12/03
Date Rec'd by lab March 12, 2003

Traffic Report Sample Nos. SB-1/0-1; SB-1/5-7; SB-1/17-19, SB-3/0-1; SB-3/7-9 SB-3/13-15; SB-2/0-1; SB-2/7-9; SB-2/11-13; SB-8/0-1; SB-8/7-9 SB-9/0-1; SB-9/5-7; SB-10/0-1; SB-10/9-11; KSB-10/9-11; SB-10/13-15 SB-9/13-15
Trip Blank No. —
Equipment Blank No. —
Bottle Blank No. —
Field Duplicate Nos. KSB-10/9-11 + SB-10/9-11
PES Nos. —

The Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses, revision II - mod 12/96 was used to evaluate the data and/or approved modifications to the EPA-NE Functional Guidelines were used to evaluate the data and are attached to this cover page: (attach modified criteria from EPA approved QAPjP or amendment to QAPjP).

[✓ A Tier II] or Tier III evaluation was used to validate the data (circle one). If a Tier II validation with a partial Tier III was used, then identify samples, parameters, etc. that received partial Tier III validation

PCBs by 8082, EPH by MADEP method.

The data were evaluated based upon the following parameters:

- Overall Evaluation of Data
- Data Completeness (CSF Audit - Tier I)
- Preservation & Technical Holding Times
- GC/MS & GC/ECD Instrument Performance Check
- Initial & Continuing Calibrations
- Blanks
- Surrogate Compounds
- Internal Standards
- Matrix Spike/Matrix Spike Duplicate
- Field Duplicates
- Sensitivity Check
- PE Samples/Accuracy Check
- Target Compound Identification
- Compound Quantitation and Reported Quantitation Limits
- TICs
- Semivolatile and Pesticide/PCB Cleanup
- System Performance

Region I Definitions and Qualifiers:

A - Acceptable Data
J - Numerical value associated with compound is an estimated quantity.
R - The data are rejected as unusable. The R replaces the numerical value or sample quantitation limit.
U - Compound not detected at that numerical sample quantitation limit.
UJ - The sample quantitation limit is an estimated quantity.
TB, BB, EB - Compound detected in aqueous trip blank, aqueous bottle blank, or aqueous equipment blank associated with soil/sediment samples.

Validator's Name E. DeCola Company Name M+E Phone Number 781-245-5200

Date Validation Started 4/10/03 Date Validation Completed 4/16/03 draft

EPA-NE
Data Validation Worksheet Cover Page - Page 2

Check if all criteria are met and no hard copy worksheet provided. Indicate NA if worksheet is not applicable to analytical method. Note: there is no standard worksheet for System Performance, however, the validator must document all system performance issues in the Data Validation Memorandum.

VOA/SV worksheets:

VOA/SV-Pest/PCB	COMPLETE SDG FILE (CSF) AUDIT	NA
VOA/SV-Pest/PCB-I	PRESERVATION AND HOLDING TIMES	
VOA/SV-II	GC/MS INSTRUMENT PERFORMANCE CHECK (TUNING)	
VOA/SV-III	INITIAL CALIBRATION	
VOA/SV-IV	CONTINUING CALIBRATION	
VOA/SV-Pest/PCB-V-A	BLANK ANALYSIS	
VOA/SV-Pest/PCB-V-B	BLANK ANALYSIS	
VOA-VI	VOA SURROGATE SPIKE RECOVERIES	
SV-VI	SV SURROGATE SPIKE RECOVERIES	
VOA/SV-VII	INTERNAL STANDARD PERFORMANCE	
VOA/SV-Pest/PCB-VIII	MATRIX SPIKE/MATRIX SPIKE DUPLICATE	
VOA/SV-Pest/PCB-IX	FIELD DUPLICATE PRECISION	
VOA/SV-Pest/PCB-X	SENSITIVITY CHECK	
VOA/SV-Pest/PCB-XI	ACCURACY CHECK	
VOA/SV-Pest/PCB-XII	TARGET COMPOUND IDENTIFICATION	
VOA/SV-Pest/PCB-XIII	SAMPLE QUANTITATION	
VOA/SV-XIV	TENTATIVELY IDENTIFIED COMPOUNDS	
VOA/SV-XV	SEMIVOLATILE CLEANUP	
TABLE II-WORKSHEET	OVERALL EVALUATION OF DATA	↓

Pest/PCB worksheets:

VOA/SV-Pest/PCB	COMPLETE SDG FILE (CSF) AUDIT	NA
VOA/SV-Pest/PCB-I	PRESERVATION AND HOLDING TIMES	✓
Pest/PCB-IIA	GC/ECD INSTRUMENT PERFORMANCE CHECK-RESOLUTION	NA
Pest/PCB-IIB	GC/ECD INSTRUMENT PERFORMANCE CHECK-RETENTION TIMES	NA
Pest/PCB-IIC	GC/ECD INSTRUMENT PERFORMANCE CHECK-ACCURACY CHECK OF INITIAL CALIBRATION	NA
Pest/PCB-IID	GC/ECD INSTRUMENT PERFORMANCE CHECK-PESTICIDE DEGRADATION	NA
Pest/PCB-III	INITIAL CALIBRATION	✓
Pest/PCB-IV	CONTINUING CALIBRATION	~~✓~~ DAT 4/28/03
VOA/SV-Pest/PCB-V-A	BLANK ANALYSIS	✓
VOA/SV-Pest/PCB-V-B	BLANK ANALYSIS	✓
Pest/PCB-VI	SURROGATE COMPOUNDS: SPIKE RECOVERIES AND RETENTION TIME SHIFT	
Pest/PCB-VII	PESTICIDE CLEANUP	NA
VOA/SV-Pest/PCB-VIII	MATRIX SPIKE/MATRIX SPIKE DUPLICATE	✓
VOA/SV-Pest/PCB-IX	FIELD DUPLICATE PRECISION	✓
VOA/SV-Pest/PCB-X	SENSITIVITY CHECK	✓
VOA/SV-Pest/PCB-XI	ACCURACY CHECK	NA
Pest/PCB-XII	COMPOUND IDENTIFICATION	NA
VOA/SV-Pest/PCB-XIII	SAMPLE QUANTITATION	NA
TABLE II-WORKSHEET	OVERALL EVALUATION OF DATA	NA

I certify that all criteria were met for the worksheets checked above.

Signature: ______________ Name: Deborah A Truin,

Date: 4/28/03

12/96

EPA-NE - Data Validation Worksheet
VOA/SV - Pest/PCB

Oxford Paper Mill

Lawrence Shaw work
PP metals, PCB, EPH
Lab # B0417

COMPLETE SDG FILE (CSF) AUDIT

NA - Non RAS package

Organic Fractions: ____________________

Missing Information	Date Lab Contacted	Date Received
EPH sample KSB-10/9-11 (B0417-16A) identified as SB-10/19-11		

Validator: ____________________ **Date:** ________

EPA-NE - Data Validation Worksheet
SV-VI

VI. ~~SV~~ SURROGATE SPIKE RECOVERIES - List all surrogate compound recoveries that are outside method QC acceptance criteria.

~~Pest~~/PCB SD

Method	Base/Neutral Method QC Acceptance Criteria					
	SD ~~NBZ-d₅~~	2-FBP	TPH-d₁₄	1,2-DCB-d₄*	Other:	
OLM03.2	Water Soil 35-114 23-120	Water Soil 43-116 30-115	Water Soil 33-141 18-137	Water Soil 16-110 20-130	DCB x DAT 4/28/03	
OLC02.1	40-110	30-110	20-140	NA	SD	
Other:					29-155	
Sample Number/Matrix	% Recovery	% Recovery	% Recovery	% Recovery	% Recovery	Action
ND SB-8/0-1					161	no action
+ SB-8/7-9					430	only one surrogate
SB-9/5-7					404	out on
SB-10/0-1					310	one column

Method	Acid Method QC Acceptance Criteria					
	Phenol-d₅	2-FP	2,4,6-TBP	2-CP-d₄*	Other:	
OLM03.2	Water Soil 10-110 24-113	Water Soil 21-110 25-121	Water Soil 10-123 19-122	Water Soil 33-110 20-130		
OLC02.1	15-115	15-110	15-130	NA		
Other:						
Sample Number/Matrix	% Recovery	% Recovery	% Recovery	% Recovery	% Recovery	Action

* Advisory Surrogates - OLM03.2

DCB- Decachlorobiphenyl

TCX limits 42-147 - all OK

Validator: E Deeb

Date: 8/11/03

VI. ~~VOA~~ EPH SURROGATE SPIKE RECOVERIES - List all surrogate compound recoveries that are outside method QC acceptance criteria.

Method	40-140% Volatile Method QC Acceptance Criteria				
	~~Toluene-d₈~~	BFB	DCE-d₄	Other:	
OLM03.2	Water 88-110 Soil 84-138	Water 86-115 Soil 59-113	Water 76-114 Soil 70-121		
OLC02.1	NA	80-120	NA		
Other:	chlorooctadecane				
Sample Number/Matrix	% Recovery	% Recovery	% Recovery	% Recovery	Action
EPH SB-8/7-9	35%				J/UJ C9-C18 aliphatic and C19-C36 aliphatic
EPA SB-8/7-9 RE	36%				J/UJ do not report + report original

Limits 40-140

Validator: E. Decola

Date: 4/15/03

EPA-NE - Data Validation Worksheet EPH
VOA/SV - Pest/PCB-IX

IX. **FIELD DUPLICATE PRECISION** - List all field duplicate analytes that are outside criteria.

Use a separate worksheet for each field duplicate pair.

Sample Number SB-D-9-11 Duplicate Sample Number KSB-D/9-11 Matrix SO

Parameter	Compound	Sample Conc.	Sample QL		Duplicate Conc.	Duplicate QL		RPD	QC Acceptance Criteria RPD or NA*	Action
			SQL	2xSQL		SQL	2xSQL			
	C_9-C_{18} Aliphatics	46000 ✓	3200	6400	380000 ✓	3200	6400	19.0 ✓	≤ 50	None
	C_{19}-C_{36} Aliphatics	76,000 ✓	4200	8400	60,000 ✓	4300	8600	23.5	< 50	↓
	C_{11}-C_{22} Aromatics	280,000 ✓	9000	18,000	280,000 ✓	9200	18400	0	< 50	↓
	Acenaphthene	ND	530	1080	1200 ✓	540	1080			J/UJ ✓
	Acenaphthylene	ND	530	↓	1900 ✓	540	↓			J/UJ
	Benzo(a)anthracene	910 ✓	↓	↓	ND ✓	↓	↓		<2xSQL-NE	None
	Benzo(a)pyrene	800 ✓	↓	↓	ND ✓	↓	↓		<2xSQL-NE	None
	Benzo(b)fluoranthene	1200 ✓	↓	↓	ND ✓	↓	↓			J/UJ
	Chrysene	1000 ✓	↓	↓	ND ✓	↓	↓		<2xSQL-NE	None
	Fluoranthene	2200 ✓	↓	↓	ND ✓	↓	↓			J/UJ

* For instances where one duplicate result is ND (or reported less than the sample QL).

Does the MS/MSD data indicate acceptable laboratory precision? [✓ Y] N

Comments: ______________________________

____

Sampler Name: ____________ Contractor Name: ____________ Date Contacted: ____________

Reason for Contact and resolution obtained: ______________________________

Validator: E. DeCola Date: 4/11/03

EPA-NE - Data Validation Worksheet
VOA/SV - Pest/PCB-IX

EPH

IX. **FIELD DUPLICATE PRECISION** - List all field duplicate analytes that are outside criteria.

Use a separate worksheet for each field duplicate pair.

Sample Number ________ Duplicate Sample Number ________ Matrix ________

Parameter	Compound	Sample Conc. DAT 4/2?/03 2100	Sample QL		Duplicate Conc. 2100 DAT	Duplicate QL 4/28/03		RPD 4/10/03	QC Acceptance Criteria RPD or NA*	Action
			SQL	2xSQL		SQL	2xSQL			
	Fluorene	1200✓	530	1060	1200	540	1080	1~~900~~0	<50	none
	~~Flor~~ EAD									
	Naphthalene	620✓	530	1060	850✓	540	1080	31.3	<50	none
	Phenanthrene	2500✓	↓	↓	1500✓	↓	↓	50	<50	↓
	Pyrene	1900✓	↓	↓	ND✓	↓	↓			J/UJ
	2-methylnaphthalene	960✓	↓	↓	1,100✓	↓	↓	13.6	<50	none

* For instances where one duplicate result is ND (or reported less than the sample QL).

Does the MS/MSD data indicate acceptable laboratory precision? [✓ Y] N

Comments: ____________________

Sampler Name: ________ Contractor Name: ________ Date Contacted: ________

Reason for Contact and resolution obtained: ____________________

Validator: E. DeCola Date: 4/11/03

PESTICIDE RESOLUTION CHECK
(CLP FORM 6G)

N/A

List the resolution between adjacent single peak pesticides in the resolution check mix that are less than 60.0% on either chromatographic column.

Analysis Date	Column	Compounds	%Resolution	Affected Samples

List the validation actions taken below. If there were no positive results for the poorly resolved peaks no action is required.

PCB ~~PESTICIDE~~ CALIBRATION VERIFICATION
(CONTINUING CALIBRATION CLP FORMS 7D,7E)

SAD 4/15/03

List the percent difference for the PCB ~~pesticide~~ compounds that exceed 15% ~~25%~~. List the percent breakdown for 4,4'–DDT or Endrin that exceed 20.0% or the combined breakdown of these two compounds that exceed 30.0%. Break down - not applicable.

SB-1/0-1

SB-3/13-15
(SB-2/0
SB-2/
4/1

	Analysis Date	Column	Compound	%D/Breakdown *	Affected Samples
@1247	3/27/03	RTXCLP pest2	Aroclor-1254	18	SB-3/0-1 (report other column); SB-3/7-9 (report other column) (J det
@:0034	3/28/03	pest 2	Aroclor-1260	17.6 *	~~SB-10/0-1~~ UJ(ND) DAT
@ 11:08	3/28/03	pest 2	Aroclor 1260	17.7 **	~~[illegible] ND~~ DAS (UJ all ND)
				no action on QC. ←	MSB-9/13-15 + MSD
					SB-1/5-7
					SB-1/17-19 DAT 4/28/03
					SB-10/9-11

* all except SB-1/5-7, SB-1/17-19, SB-10/9-11 (J/UJ 1260 in all affected samples)

List the validation actions taken below. ** SB-2/11-13, SB-8/0-1, SB-8/7-9, SB-9/0-1, SB-9/5-7, SB-10/0-1, KSB-10/9-11, SB-10/13-15, SB-9/13-15, SB-1/5-7, SB-1/17-19, SB-10/9-11 (J/UJ) 1260 in all affected samples)

* averages 3 results for each compound. Only averages w/a %D >15% are listed.

Region I
Data Review Worksheet

Site Name: Oxford Site
Reference Number: 200299.0003.00001

REGION I REVIEW OF INORGANIC CONTRACT LABORATORY DATA PACKAGE

The hardcopied (laboratory name) Mitkem Corp. data package received at Region I has been reviewed and the quality assurance and performance data summarized. The data review included:

Case No. See
SDG No. organics
No. of Samples Cover Sheet
SAS No. —
Matrix Soil
Sampling Date (s) See organics
Shipping Date (s)
Date(s) rec'd by lab Cover Sheet.

Traffic Report Numbers See organics cover sheet.

Trip Blank No.:
Equipment Blank Number:
Field Duplicate Numbers:

SOW No. SW-846 6010B and 7471A. requires that specific analytical work be done and that associated reports be provided by the laboratory to the Regions, EMSL-LV, and SMO. The general criteria used to determine the performance were based on an examination of:

- Data Completeness
- Holding Times
- Calibrations
- Blanks
- ICP Interference Check Results
- Matrix Spike Recoveries
- Laboratory Duplicates
- Field Duplicates
- Lab Control Sample Results
- Furnace AA results
- ICP Serial Dilution Results
- Detection Limit Results
- Sample Quantitation

Overall Comments:

Definitions and Qualifiers:
A - Acceptable data
J - Approximate data due to quality control criteria
R - Reject data due to quality control criteria
U - Analyte not detected

Reviewer: E. DeCola
Date: 4/14/03

Oxford Paper Mill Site
Shaw Work
Mitkem Lab # B0417
EPH; PP metals; PCBs in Soil
200299.0001.00003

Region I
Inorganic Data Review Worksheets

I. DATA COMPLETENESS

MISSING INFORMATION	DATE LAB CONTACTED	DATE RECEIVED
none		
Barium and vanadium were not reported as requested on the COC.		
ICSA - unspike results not reported on Form 4		

Form 2A

III A. INSTRUMENT CALIBRATION (Section 1)

~~all criteria met~~ EAP 4/11/03

1. Recovery Criteria

List the analytes which did not meet the percent recovery (%R) criteria for Initial and/or Continuing Calibration.

DATE	ICV/CCV#	ANALYTE	%R	ACTION	SAMPLES AFFECTED
3/17/03	CCV	Silver	89.8	J	none - last CCV run on 3/17/03
				ok since this rounds to 90%	

ACTIONS:

If any analyte does not meet the %R criteria follow the actions stated below:

For positive results:

	Accept	Estimate (J)	Reject (R)
Metals	90%-110%	75%-89% or 111%-125%	< 75% or > 125%
Mercury	80%-120%	65%-79% or 121%-135%	< 65% or > 135%
Cyanide	85%-115%	70%-84% or 116%-130%	< 70% or > 130%

For non-detected results:

	Accept	Estimate (UJ)	Reject (R)
Metals	90%-125%	75%-89%	< 75% or > 125%
Mercury	80%-135%	65%-79%	< 65% or > 135%
Cyanide	85%-130%	70%-84%	< 70% or > 130%

Region I
Inorganic Data Review Worksheets

IV A. BLANK ANALYSIS RESULTS (Sections 1-3)

List the blank contamination in sections 1 and 2 below. A separate worksheet should be used for soil and water blanks.

1. Laboratory Blanks

Matrix: Soil * only associates w/
don
use

DATE:	ICB/CCB#	PREP BL	ANALYTE	CONC./UNITS
		✓	Sb ✓	1.047 mg/kg
		✓	As ✓	-.355 mg/kg
		✓	Be ✓	.056 mg/kg (-1.0
		✓	~~Cd~~ Cr ✓	.096 mg/kg
	✓		Cu ✓	17.2 ug/L (-7.1 ug
	✓		Hg ✓	.2 ug/L
		✓	Ni ✓	~~-0~~ 0.193 mg/kg (-8 ug/L
	✓		Ag	2.6 ug/L (3.6 ug/L)
			Cd ✓	0.147 mg/kg

2. Equipment/Trip Blanks

DATE:	~~EQUIP BL #~~ ✓Cal Blank continued	ANALYTE	CONC./UNITS
		Tl	3.1 ug/L and 0.20
	✓	Zn	.862 mg/kg (-8.2 ug/L
		V	0.129 (mg/kg)
		Ba	0.923 (mg/kg)

3. Frequency Requirements

A. Was a preparation blank analyzed for each matrix, for every 20 samples, and for each digestion batch? [✓ Yes] or No

B. Was a calibration blank run at the beginning of the run, and every 10 samples or every 2 hours whichever is more frequent? [✓ Yes] or No

If no, the data may be affected. Use professional judgment to determine the severity of the effect and qualify the data accordingly. Discuss any actions below, and list the samples affected:

____

____

____

IV B. BLANK ANALYSIS RESULTS (Section 4)

4. Blank Actions

The Action Level for any analyte is equal to 5X the highest concentration of that analyte found in any blank. (Use 5X the absolute value for any negative blank results). The Action Level for samples which have been concentrated or diluted should be multiplied by the concentration/dilution factor. No positive result should be reported unless the concentration of the analyte in the sample exceeds the Action Level (AL) for that analyte. Specific actions are as follows:

1. When the concentration is greater than the IDL, but less than the Action Level, report the sample concentration detected with a U.

2. When the sample concentration is greater than the Action Level, report the sample concentration unqualified.

x note SB-1/0-1, SB-1/5-7, SB-3/0-1, SB-10/0-1 only slightly higher than blank.

Matrix: Soil | mg/kg | Matrix: ______

ELEMENT	MAX. CONC. /UNITS	AL /UNITS	ELEMENT	MAX. CONC/ UNITS	AL/ UNIT
* Sb ✓	1.047 mg/kg	5.235		see below	
As ✓	-.355 mg/kg	DAT 4/28/03 1.775	DAT 4/28/03	all > BAL	
Be ✓	.056 mg/kg ~~1.0 ug/L~~	0.28 ~~.25~~		all > BAL	
Cd ✓	0.147 mg/kg	0.735		see below	
Cr ✓	0.096 mg/kg	DAT 4/28/03 0.48		all > BAL	
Cu ✓	17.2 ug/L ~~(7 ug/L)~~	4.9, ~~1.67~~	DAT 4/28/03	see below	
Hg ✓	0.2 ug/L	DAT 4/28/03 ~~0.5~~ [illegible]	DAT 4/28/03	see below	
Ni	DAT 4/28/03 0.193 mg/kg ~~(8 ug/L)~~	.965 ~~.20~~	DAT 4/28/03	all > BAL	
Ag	2 8.6 ug/L	DAT 4/28/03 ~~.40~~ [illegible]		see below	
Tl	3.1 ug/L (.206 mg/kg)	(.78) (1.025)		see back of page	
Zn	.883 mg/kg ~~(8.2 ug/L)~~	4.41 ~~2.05~~ DAT 4/28/03	DAT 4/28/03	all > BAL	

NOTE: Blanks analyzed during a soil case must be converted to mg/kg in order to compare them with the sample results. 0/5/03 See reverse side for Vanadium + Barium →

$$\text{conc. in ug/l} \times \frac{\text{Volume diluted to (200ml)}}{\text{Weight digested (1gram)}} \times \frac{1L}{1000ml} \times \frac{1000g}{1kg} \times \frac{1mg}{1000ug} = \text{mg/kg}$$

Multiplying this result by 5 to arrive at the Action Level gives a final result in mg/kg which can then be compared to sample results

Qualify U → Sb - all samples except SB-1/0-1 SB-8/7-9 ND; SB-10/9-11 ND; KSB-10/9-11 ND.

Qualify U → Cd - all ~~ex~~ samples except SB-10/0-1, SB-1/0-1.

Cu - Qualify SB-3/13-15 w/ U

Hg - Qualify ~~all~~ SB-10/9-11; KSB-10/9-11 + SB-10/13-15 SB-9/13-15 w/ a U.

Ag - Qualify SR w/ a U for samples ~~SB-1/0-1~~; SB-1/5-7; SB-1/17-19 SB-3/13-15; DAT 4/28/03

~~Qualify SR w/ a U for SB-1/1-0~~ EAD 4/15/03 → see Back

V A. ICP INTERFERENCE CHECK SAMPLE (Sections 1 and 2)

1. Recovery Criteria

all criteria met.

List any elements in the ICS AB solution which did not meet the percent recovery criteria.

DATE	ELEMENT	%R	ACTION	SAMPLES AFFECTED

ACTIONS:

If an element does not meet the %R criteria, follow the actions stated below:

	PERCENT RECOVERY		
	< 50%	50%-79%	> 120%
Positive Sample Results	R	J	J
Non-detected Sample Results	R	UJ	A

2. Frequency Requirements

Were Interference QC samples run at the beginning and end of each sample analysis run or a minimum of twice per 8 hour shift, whichever is more frequent? [✓ Yes] or No

If no, the data may be affected. Use professional judgment to determine the severity of the effect and qualify the data accordingly. Discuss any actions below and list the samples affected:

NA for this package.

V R. ICP INTERFERENCE CHECK SAMPLE (Section 3)

These analytes were not analyzed

3. Report the concentration of any elements detected in the ICS A solution > 2X IDL that should not be present.

See resubmittal - can not evaluate without sample raw data

ELEMENT	CONC. DETECTED IN THE ICS	CONC. OF INTERFERENTS IN THE ICS AL	CA	FE	MG

No actions taken other than to complete Form 4.

Estimate the concentration produced by the interfering element in all affected samples. See the guidelines for examples. List the samples affected by the interferences below:

SAMPLE AFFECTED	ELEMENT AFFECTED	SAMPLE CONC. (µg/L)	SAMPLE INTERFERENT CONC. (µg/L) AL	CA	FE	MG	ESTIMATED. INTERF (µg/L)

ACTIONS:

1. In general, the sample data can be accepted without qualification if the sample concentrations of Al, Ca, Fe, and Mg are less than 50% of their respective levels in the ICS solution.
2. Estimate (J) positive results for affected elements for samples with levels of interferents 50% or more of that in the ICS solution.
3. Reject (R) positive results if the reported concentration is due entirely to the interfering element.
4. Estimate (UJ) non-detected results for which false negatives are suspect.

Give an explanation for any actions taken below:

____
____
____

Region I
Inorganic Data Review Worksheets

VI. MATRIX SPIKE

TR # SB-1/0-15 Matrix: Soil

1. Recovery Criteria

List the percent recoveries for analytes which did not meet the required criteria.

S - amount of spike added
SSR - spiked sample result
SR - sample result

applies to all sampl

ANALYTE	SSR	SR	S	%R	ACTION
Antimony	8.6357	8.7259	22.74	~~-.26~~ 0.4	J(+)/R(ND)
Lead	90.0578	1962.9767	22.74	-8258.2	~~J(+)/R(ND)~~ no action sample concentration >4x spike added

DAT 4/28/03

Matrix Spike Actions apply to all samples of the same matrix.

ACTIONS:

1. If the sample concentration exceed the spike concentration by a factor of 4 or more, no action is taken.
2. If any analyte does not meet the %R criteria, follow the actions stated below:

	PERCENT RECOVERY		
	< 30%	30%-74%	>125%
Positive Sample Results	J	J	J
Non-detected Results	R	UJ	A

2. Frequency Criteria

A. Was a matrix spike prepared at the required frequency? [✓ Yes] or No
B. Was a post digestion spike analyzed for elements that did not meet the required criteria for matrix spike recovery? [✓ Yes] or No

A separate worksheet should be filled out for each matrix spike pair.

Region I
Inorganic Data Review Worksheets

VII. LABORATORY DUPLICATES

List the concentrations of any analyte not meeting the criteria for duplicate precision. For soil duplicates, calculate the CRDL in mg/kg using the sample weight, volume and percent solids data for the sample. Indicate what criteria was used to evaluate precision by circling either the RPD or CRDL for each element.

Matrix: Soil

EXD 4/14

ELEMENT	CRDL WATER ug/L	 SOIL [✓ mg/kg]	SAMPLE # SB-1/0-1	DUPLICATE # SB-1/0-1D	RPD	ACTION
Aluminum	200					
Antimony	60	~~1.88~~ 1.0	8.7729	0.1499 U	200.0	J(+) ~~diffx2= 17.246~~
Arsenic	10		~~.9753~~	~~.6638~~	~~38.0~~	diff=8.625 >2xCRDL
Barium	200		9.29	6.84	30	~~(J/UJ)~~
Beryllium	5	.25	.9753	.6638	38.0	~~J(+)~~ ~~diffx2= .623~~
Cadmium	5					diff=.3115 <2xCRDL
Calcium	5000					
Chromium	10					
Cobalt	50					
Copper	25		31.3	26.5	33.6	(J/UJ)
Iron	100					
Lead	5	.50	1967.9767	59.0026	188.4	J(+) 75x CRDL
Magnesium	5000					
Manganese	15					
Mercury	0.2					
Nickel	40		22.7	17.3	[illegible].9	(J/UJ)
Potassium	5000					
Selenium	5					EXD 4/14/03
Silver	10	1.50	.8728 B	0.2568 B	109.1	~~X 2xCRDL/Diff=1.232~~ no action
Sodium	5000					diff=.616 <2xCRDL
Thallium	10					no action
Vanadium	50					
Zinc	20					
Cyanide	10					

Laboratory duplicate actions should be applied to all other samples of the same matrix type.

ACTION:

20% for soils per method.

1. Estimate (J) positive results for elements which have an RPD > 20% for waters and > 35% for soils.
2. If sample results are less than 5X the CRDL, estimate (J) positive results for elements whose absolute difference is > CRDL (2X CRDL for soils). If both samples are non-detected, the RPD is not calculated (NC).

XI. INDUCTIVELY COUPLED PLASMA (ICP) SERIAL DILUTION ANALYSIS

✓ Serial dilutions were performed for each matrix and results of the diluted sample analysis agreed within ± 10% of the original undiluted analysis.

_____ Serial dilution was not performed for the following:

_____ Serial dilutions were performed, but analytical results did not agree within ± 10% for analyte concentrations greater than 50X the IDL before dilution.

Report all results below that do not meet the required laboratory criteria for ICP serial dilution analysis.

Matrix: Soil SB-H0-1L

SD 5/5B

ELEMENT	IDL Mg/L	50X IDL	SAMPLE RESULT	SERIAL DILUTION	% D	ACTION
Aluminum						
Antimony	3.0	150	175.55	193.0	9.9	none
Barium	4.0		1368.45	1527.05	11.6	(J)
Beryllium	5	25	19.52	23.70 B	21.4	NE < 50x IDL
Cadmium	.7	35	24.61	26.77	7.9	none; NE < 50xI
Calcium						
Chromium	.6	30	504.69	542.31	7.5	none
Cobalt						
Copper	4.0	200	745.47	757.98	1.7	none
Iron						4/28/03
Lead	4.0	200	39379.21	44030.46	11.8	~~none~~ (J)
Magnesium						
Manganese						DAT 4/28/03
Nickel	.8	40	453.65	505.86	11.5	~~none~~ (J)
Potassium						
Silver	2.0	100	17.46 B	21.23 B	21.6	NE < 50x IDL
Sodium						
Vanadium						DAT 4/28/03
Zinc	7.0	350	1583.86	1780.93	2.4	~~none~~ (J)

Actions apply to all samples of the same matrix

ACTIONS:

1. Estimate (J) all positive results and (UJ) all nondetects if the % D > ~~15~~%.

10% per method!

DAT 4/28/03

Region I
Inorganic Data Review Worksheets

XIII. SAMPLE QUANTITATION (continued)

List the positive sample results that were reported at concentrations less than 2xIDL and have not already been qualified. The positive results have been estimated (J) due to uncertainty in the quantitation near the IDL.

Analyte	Samples Affected
Selenium	SB-3/7-9 ; SB-2/7-9 ; SB-8/0-1; SB-9/0-1
☆-☆ Silver	SB-1/0-1 ; SB-1/5-7; SB-1/17-19 + SB-3/13-15.
☆☆ thalium	SB-1/0-1, SB-1/5-7; SB-1/17-19, SB-3/0-1 SB3/13-15, SB-2/7-9, SB-10/ SB-8/7-9, SB-10/9-11, + SB-5/9-11
☆☆ Mercury	SB-10/13-15
☆☆ cadmium	SB-1/17-19 ; SB-3/7-9; SB-3/13-15 ; SB-2/11-13; SB-9/0-1 SB-9/13-15 SB-10/13 , SB-10/9-11
☆ antimony	SB-9/17-19 SB-3/7-9; SB-3/13-15 SB-2/0-1 SB-2/7-9 SB2/11 SB-9/13-15 SB-8/0-1; SB-9/0-1; SB-9/5-7 SB-10/13-15

☆ the antimony results were qualified as non detect due to ~~tot~~ blank contamination + were further qualified as rejected due to poor MS/MSD.

☆☆ all ~~conts~~ samples for these analytes were qualified as ND due to blank contamination. except Ag in SB-1/0-1

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-6/0-1
Lab ID: B0428-01A
Matrix: Soil, 78% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/13/03
Date Received: 3/14/03
Date Extracted: 3/21/03
Date Analyzed: 4/13/03 F1, 4/13/03 F2
Dilution: 1

RS
6/10/03

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	9,500 J	3,800
C19 - C36 Aliphatics	180,000 J	5,100
C11 - C22 Aromatics	400,000 J	11,000
Target Analytes		
Acenaphthene	2,900 J	640
Acenaphthylene	~~ND~~ 640 UJ	640
Anthracene	6,900 J	640
Benzo(a)anthracene	21,000 J	640
Benzo(a)pyrene	16,000 J	640
Benzo(b)fluoranthene	27,000 J	640
Benzo(ghi)perylene	8,000 J	640
Benzo(k)fluoranthene	8,900 J	640
Chrysene	20,000 J	640
Dibenzo(a,h)anthracene	3,300 J	640
Fluoranthene	44,000 J	640
Fluorene	2,400 J	640
Indeno(1,2,3-cd)pyrene	11,000 J	640
Naphthalene	800 J	640
Phenanthrene	23,000 J	640
Pyrene	42,000 J	640
2-Methylnaphthalene	~~ND~~ 640 UJ	640

QC Batch: MB-6238

Surrogate Recovery (%):	
Chlorooctadecane	47%
o-Terphenyl	56%
2-Fluorobiphenyl	89%
2-Bromonaphthalene	87%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-6/5-7
Lab ID: B0428-02A
Matrix: Soil, 84% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/13/03
Date Received: 3/14/03
Date Extracted: 3/21/03
Date Analyzed: 4/14/03 F1, 4/13/03 F2
Dilution: 1

RS
6/10/03

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	7,900 J	3,500
C19 - C36 Aliphatics	46,000 J	4,700
C11 - C22 Aromatics	220,000 J	10,000
Target Analytes		
Acenaphthene	4,100 J	590
Acenaphthylene	~~ND~~ 590 UJ	590
Anthracene	8,100 J	590
Benzo(a)anthracene	14,000 J	590
Benzo(a)pyrene	9,200 J	590
Benzo(b)fluoranthene	16,000 J	590
Benzo(ghi)perylene	4,400 J	590
Benzo(k)fluoranthene	5,400 J	590
Chrysene	15,000 J	590
Dibenzo(a,h)anthracene	1,800 J	590
Fluoranthene	39,000 J	590
Fluorene	3,900 J	590
Indeno(1,2,3-cd)pyrene	6,600 J	590
Naphthalene	920 J	590
Phenanthrene	38,000 J	590
Pyrene	35,000 J	590
2-Methylnaphthalene	720 J	590

QC Batch: MB-6238

Surrogate Recovery (%):	
Chlorooctadecane	46%
o-Terphenyl	51%
2-Fluorobiphenyl	88%
2-Bromonaphthalene	85%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.	
Analysis: MADEP EPH 98-1	Date Collected: 3/13/03
Client ID: SB-6/14-16	Date Received: 3/14/03
Lab ID: B0428-03A	Date Extracted: 3/21/03
Matrix: Soil, 76% Solid	Date Analyzed: 4/13/03 F1, 4/14/03 F2
Concentration in: ug/kg, dry weight basis	Dilution: 1

RS
6/10/03

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	11,000 J	4,000
C19 - C36 Aliphatics	7,500 J	5,300
C11 - C22 Aromatics	14,000 J	11,000
Target Analytes		
Acenaphthene	~~ND~~ 660 UJ	660
Acenaphthylene	~~ND~~ 660 UJ	660
Anthracene	~~ND~~ 660 UJ	660
Benzo(a)anthracene	~~ND~~ 660 UJ	660
Benzo(a)pyrene	~~ND~~ 660 UJ	660
Benzo(b)fluoranthene	~~ND~~ 660 UJ	660
Benzo(ghi)perylene	~~ND~~ 660 UJ	660
Benzo(k)fluoranthene	~~ND~~ 660 UJ	660
Chrysene	~~ND~~ 660 UJ	660
Dibenzo(a,h)anthracene	~~ND~~ 660 UJ	660
Fluoranthene	~~ND~~ 660 UJ	660
Fluorene	~~ND~~ 660 UJ	660
Indeno(1,2,3-cd)pyrene	~~ND~~ 660 UJ	660
Naphthalene	~~ND~~ 660 UJ	660
Phenanthrene	~~ND~~ 660 UJ	660
Pyrene	~~ND~~ 660 UJ	660
2-Methylnaphthalene	~~ND~~ 660 UJ	660

QC Batch: MB-6238

Surrogate Recovery (%):	
Chlorooctadecane	79%
o-Terphenyl	80%
2-Fluorobiphenyl	93%
2-Bromonaphthalene	88%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: KSB-6/14-16
Lab ID: B0428-04A
Matrix: Soil, 76% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/13/03
Date Received: 3/14/03
Date Extracted: 3/21/03
Date Analyzed: 4/13/03 F1, 4/13/03 F2
Dilution: 1

RS
6/10/03

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	12,000 J	3,900
C19 - C36 Aliphatics	6,400 J	5,200
C11 - C22 Aromatics	~~ND~~ 11,000 UJ	11,000
Target Analytes		
Acenaphthene	~~ND~~ 640 UJ	640
Acenaphthylene	~~ND~~ 640 UJ	640
Anthracene	~~ND~~ 640 UJ	640
Benzo(a)anthracene	~~ND~~ 640 UJ	640
Benzo(a)pyrene	~~ND~~ 640 UJ	640
Benzo(b)fluoranthene	~~ND~~ 640 UJ	640
Benzo(ghi)perylene	~~ND~~ 640 UJ	640
Benzo(k)fluoranthene	~~ND~~ 640 UJ	640
Chrysene	~~ND~~ 640 UJ	640
Dibenzo(a,h)anthracene	~~ND~~ 640 UJ	640
Fluoranthene	~~ND~~ 640 UJ	640
Fluorene	~~ND~~ 640 UJ	640
Indeno(1,2,3-cd)pyrene	~~ND~~ 640 UJ	640
Naphthalene	~~ND~~ 640 UJ	640
Phenanthrene	~~ND~~ 640 UJ	640
Pyrene	~~ND~~ 640 UJ	640
2-Methylnaphthalene	~~ND~~ 640 UJ	640

Surrogate Recovery (%):	
Chlorooctadecane	72%
o-Terphenyl	73%
2-Fluorobiphenyl	92%
2-Bromonaphthalene	87%

QC Batch: MB-6238

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-7/0-1
Lab ID: B0428-05A
Matrix: Soil, 70% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/14/03
Date Received: 3/14/03
Date Extracted: 3/21/03
Date Analyzed: 4/14/03 F1, 4/14/03 F2
Dilution: 1

6/10/03

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	16,000	4,200
C19 - C36 Aliphatics	12,000	5,200
C11 - C22 Aromatics	35,000	12,000
Target Analytes		
Acenaphthene	~~ND~~ 710 U	710
Acenaphthylene	~~ND~~ 710 U	710
Anthracene	~~ND~~ 710 U	710
Benzo(a)anthracene	~~ND~~ 710 U	710
Benzo(a)pyrene	~~ND~~ 710 U	710
Benzo(b)fluoranthene	900	710
Benzo(ghi)perylene	~~ND~~ 710 U	710
Benzo(k)fluoranthene	~~ND~~ 710 U	710
Chrysene	720	710
Dibenzo(a,h)anthracene	~~ND~~ 710 U	710
Fluoranthene	1,500	710
Fluorene	~~ND~~ 710 U	710
Indeno(1,2,3-cd)pyrene	~~ND~~ 710 U	710
Naphthalene	~~ND~~ 710 U	710
Phenanthrene	960	710
Pyrene	1,300	710
2-Methylnaphthalene	~~ND~~ 710 U	710

QC Batch: MB-6238

Surrogate Recovery (%):	
Chlorooctadecane	76%
o-Terphenyl	77%
2-Fluorobiphenyl	92%
2-Bromonaphthalene	89%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-7/7-9
Lab ID: B0428-06A
Matrix: Soil, 84% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/14/03
Date Received: 3/14/03
Date Extracted: 3/21/03
Date Analyzed: 4/14/03 F1, 4/14/03 F2
Dilution: 1

RS
6/10/03

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	13,000	3,600
C19 - C36 Aliphatics	32,000	4,800
C11 - C22 Aromatics	120,000	10,000
Target Analytes		
Acenaphthene	1,000	600
Acenaphthylene	~~ND~~ 600 U	600
Anthracene	2,400	600
Benzo(a)anthracene	5,900	600
Benzo(a)pyrene	4,200	600
Benzo(b)fluoranthene	6,800	600
Benzo(ghi)perylene	2,200	600
Benzo(k)fluoranthene	2,500	600
Chrysene	5,700	600
Dibenzo(a,h)anthracene	880	600
Fluoranthene	13,000	600
Fluorene	990	600
Indeno(1,2,3-cd)pyrene	3,000	600
Naphthalene	~~ND~~ 600 U	600
Phenanthrene	8,300	600
Pyrene	12,000	600
2-Methylnaphthalene	~~ND~~ 600U	600

QC Batch: MB-6238

Surrogate Recovery (%):	
Chlorooctadecane	59%
o-Terphenyl	66%
2-Fluorobiphenyl	90%
2-Bromonaphthalene	87%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-5/0-1
Lab ID: B0428-07A
Matrix: Soil, 78% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/14/03
Date Received: 3/14/03
Date Extracted: 3/21/03
Date Analyzed: 4/14/03 F1, 4/14/03 F2
Dilution: 1

(15)
6/10/03

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	9,100	3,800
C19 - C36 Aliphatics	10,000	5,100
C11 - C22 Aromatics	65,000	11,000
Target Analytes		
Acenaphthene	~~ND~~ 640 U	640
Acenaphthylene	~~ND~~ 640 U	640
Anthracene	1,200	640
Benzo(a)anthracene	2,400	640
Benzo(a)pyrene	1,800	640
Benzo(b)fluoranthene	3,000	640
Benzo(ghi)perylene	~~ND~~ 640 U	640
Benzo(k)fluoranthene	1,200	640
Chrysene	2,400	640
Dibenzo(a,h)anthracene	~~ND~~ 640 U	640
Fluoranthene	6,000	640
Fluorene	~~ND~~ 640 U	640
Indeno(1,2,3-cd)pyrene	1,300	640
Naphthalene	~~ND~~ 640 U	640
Phenanthrene	4,800	640
Pyrene	5,400	640
2-Methylnaphthalene	~~ND~~ 640 U	640

Surrogate Recovery (%):	
Chlorooctadecane	64%
o-Terphenyl	68%
2-Fluorobiphenyl	85%
2-Bromonaphthalene	88%

QC Batch: MB-6238

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-5/9-11
Lab ID: B0428-08A
Matrix: Soil, 84% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/14/03
Date Received: 3/14/03
Date Extracted: 3/21/03
Date Analyzed: 4/14/03 F1, 4/14/03 F2
Dilution: 1

PS
6/16/03

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	7,800	3,500
C19 - C36 Aliphatics	~~ND~~ 4700 U	4,700
C11 - C22 Aromatics	32,000	10,000
Target Analytes		
Acenaphthene	~~ND~~ 590 U	590
Acenaphthylene	~~ND~~ 590 U	590
Anthracene	~~ND~~ 590 U	590
Benzo(a)anthracene	890	590
Benzo(a)pyrene	620	590
Benzo(b)fluoranthene	1,000	590
Benzo(ghi)perylene	~~ND~~ 590 U	590
Benzo(k)fluoranthene	~~ND~~ 590 U	590
Chrysene	900	590
Dibenzo(a,h)anthracene	~~ND~~ 590 U	590
Fluoranthene	2,000	590
Fluorene	~~ND~~ 590 U	590
Indeno(1,2,3-cd)pyrene	~~ND~~ 590 U	590
Naphthalene	~~ND~~ 590 U	590
Phenanthrene	1,700	590
Pyrene	1,900	590
2-Methylnaphthalene	~~ND~~ 590 U	590

QC Batch: MB-6238

Surrogate Recovery (%):	
Chlorooctadecane	68%
o-Terphenyl	69%
2-Fluorobiphenyl	94%
2-Bromonaphthalene	92%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-5/14-16
Lab ID: B0428-09A
Matrix: Soil, 78% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/14/03
Date Received: 3/14/03
Date Extracted: 3/21/03
Date Analyzed: 4/14/03 F1, 4/14/03 F2
Dilution: 1

RS
6/10/03

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	11,000	3,800
C19 - C36 Aliphatics	~~ND~~ 5000 U	5,000
C11 - C22 Aromatics	19,000	11,000

Target Analytes	Results	Reporting Limits
Acenaphthene	~~ND~~ 630 U	630
Acenaphthylene	~~ND~~ 630 U	630
Anthracene	~~ND~~ 630 U	630
Benzo(a)anthracene	~~ND~~ 630 U	630
Benzo(a)pyrene	~~ND~~ 630 U	630
Benzo(b)fluoranthene	~~ND~~ 630 U	630
Benzo(ghi)perylene	~~ND~~ 630 U	630
Benzo(k)fluoranthene	~~ND~~ 630 U	630
Chrysene	~~ND~~ 630 U	630
Dibenzo(a,h)anthracene	~~ND~~ 630 U	630
Fluoranthene	~~ND~~ 630 U	630
Fluorene	~~ND~~ 630 U	630
Indeno(1,2,3-cd)pyrene	~~ND~~ 630 U	630
Naphthalene	~~ND~~ 630 U	630
Phenanthrene	~~ND~~ 630 U	630
Pyrene	~~ND~~ 630 U	630
2-Methylnaphthalene	~~ND~~ 630 U	630

QC Batch: MB-6238

Surrogate Recovery (%):	
Chlorooctadecane	76%
o-Terphenyl	72%
2-Fluorobiphenyl	86%
2-Bromonaphthalene	85%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-4/0-1
Lab ID: B0428-11A
Matrix: Soil, 75% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/17/03
Date Received: 3/17/03
Date Extracted: 3/21/03
Date Analyzed: 4/14/03 F1, 4/14/03 F2
Dilution: 1

RS
6/10/03

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	11,000	4,000
C19 - C36 Aliphatics	66,000	5,300
C11 - C22 Aromatics	110,000	11,000
Target Analytes		
Acenaphthene	~~ND~~ 670 U	670
Acenaphthylene	~~ND~~ 670 U	670
Anthracene	880	670
Benzo(a)anthracene	2,000	670
Benzo(a)pyrene	1,500	670
Benzo(b)fluoranthene	2,500	670
Benzo(ghi)perylene	~~ND~~ 670 U	670
Benzo(k)fluoranthene	960	670
Chrysene	1,900	670
Dibenzo(a,h)anthracene	~~ND~~ 670 U	670
Fluoranthene	4,500	670
Fluorene	~~ND~~ 670 U	670
Indeno(1,2,3-cd)pyrene	1,100	670
Naphthalene	~~ND~~ 670 U	670
Phenanthrene	2,800	670
Pyrene	4,300	670
2-Methylnaphthalene	~~ND~~ 670 U	670

QC Batch: MB-6238

Surrogate Recovery (%):	
Chlorooctadecane	61%
o-Terphenyl	65%
2-Fluorobiphenyl	96%
2-Bromonaphthalene	94%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-4/5-7
Lab ID: B0428-12A
Matrix: Soil, 91% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/17/03
Date Received: 3/17/03
Date Extracted: 3/21/03
Date Analyzed: 4/14/03 F1, 4/14/03 F2
Dilution: 1

RS
6/10/03

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	8,500	3,300
C19 - C36 Aliphatics	49,000	4,400
C11 - C22 Aromatics	160,000	9,300
Target Analytes		
Acenaphthene	1,400	550
Acenaphthylene	~~ND~~ 550 U	550
Anthracene	3,500	550
Benzo(a)anthracene	6,500	550
Benzo(a)pyrene	4,700	550
Benzo(b)fluoranthene	7,700	550
Benzo(ghi)perylene	2,200	550
Benzo(k)fluoranthene	2,700	550
Chrysene	6,300	550
Dibenzo(a,h)anthracene	900	550
Fluoranthene	14,000	550
Fluorene	1,600	550
Indeno(1,2,3-cd)pyrene	3,100	550
Naphthalene	620	550
Phenanthrene	12,000	550
Pyrene	13,000	550
2-Methylnaphthalene	~~ND~~ 550 U	550

QC Batch: MB-6238

Surrogate Recovery (%):	
Chlorooctadecane	54%
o-Terphenyl	61%
2-Fluorobiphenyl	85%
2-Bromonaphthalene	85%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: SB-4/13-15
Lab ID: B0428-13A
Matrix: Soil, 76% Solid
Concentration in: ug/kg, dry weight basis

Date Collected: 3/17/03
Date Received: 3/17/03
Date Extracted: 3/21/03
Date Analyzed: 4/14/03 F1, 4/14/03 F2
Dilution: 1

RS
6/10/03

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	13,000 J	3,900
C19 - C36 Aliphatics	14,000	5,200
C11 - C22 Aromatics	~~ND~~ 11,000 U	11,000
Target Analytes		
Acenaphthene	~~ND~~ 650 U	650
Acenaphthylene	~~ND~~ 650 U	650
Anthracene	~~ND~~ 650 U	650
Benzo(a)anthracene	~~ND~~ 650 U	650
Benzo(a)pyrene	~~ND~~ 650 U	650
Benzo(b)fluoranthene	~~ND~~ 650 U	650
Benzo(ghi)perylene	~~ND~~ 650 U	650
Benzo(k)fluoranthene	~~ND~~ 650 U	650
Chrysene	~~ND~~ 650 U	650
Dibenzo(a,h)anthracene	~~ND~~ 650 U	650
Fluoranthene	~~ND~~ 650 U	650
Fluorene	~~ND~~ 650 U	650
Indeno(1,2,3-cd)pyrene	~~ND~~ 650 U	650
Naphthalene	~~ND~~ 650 U	650
Phenanthrene	~~ND~~ 650 U	650
Pyrene	~~ND~~ 650 U	650
2-Methylnaphthalene	~~ND~~ 650 U	650

QC Batch: MB-6238

Surrogate Recovery (%):	
Chlorooctadecane	64%
o-Terphenyl	67%
2-Fluorobiphenyl	92%
2-Bromonaphthalene	86%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-6/0-1

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0428

Matrix: (soil/water) SOIL Lab Sample ID: B0428-01A

Sample wt/vol: 30.5 (g/mL) G Lab File ID: E1E0287F

% Moisture: 22 decanted: (Y/N) N Date Received: 03/14/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/27/03

Concentrated Extract Volume: 10000 (uL) Date Analyzed: 04/01/03

Injection Volume: 1.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

TD

6/16/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	42	U
11104-28-2	Aroclor-1221	42	U
11141-16-5	Aroclor-1232	42	U
53469-21-9	Aroclor-1242	42	U
12672-29-6	Aroclor-1248	42	U
11097-69-1	Aroclor-1254	210	
11096-82-5	Aroclor-1260	42	UJ

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-6/5-7

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0428

Matrix: (soil/water) SOIL Lab Sample ID: B0428-02A

Sample wt/vol: 30.1 (g/mL) G Lab File ID: E1E0288F

% Moisture: 16 decanted: (Y/N) N Date Received: 03/14/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/27/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 04/01/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

RJ
6/10/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	------Aroclor-1016	40	U
11104-28-2	------Aroclor-1221	40	U
11141-16-5	------Aroclor-1232	40	U
53469-21-9	------Aroclor-1242	40	U
12672-29-6	------Aroclor-1248	40	U
11097-69-1	------Aroclor-1254	680	
11096-82-5	------Aroclor-1260	40	UJ

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-6/14-16

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0428

Matrix: (soil/water) SOIL Lab Sample ID: B0428-03A

Sample wt/vol: 30.5 (g/mL) G Lab File ID: E1B0289F

% Moisture: 24 decanted: (Y/N) N Date Received: 03/14/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/27/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 04/01/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

Ⓡ 6/10/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	43	U
11104-28-2	Aroclor-1221	43	U
11141-16-5	Aroclor-1232	43	U
53469-21-9	Aroclor-1242	43	U
12672-29-6	Aroclor-1248	43	U
11097-69-1	Aroclor-1254	43	U
11096-82-5	Aroclor-1260	43	UJ

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

KSB-6/14-16

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0428

Matrix: (soil/water) SOIL Lab Sample ID: B0428-04A

Sample wt/vol: 30.0 (g/mL) G Lab File ID: E1E0290F

% Moisture: 24 decanted: (Y/N) N Date Received: 03/14/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/27/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 04/01/03 PS

Injection Volume: 1.0(uL) Dilution Factor: 1.0 6/10/03

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	44	U
11104-28-2	Aroclor-1221	44	U
11141-16-5	Aroclor-1232	44	U
53469-21-9	Aroclor-1242	44	U
12672-29-6	Aroclor-1248	44	U
11097-69-1	Aroclor-1254	44	U
11096-82-5	Aroclor-1260	44	UJ

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-7/0-1

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0428

Matrix: (soil/water) SOIL Lab Sample ID: B0428-05A

Sample wt/vol: 30.1 (g/mL) G Lab File ID: E1E0291F

% Moisture: 30 decanted: (Y/N) N Date Received: 03/14/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/27/03

Concentrated Extract Volume: 10000 (uL) Date Analyzed: 04/01/03

6/10/03

Injection Volume: 1.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	------Aroclor-1016	47	U
11104-28-2	------Aroclor-1221	47	U
11141-16-5	------Aroclor-1232	47	U
53469-21-9	------Aroclor-1242	47	U
12672-29-6	------Aroclor-1248	47	U
11097-69-1	------Aroclor-1254	47	U
11096-82-5	------Aroclor-1260	47	UJ

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-7/7-9

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0428

Matrix: (soil/water) SOIL Lab Sample ID: B0428-06A

Sample wt/vol: 30.4 (g/mL) G Lab File ID: E1E0292F

% Moisture: 16 decanted: (Y/N) N Date Received: 03/14/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/27/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 04/01/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

PS
6/10/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2------	Aroclor-1016	39	U
11104-28-2------	Aroclor-1221	39	U
11141-16-5------	Aroclor-1232	39	U
53469-21-9------	Aroclor-1242	39	U
12672-29-6------	Aroclor-1248	39	U
11097-69-1------	Aroclor-1254	100	
11096-82-5------	Aroclor-1260	39	UJ

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.
SB-5/0-1

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0428

Matrix: (soil/water) SOIL Lab Sample ID: B0428-07A

Sample wt/vol: 30.2 (g/mL) G Lab File ID: E1E0293F

% Moisture: 22 decanted: (Y/N) N Date Received: 03/14/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/27/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 04/01/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

RS
6/10/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	42	U
11104-28-2	Aroclor-1221	42	U
11141-16-5	Aroclor-1232	42	U
53469-21-9	Aroclor-1242	42	U
12672-29-6	Aroclor-1248	42	U
11097-69-1	Aroclor-1254	88	
11096-82-5	Aroclor-1260	42	UJ

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-5/9-11

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0428

Matrix: (soil/water) SOIL Lab Sample ID: B0428-08A

Sample wt/vol: 30.6 (g/mL) G Lab File ID: E1E0294F

% Moisture: 16 decanted: (Y/N) N Date Received: 03/14/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/27/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 04/02/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

RS
6/16/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	39	U
11104-28-2	Aroclor-1221	39	U
11141-16-5	Aroclor-1232	39	U
53469-21-9	Aroclor-1242	39	U
12672-29-6	Aroclor-1248	39	U
11097-69-1	Aroclor-1254	39	U
11096-82-5	Aroclor-1260	39	UJ

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-5/14-16

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0428

Matrix: (soil/water) SOIL Lab Sample ID: B0428-09A

Sample wt/vol: 30.5 (g/mL) G Lab File ID: E1E0303F

% Moisture: 22 decanted: (Y/N) N Date Received: 03/14/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted:03/27/03

6/10/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 04/02/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	------Aroclor-1016	42	U
11104-28-2	------Aroclor-1221	42	U
11141-16-5	------Aroclor-1232	42	U
53469-21-9	------Aroclor-1242	42	U
12672-29-6	------Aroclor-1248	42	U
11097-69-1	------Aroclor-1254	42	U
11096-82-5	------Aroclor-1260	42	U

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-4/0-1

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0428

Matrix: (soil/water) SOIL Lab Sample ID: B0428-11A

Sample wt/vol: 30.5 (g/mL) G Lab File ID: E1E0307F

% Moisture: 25 decanted: (Y/N) N Date Received: 03/17/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/27/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 04/02/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

RS

6/10/03

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	Aroclor-1016	44	U
11104-28-2	Aroclor-1221	44	U
11141-16-5	Aroclor-1232	44	U
53469-21-9	Aroclor-1242	44	U
12672-29-6	Aroclor-1248	44	U
11097-69-1	Aroclor-1254	71	
11096-82-5	Aroclor-1260	44	U

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-4/5-7

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0428

Matrix: (soil/water) SOIL Lab Sample ID: B0428-12A

Sample wt/vol: 30.2 (g/mL) G Lab File ID: E1E0308F

RS 6/16/03

% Moisture: 9 decanted: (Y/N) N Date Received: 03/17/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/27/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 04/02/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	------Aroclor-1016	36	U
11104-28-2	------Aroclor-1221	36	U
11141-16-5	------Aroclor-1232	36	U
53469-21-9	------Aroclor-1242	36	U
12672-29-6	------Aroclor-1248	36	U
11097-69-1	------Aroclor-1254	140	
11096-82-5	------Aroclor-1260	36	U

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

SB-4/13-15

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0428

Matrix: (soil/water) SOIL Lab Sample ID: B0428-13A

Sample wt/vol: 30.1 (g/mL) G Lab File ID: E1E0309F

% Moisture: 24 decanted: (Y/N) N Date Received: 03/17/03

6/10/03

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 03/27/03

Concentrated Extract Volume: 10000 (uL) Date Analyzed: 04/02/03

Injection Volume: 1.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
12674-11-2	------Aroclor-1016	44	U
11104-28-2	------Aroclor-1221	44	U
11141-16-5	------Aroclor-1232	44	U
53469-21-9	------Aroclor-1242	44	U
12672-29-6	------Aroclor-1248	44	U
11097-69-1	------Aroclor-1254	44	U
11096-82-5	------Aroclor-1260	44	U

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

KSB-6/14-16

Lab Name:	MITKEM_CORPORATION	Contract:			
Lab Code:	MITKEM	Case No.:		SAS No.:	
SDG No.:	B0428				
Matrix (soil/water):	SOIL	Lab Sample ID:	B0428-04A		
Level (low/med):	MED	Date Received:	03/14/03		
% Solids:	76.0				

Concentration Units (ug/L or mg/kg dry weight): MG/KG

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6/10/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	~~0.18~~ R	~~U~~	~~*N~~	P
7440-38-2	Arsenic	3.7 J		~~EN~~	P
7440-39-3	Barium	12.8 J		~~E~~	P
7440-41-7	Beryllium	0.55			P
7440-43-9	Cadmium	0.051 J	~~B~~	~~N~~	P
7440-70-2	Calcium				NR
7440-47-3	Chromium	16.4 J		~~E~~	P
7440-48-4	Cobalt				NR
7440-50-8	Copper	4.0 U			P
7439-89-6	Iron				NR
7439-92-1	Lead	3.8 J		~~E~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.018 UJ	~~U~~		CV
7440-02-0	Nickel	10.6 J			P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.55	U		P
7440-22-4	Silver	0.12	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	0.18	U		P
7440-62-2	Vanadium	157 J			P
7440-66-6	Zinc	17.9 J		~~EN~~	P
	Cyanide				NR

Color Before:		Clarity Before:		Texture:	
Color After:		Clarity After:		Artifacts:	

Comments:

85

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1
INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-4/0-1

Lab Name: MITKEM_CORPORATION________ Contract: __________

ab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0428__

atrix (soil/water): SOIL____ Lab Sample ID: B0428-11A_____

Level (low/med): MED____ Date Received: 03/17/03____

Solids: 75.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

Ⓡ
6/16/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	1.1 UJ	~~B~~	~~*N~~	P
7440-38-2	Arsenic	11.1 J		~~EN~~	P
7440-39-3	Barium	53.3 J		~~E~~	P
7440-41-7	Beryllium	1.0			P
7440-43-9	Cadmium	1.0		~~N~~	P
7440-70-2	Calcium				NR
7440-47-3	Chromium	40.4 J		~~E~~	P
7440-48-4	Cobalt				NR
7440-50-8	Copper	19.3			P
7439-89-6	Iron				NR
7439-92-1	Lead	35.5 J		~~E~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	~~0.26~~ R			CV
7440-02-0	Nickel	27.4 J		~~E~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.53 UJ	~~U~~		P
7440-22-4	Silver	0.12 UJ	~~B~~		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	0.96 J	~~B~~		P
7440-62-2	Vanadium	45.7 J		~~*~~	P
7440-66-6	Zinc	57.9 J		~~EN~~	P
	Cyanide				NR

lor Before: __________ Clarity Before: ________ Texture: _______

Color After: __________ Clarity After: ________ Artifacts: _______

mments:

FORM I - IN SW846

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1
INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.
SB-4/13-15

Lab Name: MITKEM_CORPORATION______ Contract: ________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0428__

Matrix (soil/water): SOIL____ Lab Sample ID: B0428-13A_____

Level (low/med): MED____ Date Received: 03/17/03____

% Solids: 76.0____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

RS
6/10/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	0.91 ~~0.21~~ UJ	~~B~~	~~N~~	P
7440-38-2	Arsenic	4.4 J		EN	P
7440-39-3	Barium	20.0 J		~~E~~	P
7440-41-7	Beryllium	1.1			P
7440-43-9	Cadmium	0.22 J	~~B~~	~~N~~	P
7440-70-2	Calcium				NR
7440-47-3	Chromium	20.8 J		~~E~~	P
7440-48-4	Cobalt				NR
7440-50-8	Copper	3.9 U			P
7439-89-6	Iron				NR
7439-92-1	Lead	4.6 J		~~E~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	~~0.010~~ R	~~U~~		CV
7440-02-0	Nickel	[illegible] J		~~E~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.48 UJ	~~U~~		P
7440-22-4	Silver	0.14 UJ	~~B~~		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	0.61 J	~~B~~		P
7440-62-2	Vanadium	15.7 J			P
7440-66-6	Zinc	23.2 J		~~EN~~	P
	Cyanide				NR

Color Before: ________ Clarity Before: ________ Texture: ________

Color After: ________ Clarity After: ________ Artifacts: ________

Comments:

87R

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-4/5-7

ab Name: MITKEM_CORPORATION________ Contract: __________

ab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0428__

atrix (soil/water): SOIL____ Lab Sample ID: B0428-12A_____

Level (low/med): MED____ Date Received: 03/17/03____

Solids: 91.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

RS

6/16/03

CAS No.	Analyte	Concentration	C	Q	M
_7429-90-5_____	Aluminum_____				NR
_7440-36-0_____	Antimony_____	2.3 J		~~*N~~	P_
_7440-38-2_____	Arsenic_____	31.8 J		~~EN~~	P_
_7440-39-3_____	Barium_____	101 J		~~E~~	P_
_7440-41-7_____	Beryllium_____	0.84			P_
_7440-43-9_____	Cadmium_____	1.7_		~~N~~	P_
_7440-70-2_____	Calcium_____				NR
_7440-47-3_____	Chromium_____	27.0 J		~~E~~	P_
_7440-48-4_____	Cobalt_____				NR
_7440-50-8_____	Copper_____	40.2			P_
_7439-89-6_____	Iron_____				NR
_7439-92-1_____	Lead_____	90.6 J		~~E~~	P_
_7439-95-4_____	Magnesium_____				NR
_7439-96-5_____	Manganese_____				NR
_7439-97-6_____	Mercury_____	~~0.54~~ R			CV
_7440-02-0_____	Nickel_____	19.8 J		~~E*~~	P_
_7440-09-7_____	Potassium_____				NR
_7782-49-2_____	Selenium_____	0.42 UJ	~~U~~		P_
_7440-22-4_____	Silver_____	0.10 UJ	~~B~~		P_
_7440-23-5_____	Sodium_____				NR
_7440-28-0_____	Thallium_____	0.78 J	~~B~~		P_
_7440-62-2_____	Vanadium_____	26.6 J		~~*~~	P_
_7440-66-6_____	Zinc_____	125 J		~~EN~~	P_
	Cyanide_____				NR

lor Before: __________ Clarity Before: ________ Texture: _______

olor After: __________ Clarity After: ________ Artifacts: _______

mments:

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88 R

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-5/0-1

Lab Name: MITKEM_CORPORATION________ Contract: __________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0428__

Matrix (soil/water): SOIL____ Lab Sample ID: B0428-07A_____

Level (low/med): MED____ Date Received: 03/14/03____

% Solids: 78.0____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

6/10/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	~~0.19~~ R	~~U~~	~~N~~	P
7440-38-2	Arsenic	7.0 J		~~EN~~	P
7440-39-3	Barium	20.8 J		~~E~~	P
7440-41-7	Beryllium	0.33 J			P
7440-43-9	Cadmium	0.15 J	~~B~~	~~N~~	P
7440-70-2	Calcium				NR
7440-47-3	Chromium	8.1 J		~~E~~	P
7440-48-4	Cobalt				NR
7440-50-8	Copper	9.0 U			P
7439-89-6	Iron				NR
7439-92-1	Lead	18.2 J		~~E~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.46			CV
7440-02-0	Nickel	11.9 J		~~E~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	1.3 J	~~B~~		P
7440-22-4	Silver	0.12	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	0.19	U		P
7440-62-2	Vanadium	52.8 J			P
7440-66-6	Zinc	29.4 J		~~EN~~	P
	Cyanide				NR

Color Before: ________ Clarity Before: ________ Texture: ________

Color After: ________ Clarity After: ________ Artifacts: ________

Comments:

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-5/14-16

ab Name: MITKEM_CORPORATION________ Contract: __________

ab Code: MITKEM Case No.: ______ SAS No.: _______ SDG No.: B0428__

atrix (soil/water): SOIL____ Lab Sample ID: B0428-09A_____

Level (low/med): MED____ Date Received: 03/14/03____

Solids: 78.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

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RAC LEAD CHEMIST
RECEIVED
MAY 15 2003

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	~~0.16~~ R	~~U~~	~~*N~~	P
7440-38-2	Arsenic	5.7 J		~~EN~~	P
7440-39-3	Barium	24.1 J		~~E~~	P
7440-41-7	Beryllium	0.66			P
7440-43-9	Cadmium	0.038 UJ	~~U~~		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	18.0 J		~~E~~	P
7440-48-4	Cobalt				NR
7440-50-8	Copper	58.8			P
7439-89-6	Iron				NR
7439-92-1	Lead	3.5 J		~~E~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.039 J			CV
7440-02-0	Nickel	12.4 J		~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.49	U		P
7440-22-4	Silver	0.11	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	0.16	U		P
7440-62-2	Vanadium	11.6 J		~~*~~	P
7440-66-6	Zinc	22.5 J		~~EN~~	P
	Cyanide				NR

6/16/03

or Before: __________ Clarity Before: _________ Texture: ________

olor After: __________ Clarity After: _________ Artifacts: ________

mments:

90R

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-5/9-11

Lab Name: MITKEM_CORPORATION________ Contract: __________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0428__

Matrix (soil/water): SOIL____ Lab Sample ID: B0428-08A_____

Level (low/med): MED____ Date Received: 03/14/03____

% Solids: 84.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

RS
6/10/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	1.7 J		~~*N~~	P
7440-38-2	Arsenic	47.4 J		~~EN~~	P
7440-39-3	Barium	55.8 J		~~E~~	P
7440-41-7	Beryllium	0.57			P
7440-43-9	Cadmium	0.75		~~N~~	P
7440-70-2	Calcium				NR
7440-47-3	Chromium	25.3 J		~~E~~	P
7440-48-4	Cobalt				NR
7440-50-8	Copper	27.1			P
7439-89-6	Iron				NR
7439-92-1	Lead	23.5 J		~~E~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	1.1			CV
7440-02-0	Nickel	13.1 J		~~E~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.50 J	~~B~~		P
7440-22-4	Silver	0.10	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	0.82 J	~~B~~		P
7440-62-2	Vanadium	19.1 J			P
7440-66-6	Zinc	33.5 J		~~EN~~	P
	Cyanide				NR

Color Before: __________ Clarity Before: ________ Texture: ________

Color After: __________ Clarity After: ________ Artifacts: ________

Comments:

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-6/0-1

Lab Name:	MITKEM_CORPORATION	Contract:			
b Code:	MITKEM	Case No.:		SAS No.:	SDG No.: B0428
trix (soil/water):	SOIL		Lab Sample ID:	B0428-01A	
Level (low/med):	MED		Date Received:	03/14/03	
Solids:	78.0				

Concentration Units (ug/L or mg/kg dry weight): MG/KG

RS
6/16/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	7.0 J		~~*N~~	P
7440-38-2	Arsenic	49.1 J		~~EN~~	P
7440-39-3	Barium	143 J		~~E~~	P
7440-41-7	Beryllium	0.91			P
7440-43-9	Cadmium	2.0		~~N~~	P
7440-70-2	Calcium				NR
7440-47-3	Chromium	62.9 J		~~E~~	P
7440-48-4	Cobalt				NR
7440-50-8	Copper	70.3			P
7439-89-6	Iron				NR
7439-92-1	Lead	140 J		~~E~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	1.3			CV
7440-02-0	Nickel	100 J		~~E~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.55	U		P
7440-22-4	Silver	0.12	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	0.18	U		P
7440-62-2	Vanadium	376 J		~~*~~	P
7440-66-6	Zinc	274 J		~~EN~~	P
	Cyanide				NR

r Before:		Clarity Before:		Texture:	
olor After:		Clarity After:		Artifacts:	

nents:

FORM I - IN

SW846

92 R

U.S. EPA - CLP

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-6/14-16

Lab Name:	MITKEM_CORPORATION	Contract:			
Lab Code:	MITKEM	Case No.:		SAS No.:	SDG No.: B0428
Matrix (soil/water):	SOIL			Lab Sample ID:	B0428-03A
Level (low/med):	MED			Date Received:	03/14/03
% Solids:	76.0				

Concentration Units (ug/L or mg/kg dry weight): MG/KG

PS
6/10/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	0.96 ~~0.39~~ UJ	~~B~~	~~N~~	P
7440-38-2	Arsenic	4.1 J		~~EN~~	P
7440-39-3	Barium	14.4 J		~~E~~	P
7440-41-7	Beryllium	0.55			P
7440-43-9	Cadmium	0.060 J	~~B~~	~~N~~	P
7440-70-2	Calcium				NR
7440-47-3	Chromium	16.1 J		~~E~~	P
7440-48-4	Cobalt				NR
7440-50-8	Copper	4.1 U			P
7439-89-6	Iron				NR
7439-92-1	Lead	4.6 J		~~E~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.019 UJ	~~U~~		CV
7440-02-0	Nickel	11.4 J		~~E*~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.51	U		P
7440-22-4	Silver	0.11	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	0.17	U		P
7440-62-2	Vanadium	174 J			P
7440-66-6	Zinc	21.1 J		~~EN~~	P
	Cyanide				NR

Color Before:		Clarity Before:		Texture:	
Color After:		Clarity After:		Artifacts:	

Comments:

93R

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-6/5-7

ab Name: MITKEM_CORPORATION________ Contract: __________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0428__

atrix (soil/water): SOIL____ Lab Sample ID: B0428-02A_____

Level (low/med): MED____ Date Received: 03/14/03____

Solids: 84.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

RS

6/10/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	1.1 UJ		~~N~~	P
7440-38-2	Arsenic	30.9 J		~~EN~~	P
7440-39-3	Barium	113 J		~~E~~	P
7440-41-7	Beryllium	0.77			P
7440-43-9	Cadmium	2.4		~~N~~	P
7440-70-2	Calcium				NR
7440-47-3	Chromium	36.0 J		~~E~~	P
7440-48-4	Cobalt				NR
7440-50-8	Copper	33.8			P
7439-89-6	Iron				NR
7439-92-1	Lead	84.4 J		~~E~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.51			CV
7440-02-0	Nickel	51.1 J		~~E~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.49	U		P
7440-22-4	Silver	0.11	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	0.29 J	~~B~~		P
7440-62-2	Vanadium	264 J			P
7440-66-6	Zinc	134 J		~~EN~~	P
	Cyanide				NR

or Before: __________ Clarity Before: ________ Texture: _______

olor After: __________ Clarity After: ________ Artifacts: _______

mments:

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-7/0-1

Lab Name: MITKEM_CORPORATION______ Contract: ________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0428__

Matrix (soil/water): SOIL____ Lab Sample ID: B0428-05A_____

Level (low/med): MED____ Date Received: 03/14/03____

% Solids: 70.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

RS

6/16/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	~~0.19~~ R	~~U~~	~~*N~~	P
7440-38-2	Arsenic	21.0 J		~~EN~~	P
7440-39-3	Barium	57.5 J		~~E~~	P
7440-41-7	Beryllium	0.93			P
7440-43-9	Cadmium	0.31 J	~~B~~	~~N~~	P
7440-70-2	Calcium				NR
7440-47-3	Chromium	12.5 J		~~E~~	P
7440-48-4	Cobalt				NR
7440-50-8	Copper	16.2			P
7439-89-6	Iron				NR
7439-92-1	Lead	24.4 J		~~E~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.23			CV
7440-02-0	Nickel	32.5 J		~~E~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	1.8 J	~~B~~		P
7440-22-4	Silver	0.13	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	0.71 J	~~B~~		P
7440-62-2	Vanadium	166 J			P
7440-66-6	Zinc	32.6 J		~~EN~~	P
	Cyanide				NR

Color Before: ________ Clarity Before: ________ Texture: ________

Color After: ________ Clarity After: ________ Artifacts: ________

Comments:

FORM I - IN SW846

U.S. EPA - CLP

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

SB-7/7-9

Lab Name: MITKEM_CORPORATION________ Contract: __________

ab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0428__

atrix (soil/water): SOIL____ Lab Sample ID: B0428-06A_____

Level (low/med): MED____ Date Received: 03/14/03____

Solids: 84.0_____

Concentration Units (ug/L or mg/kg dry weight): MG/KG

RS

6/10/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	1.0 UJ	~~B~~	~~*N~~	P
7440-38-2	Arsenic	24.1 J		~~EN~~	P
7440-39-3	Barium	103 J		~~E~~	P
7440-41-7	Beryllium	0.72			P
7440-43-9	Cadmium	0.96		~~N~~	P
7440-70-2	Calcium				NR
7440-47-3	Chromium	31.2 J		~~E~~	P
7440-48-4	Cobalt				NR
7440-50-8	Copper	64.1			P
7439-89-6	Iron				NR
7439-92-1	Lead	103 J		~~E~~	P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.70			CV
7440-02-0	Nickel	90.3 J		~~E~~	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	0.47	U		P
7440-22-4	Silver	0.10	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	0.16	U		P
7440-62-2	Vanadium	598 J			P
7440-66-6	Zinc	252 J		~~EN~~	P
	Cyanide				NR

lor Before: ________ Clarity Before: ________ Texture: ________

Color After: ________ Clarity After: ________ Artifacts: ________

mments:

96 R

M&E Metcalf & Eddy

CHAIN OF CUSTODY FORM

1 of 1

Job/Project Name: Oxford Paper Mill	Job/Project Location: Lawrence, MA	Job/Project Number: 200299-1-2
Samplers: (Signatures)	Recorder: (Signature)	Date: 3/14/03
Lab (Samples Sent To): MITKEM		

SAMPLING Date	SAMPLING Time	SAMPLE NUMBER	SAMPLE LOCATION	MATRIX Water	MATRIX Soil				COMPOSITE/GRAB	PRESERVATIVE (Y/N)	PP metals plus Al MADEP EPH	PCB's							Total #	COMMENTS
3/13/03	0812	SB-6/0-1	SB6/0-1		X				C	ICE	1	1							2	
	0942	SB-6/5-7	SB-6/5-7																	
	1054	SB-6/14-16	SB-6/14-16																	
↓	1056	KSB-6/14-16	KSB-6/14-16		↓				↓	↓	↓	↓							↓	
3/14/03	0816	SB-7/0-1	SB-7/0-1		X				C	ICE	1	1							2	
	0840	SB-7/7-9	SB-7/7-9																	
	1220	SB-5/0-1	SB-5/0-1																	
	1308	SB-5/9-11	SB-5/9-11																	
	1348	MSB-5/14-16	SB-5/14-16									↓								
↓	1350	MSB-5/14-16	MSB-5/14-16		↓				↓	↓	2	2							↓	MS/MSD

Relinquished By: (Signature)	Date: 3/14/03 Time: 1415	Received By: (Signature)	Relinquished By: (Signature)	Date: Time:	Received By: (Signature)
Relinquished By: (Signature)	Date: Time:	Received By: (Signature)	Relinquished By: (Signature)	Date: Time:	Received By: (Signature)
Relinquished By: (Signature)	Date: Time:	Received for Lab By: (Signature)	Date: Time:	Comments:	

Method of Shipment:

Distribution: Original to Lab, Copy 1 to Field Files, Copy 2 to Project Manager

M&E Metcalf & Eddy

CHAIN OF CUSTODY FORM

1 of 1

Job/Project Name: OXFORD PAPER MILL
Job/Project Location: Lawrence, MA
Job/Project Number: 200299 -1-2
Samplers: (Signatures)
Recorder: (Signature)
Date: 3/17/03
Lab (Samples Sent To): Mitkem

SAMPLING		SAMPLE NUMBER	SAMPLE LOCATION	MATRIX							ANALYSIS REQUESTED								COMMENTS
Date	Time			Water	Soil				COMPOSITE/GRAB	PRESERVATIVE (Y/N)	17 metals PAHs	B/N, MADEP EPH	PCB's					Total #	
3/17/03	0811	SB-4/0-1	SB-4/0-1		X				C	ice	1	1						2	
↓	0855	SB-4/5-7	SB-4/5-7		↓				↓	↓	↓	↓						↓	
↓	0921	SB-4/13-15	SB-4/13-15		↓				↓	↓	↓	↓						↓	strong degraded HC odor.

Relinquished By: (Signature)	Date: 3/17/03	Time: 1246	Received By: (Signature) J. Davis	Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)
Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)	Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)
Relinquished By: (Signature)	Date:	Time:	Received for Lab By: (Signature)	Date:	Time:	Comments:	

Method of Shipment: P/L by Mitkem

Distribution: Original to Lab, Copy 1 to Field Files, Copy 2 to Project Manager

Metcalf & Eddy

Memorandum

PROJECT NO:	036200299.0001.00003	**DATE:** June 10, 2003
TO:	Oxford Paper Mill File	**OFFICE:** Wakefield
FROM:	R. Shoemaker (RS)	**COMPANY:** Metcalf & Eddy, Inc.
REVIEWED BY:	D. Truini.	
CC:	B. Weir, N. Thurber, D. Laferte (memo only)	

SUBJECT: Limited QC Review/Modified Tier II-Like Review
PCB, EPH and Priority Pollutant Metals Analytical Results
Mitkem Corporation, Warwick, Rhode Island
Lab Project # B0428

On March 13, 14, and 17, 2003, 12 soil samples were collected at the Oxford Paper Mill site, located in Lawrence, Massachusetts by Shaw Environmental & Infrastructure, Inc. (Shaw) and Metcalf & Eddy, Inc. (M&E) field personnel. The sampling was performed as part of Shaw's contract with the City of Lawrence, MA and Shaw's contract with M&E (Shaw Project Number 608134, M&E Project Number 200299-0001).

The samples were submitted to Mitkem Corporation, located in Warwick, Rhode Island for the analysis of Polychlorinated Biphenyls (PCB) using EPA SW-846 Method 8082, Extractable Petroleum Hydrocarbons (EPH) using the MADEP *Method for the Determination of Extractable Petroleum Hydrocarbons (EPH) (January 1998)*, and Priority Pollutant Metals with the addition of barium and vanadium using EPA SW-846 Methods 6010B and 7471A. Samples were received by the laboratory on March 14 and 17, 2003. The data package was received in the M&E office on April 21, 2003.

In accordance with M&E's contract with Shaw, and the EPA and MADEP-approved work plan for the subject site dated January 2003, M&E reviewed the data using EPA Region I Tier II level guidelines, as modified by M&E/EPA for the Targeted Brownfields Assessment Program (EPA Response Action Contract, Work Assignment Number 106-SIBZ-0100). The data deliverables, and the modified Tier II level data validation guidelines used to evaluate the data, are also consistent with MADEP's Presumptive Certainty guidelines for the usability of analytical data. The data review included:

- Data Completeness
- Preservation and Technical Holding Times
- NA • GC/ECD Instrument Performance Checks
- Initial and Continuing Calibrations
- Blanks

- Surrogate Recoveries and Retention Time Shifts
- * • Inductively Coupled Plasma (ICP) Interference Check Sample
- ICP Serial Dilution Analysis Results
- NA • Internal Standards
- Matrix Spike/Matrix Spike Duplicate
- Laboratory Duplicates
- * • Field Duplicates
- NA • Sensitivity Check
- Performance Evaluation Samples/Accuracy Check
- NA • Target Compound Identification
- Compound Quantitation and Reported Quantitation Limits
- * • System Performance

* = All criteria met for this parameter
NA = Not applicable and/or no information was provided by the laboratory

Note: Worksheets are not included for parameters that have met criteria or for criteria that are not applicable to the method and/or to the modified Tier II-like review.

Included in Attachment I is a copy of the chain-of-custody (COC) record. Included in Attachment II are the result summary sheets, annotated with qualifiers, if necessary, as detailed in this memorandum. Included in Attachment III are the data validation worksheets. Included in Attachment IV are relevant communication records.

Data Completeness

The true values for lead and selenium in the ICS AB solution on the Form IV were incorrect. M&E contacted the laboratory about this error on April 22, 2003. A revised Form IV with the correct true values for lead and selenium in the ICS AB solution was received at M&E on April 25, 2003. The data package submitted did not include the barium and vanadium sample results and quality control data. M&E contacted the laboratory on this matter on April 28, 2003. M&E also requested a revised Form IV with the data for the non-spiked analytes of the ICS A solution at this time as well. The barium and vanadium sample results, quality control data, and a revised Form IV were received at M&E on May 5, 2003. However, the resubmitted data had errors on the Form I for sample SB-5/14-16 and the Form XIII. M&E contacted the laboratory about these errors on May 12, 2003. A revised Form I for sample SB-5/14-16 and Form XIII were received at M&E on May 15, 2003. Relevant communication records regarding this matter are included as an attachment to this memorandum.

The data package was complete for PCBs and EPH.

B0428

Preservation and Technical Holding Times

The 7-day extraction holding time was exceeded in samples SB-6/0-1, SB-6/5-7, SB-6/14-16, and KSB-6/14-16 by one day. The positive and nondetect EPH results for these samples were qualified as estimated (J and UJ, respectively) due to possible sample degradation.

All holding times were met for PCBs and Priority Pollutant Metals plus barium and vanadium.

Initial and Continuing Calibrations

PCB

The following table summarizes the continuing calibration (CC) analysis results that failed to meet the CC criterion of percent difference (%D) ≤15. Note that the 3 peaks used to quantitate the PCB results were averaged to determine %D exceedances.

Instrument/Column	RTXCLPPEST 2	RTXCLPPEST 2
Calibration Date	CC 3/28/03 @ 11:08	CC 4/1/03 @ 17:47
Compound	Average %D	Average %D
Aroclor-1260	17.7	15.3
Associated Samples and Action.	None. All associated samples are QC samples.	Estimate (UJ) the nondetect Aroclor 1260 results in samples SB-6/0-1, SB-6/5-7, SB-6/14-16, KSB-6/14-16, SB-7/0-1, SB-7/7-9, SB-5/0-1, and SB-5/9-11

Priority Pollutant Metals plus Barium and Vanadium

The following table summarizes the initial calibration verification (ICV) analysis results that failed to meet the ICV criterion of percent recovery (%R) between 90%-110%:

Calibration Date	ICV 3/24/03
Compound	% Recovery
mercury	34.6
Associated Samples and Action.	Reject (R) the positive results in samples SB-4/0-1and SB-4/5-7, and the nondetect result in sample SB-4/13-15

All initial and continuing calibration criteria was met for EPH. However, it should be noted that the laboratory did not follow the method requirements for calculation of the EPH range continuing calibration factors. Per the MADEP method, the range calibration factor is calculated by tabulating the summation of the peak areas of all component standards in each range fraction against the total mass injected. The laboratory calculated calibration factors for each individual peak rather than a summation. No action was taken since the individual calibration factors were all <25% relative percent difference (RPD).

Blanks

Priority Pollutant Metals plus Barium and Vanadium

A review of laboratory blank results indicates the presence of positive and negative laboratory contamination for the analytes listed below.

Analyte	Max. Conc. Contaminant	BAL* (mg/kg)	Affected Samples/Action
antimony	0.203 mg/Kg	1.0	Qualify the reported value as nondetect (U) in samples SB-4/0-1, SB-4 /13-15, SB-6/5-7, SB-6/14-16, and SB-7/7-9. Raise the detection limit to the |BAL| in samples SB-4/13-15 and SB-6/14-16.
	-3.4 µg/L	0.85	
arsenic	-3.0 µg/L	0.75	None. All sample results >|BAL|.
barium	0.365 mg/Kg	1.8	None. All sample results >BAL.
beryllium	-1.2 µg/L	0.30	Qualify the reported value as estimated (J) in sample SB-5/0-1.
cadmium	-0.80 µg/L	0.20	Qualify the reported value as estimated (J and UJ) in samples KSB-6/14-16, SB-5/0-1, SB-5/14-16, and SB-6/14-16.
chromium	0.039 mg/Kg	0.20	None. All sample results >BAL.
copper	2.272 mg/Kg	11.4	Qualify the reported value as nondetect (U) in samples KSB-6/14-16, SB-6/14-16, SB-4/13-15, and SB-5/0-1.
	-10.4 µg/L	2.6	
mercury	-0.20 µg/L	0.17	Qualify the reported value as estimated (J and UJ) in samples KSB-6/14-16, SB-6/14-16, and SB-5/14-16.
nickel	0.408 mg/Kg	2.0	None. All sample results >BAL.
	-1.9 µg/L	0.48	
silver	0.256 mg/Kg	1.3	Qualify the reported value as nondetect (U) in samples SB-4/0-1, SB-4/5-7, and SB-4/13-15.
vanadium	1.1 µg/L	0.28	None. All sample results >|BAL|.
	-0.066 mg/Kg	0.33	
zinc	2.291 mg/Kg	11.5	None. All sample results >BAL.
	-10.5 µg/L	2.6	

* Values adjusted for sample preparation factors.
|BAL| - Negative Blank Action Level

Blank actions for analytes associated with positive blank contamination:

- If the sample result was <BAL, the result was qualified as a nondetect (U) at the reported concentration
- If the sample result was >BAL, qualification of the data was not required

Blank actions for analytes associated with negative instrument drift:

- concentration > absolute value of the negative BAL; report value unqualified.
- concentration nondetect; report detection limit as estimated (UJ).
- concentration ≤ absolute value of the negative BAL; estimate (J) positive result.

For positive blank contamination and negative instrument drift where the positive BAL is > the negative BAL, sample results were qualified as follows:

- If the sample result was positive and > the negative BAL and < the positive BAL, the result was qualified as nondetect (U) at the reported concentration
- If the sample result was positive and < the negative BAL, the result was qualified as nondetect (U), and the detection limit was raised to the negative BAL.
- If the sample result was nondetect, the detection limit was raised to the negative BAL.
- If the sample result was > the positive BAL, qualification of the data was not required

For positive and negative blank contamination where the negative |BAL| is > positive BAL sample results were qualified as follows:

- If the sample result was positive and < negative BAL, the result was qualified as nondetect (U), and the detection limit was raised to the negative BAL.
- If the sample result was nondetect, the detection limit was raised to the negative BAL.
- If the sample result was > positive and negative BALs, qualification of the data was not required

Note: No further action was taken for mercury in sample SB-4/13-15 since this result was previously rejected (R) due to severely low ICV recovery.

No blank contamination was detected in the PCB and EPH method blanks. However, it should be noted that contamination from the solid phase extraction/fractionation cartridges used to separate the aliphatic from the aromatic hydrocarbons was present in the EPH method blank and in all sample analyses. Per section 11.2.6 of the MADEP *Method for the Determination of Extractable Petroleum Hydrocarbons (EPH) (January 1998)*, the laboratory subtracted the contamination from the EPH range results.

Surrogate Recoveries and Retention Time Shifts

PCBs

The PCB surrogate compounds that did not meet the acceptance criterion of percent recovery (%R) of 29-155% for decachlorobiphenyl (DCB) are summarized in the following table:

Sample ID	DCB Column I	Action
SB-6/5-7	687	No action. Only 1 surrogate of 4 was outside of recovery criteria.
SB-7/7-9	236	No action. Only 1 surrogate of 4 was outside of recovery criteria.
SB-4/5-7	361	No action. Only 1 surrogate of 4 was outside of recovery criteria.

All samples met surrogate recovery criteria for EPH. Surrogate criteria is not applicable for priority pollutant metals analysis.

ICP Serial Dilution Analysis Results

The ICP serial dilution analysis produced percent differences (%D)s that exceeded the acceptance criteria of < 10% for arsenic, barium, chromium, lead, nickel, and zinc (11.6%, 13.1%, 11.5%, 18.4%, 16.6%, and 16.1%, respectively). The positive results for arsenic, barium, chromium, lead, nickel, and zinc were qualified as estimated (J) in all samples.

ICP serial dilution analysis is not applicable for EPH and PCB analysis.

Matrix Spike/Matrix Spike Duplicate

EPH

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed on soil sample SB-4/13-15. The following table summarizes the EPH analyte that did not meet the MS/MSD acceptance criteria:

Compound	MS %R	MSD %R	%R Acceptance Limits	Action
C_9 - C_{18} Aliphatics	39	34	40-140	Estimate (J) the positive result in sample SB-4/13-15.

Priority Pollutant Metals

Matrix spike (MS) analysis was performed on soil sample SB-6/0-1. The following table summarizes the analytes that did not meet the %R criteria of 75 - 125%:

Analyte	Spiked Sample Result (mg/kg)	Sample Result (mg/kg)	Spike Amount	MS %R	Affected Samples/Action
antimony	9.7185	7.0483	27.78	9.6	Estimate (J) the positive results in samples SB-4/5-7, SB-5/9-11, and SB-6/0-1. Reject (R) the nondetect results in samples KSB-6/14-16, SB-5/0-1, SB-5/14-16, and SB-7/0-1. Estimate (UJ) the blank-qualified nondetect results in samples SB-4/0-1, SB-4/13-15, SB-6/14-16, SB-6/5-7, and SB-7/7-9.
arsenic	98.3934	49.1157	27.78	177.4	Estimate (J) the positive results in all samples.
zinc	261.9903	274.1253	138.58	-8.8	Estimate (J) the positive results in all samples.

Professional judgement was used to estimate (UJ) rather than reject (R) the blank-qualified nondetect results for antimony in samples SB-4/0-1, SB-4/13-15, SB-6/14-16, SB-6/5-7, and SB-7/7-9. No further actions were taken for arsenic since these results were previously qualified as estimated (J) due to serial dilution %D exceedence.

All MS/MSD criteria were met for PCB analysis.

Laboratory Duplicates

Priority Pollutant Metals

The priority pollutant metals analyte that did not meet acceptance criteria of relative percent difference (%RPD)<20 in soil sample SB-6/0-1 is summarized in the following table:

Analyte	Sample Result (mg/kg)	Duplicate Sample Result (mg/kg)	%RPD	Affected Samples/Action
antimony	7.0483	2.7721	87.1	Estimate (J) the positive results in samples SB-4/5-7, SB-5/9-11, and SB-6/0-1. Estimate (UJ) the blank-qualified nondetect results in samples SB-4/0-1, SB-4/13-15, SB-6/14-16, SB-6/5-7, and SB-7/7-9.
nickel	100.4591	81.5393	20.8	Estimate (J) the positive results in all samples.
vanadium	376.219	516.3786	31.4	Estimate (J) the positive results in all samples.

No further actions were taken for vanadium since these results were previously qualified as estimated (J) due to serial dilution %D exceedence. No further actions were taken for antimony since these results were previously qualified as estimated (J and UJ) due to poor matrix spike recoveries. Laboratory duplicates are not analyzed in EPH and PCB analysis.

Performance Evaluation Samples/Accuracy Check

Priority Pollutant Metals

The priority pollutant metals analytes that did not meet laboratory control sample (LCS) acceptance criteria are summarized in the following table:

Analyte	LCS Concentration (mg/Kg)	LCS Acceptance Criteria (mg/Kg)	Affected Samples/Action
chromium	82.5	84.4 - 97.4	Estimate (J) the positive results in samples SB-4/0-1, SB-4/5-7, and SB-4/13-15.
selenium	36.1	37.3 - 46.9	Estimate (UJ) the nondetect results in samples SB-4/0-1, SB-4/5-7, and SB-4/13-15.

No further actions were taken for chromium since these results were previously qualified as estimated (J) due to serial dilution %D exceedance.

All LCS criteria were met for EPH and PCB analysis.

Compound Quantitation and Reported Quantitation Limits

Priority Pollutant Metals

The following table summarizes the priority pollutants metal results, including those results blank-qualified as nondetect, that are less than the reporting limit (RL) but greater than the instrument detection limit (IDL), and were not previously qualified as estimated (J) due to quality control parameters listed above. The listed results are qualified as estimated (J and UJ, respectively) due to uncertainty in the quantitation:

Analyte	Affected Samples/Action
cadmium	SB-4/13-15, SB-7/0-1
selenium	SB-5/0-1, SB-5/9-11, SB-7/0-1
silver	SB-4/0-1, SB-4/5-7, SB-4/13-15
thallium	SB-4/0-1, SB-4/5-7, SB-4/13-15, SB-5/9-11, SB-6/5-7, SB-7/0-1

The positive results for silver in all samples listed above were previously qualified as nondetect (U) due to blank contamination. These results are further qualified as estimated, nondetect (UJ) due to blank contamination and uncertainty in quantitation.

All criteria was met for EPH and PCB analysis for compound quantitation and reported quantitation limits.

EPA-NE
Data Validation Worksheet Cover Page - Page 1

Site Name Oxford Paper Mill
Reference No. ~~0362000~~ 036200279.0001.00003

REGION I ORGANIC DATA VALIDATION

The following data package has been validated:

Lab Name MITKEM
Case/Project No. — #B0428
SDG No. B0428
No. of Samples/Matrix ~~13~~ 12 Soil
SOW/Method No. MA DEP EPH SW-846 8082
Sampling Date(s) 3/13/03, 3/14/03, 3/17/03
Shipping Date(s) 3/14/03, 3/17/03 (Courier)
Date Rec'd by lab 3/14/03, 3/17/03

Traffic Report Sample Nos. SB-6/0-1, SB-6/5-7, SB-6/14-16, KSB-6/14-16, SB-7/0-1, SB-7/7-9, SB-5/0-1, SB-5/9-11, SB-5/14-16, SB-4/0-1, SB-4/5-7, SB-4/13-15

Trip Blank No. NA
Equipment Blank No. NA
Bottle Blank No. NA
Field Duplicate Nos. SB-6/14-16 + KSB-6/14-16
PES Nos. NA

The Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses, revision 12/96 was used to evaluate the data and/or approved modifications to the EPA-NE Functional Guidelines were used to evaluate the data and are attached to this cover page: (attach modified criteria from EPA approved QAPjP or amendment to QAPjP).

A Tier II or Tier III evaluation was used to validate the data (circle one). If a Tier II validation with a partial Tier III was used, then identify samples, parameters, etc. that received partial Tier III validation

Modified Tier II for Brownfields

The data were evaluated based upon the following parameters:

- Overall Evaluation of Data
- Data Completeness (CSF Audit - Tier I)
- Preservation & Technical Holding Times
- → ~~GC/MS & GC/ECD Instrument Performance Check~~
- Initial & Continuing Calibrations
- Blanks
- Surrogate Compounds
- ~~Internal Standards~~
- Matrix Spike/Matrix Spike Duplicate
- Field Duplicates
- ~~Sensitivity Check~~
- ~~PE Samples~~/Accuracy Check
- Target Compound Identification
- Compound Quantitation and Reported Quantitation Limits
- ~~TICs~~
- ~~Semivolatile and Pesticide/PCB Cleanup~~
- ~~System Performance~~

Region I Definitions and Qualifiers:

A - Acceptable Data
J - Numerical value associated with compound is an estimated quantity.
R - The data are rejected as unusable. The R replaces the numerical value or sample quantitation limit.
U - Compound not detected at that numerical sample quantitation limit.
UJ - The sample quantitation limit is an estimated quantity.
TB, BB, EB - Compound detected in aqueous trip blank, aqueous bottle blank, or aqueous equipment blank associated with soil/sediment samples.

Validator's Name Robert Shoemaker Company Name M+E Phone Number 781-224-6421
Date Validation Started 4/23/03 Date Validation Completed 5/12/03

heck if all criteria are met and no hard copy worksheet provided. Indicate NA if worksheet is not applicable analytical method. Note: there is no standard worksheet for System Performance, however, the validator ust document all system performance issues in the Data Validation Memorandum.

EPH
~~OA/SV~~ worksheets:

VOA/SV-Pest/PCB	COMPLETE SDG FILE (CSF) AUDIT	✓
VOA/SV-Pest/PCB-I	PRESERVATION AND HOLDING TIMES	
VOA/SV-II	GC/MS INSTRUMENT PERFORMANCE CHECK (TUNING)	
VOA/SV-III	INITIAL CALIBRATION	✓
VOA/SV-IV	CONTINUING CALIBRATION	✓
VOA/SV-Pest/PCB-V-A	BLANK ANALYSIS	✓
VOA/SV-Pest/PCB-V-B	BLANK ANALYSIS	✓
VOA-VI	VOA SURROGATE SPIKE RECOVERIES	NA
SV-VI	SV SURROGATE SPIKE RECOVERIES	✓
VOA/SV-VII	INTERNAL STANDARD PERFORMANCE	NA
VOA/SV-Pest/PCB-VIII	MATRIX SPIKE/MATRIX SPIKE DUPLICATE	
VOA/SV-Pest/PCB-IX	FIELD DUPLICATE PRECISION	✓
VOA/SV-Pest/PCB-X	SENSITIVITY CHECK	✓ NA
VOA/SV-Pest/PCB-XI	ACCURACY CHECK	✓
VOA/SV-Pest/PCB-XII	TARGET COMPOUND IDENTIFICATION	NA
VOA/SV-Pest/PCB-XIII	SAMPLE QUANTITATION	✓
VOA/SV-XIV	TENTATIVELY IDENTIFIED COMPOUNDS	NA
VOA/SV-XV	SEMIVOLATILE CLEANUP	NA
TABLE II-WORKSHEET	OVERALL EVALUATION OF DATA	NA

est/PCB worksheets:

VOA/SV-Pest/PCB	COMPLETE SDG FILE (CSF) AUDIT	✓
VOA/SV-Pest/PCB-I	PRESERVATION AND HOLDING TIMES	✓
Pest/PCB-IIA	GC/ECD INSTRUMENT PERFORMANCE CHECK-RESOLUTION	NA
Pest/PCB-IIB	GC/ECD INSTRUMENT PERFORMANCE CHECK-RETENTION TIMES	NA
Pest/PCB-IIC	GC/ECD INSTRUMENT PERFORMANCE CHECK-ACCURACY CHECK OF INITIAL CALIBRATION	NA
Pest/PCB-IID	GC/ECD INSTRUMENT PERFORMANCE CHECK-PESTICIDE DEGRADATION	NA
Pest/PCB-III	INITIAL CALIBRATION	✓
Pest/PCB-IV	CONTINUING CALIBRATION	
VOA/SV-Pest/PCB-V-A	BLANK ANALYSIS	✓
VOA/SV-Pest/PCB-V-B	BLANK ANALYSIS	✓
Pest/PCB-VI	SURROGATE COMPOUNDS: SPIKE RECOVERIES AND RETENTION TIME SHIFT	
Pest/PCB-VII	PESTICIDE CLEANUP	NA
VOA/SV-Pest/PCB-VIII	MATRIX SPIKE/MATRIX SPIKE DUPLICATE	✓
VOA/SV-Pest/PCB-IX	FIELD DUPLICATE PRECISION	✓
VOA/SV-Pest/PCB-X	SENSITIVITY CHECK	✓ NA
VOA/SV-Pest/PCB-XI	ACCURACY CHECK	✓
Pest/PCB-XII	COMPOUND IDENTIFICATION	NA
VOA/SV-Pest/PCB-XIII	SAMPLE QUANTITATION	✓
TABLE II-WORKSHEET	OVERALL EVALUATION OF DATA	NA

I certify that all criteria were met for the worksheets checked above.

Signature:

Name: Robert L. Shoemaker

Date: 5/13/03

[redacted]: ______ Company: ______ Contacted: Yes No Date: ______

PRESERVATION AND HOLDING TIMES -

Circle sample numbers with exceeded technical holding times or omitted preservation.
List all required preservation codes and circle omitted preservation codes.
Circle all exceeded technical holding times.
Identify extraction technique after "# of Days"/(*Extraction Code).

Sample No. (TR No.)	Matrix	Pres. Code	Date Sampled	VOA			Ⓢ ~~BNA~~ MADEP EPH					PEST/PCB				
				Date Analyzed	# of Days from Samp. to Anal.	Action	Date Extracted	# of Days from Samp. to Extr./(*)	Date Analyzed	# of Days from Extr. to Anal.	Action	Date Extracted	# of Days from Samp. to Extr./(*)	Date Analyzed	# of Days from Extr. to Anal.	Action
SB-6/0-1	SO	1,3	3/13/03				3/21/03	⑧	4/13/03	23	J UJ	3/27/03	14	4/1/03	5	No Action Necessary
SB-6/5-7									4/13/03 4/14/03	23/24						
SB-6/14-16									↓	↓						
KSB-6/14-16			↓					↓	4/13/03	23	↓		↓			
SB-7/0-1			3/14/03					7	4/14/03	24	No Action Necessary		13			
SB-7/7-9																
SB-5/0-1														↓	↓	
SB-5/9-11														4/2/03	6	
SB-5/14-16			↓					↓		↓			↓			
SB-4/0-1			3/17/03					4		24			10			
SB-4/5-7																
SB-4/13-15	↓	↓	↓				↓	↓	↓	↓	↓		↓			
MSB-5/14-16	SO	1,3	3/14/03									↓	13	↓	↓	↓

Preservation Code:
1. Cool @ 4°C (± 2°)
2. Preserve with HCl to at least pH 2
3. Protect from light
4. Freeze
5. Room Temperature (Avoid excessive heat)

(*Extraction Code:)
L/L - Liquid/Liquid
SON - Sonication
SEP - Separatory Funnel
SOX - Soxhlet
SPE - Solid Phase Extraction

Action Code:
J - Estimate (J) Detected Values
UJ - Estimate (UJ) Non-Detected Values
R - Reject (R) Non-Detected Values

Validator: ______

Date: 4/23/03

EPA-NE - Data Validation Worksheet
VOA/SV-IV

All [illegible] ~~[illegible]~~ [illegible] < 20%

IV. CONTINUING CALIBRATION - List all analytes that are outside calibration criteria.

	Date of ICAL	Date of CCAL	Instrument	Parameter	Matrix	Compound	%D	RRF	Samples Affected	Action
11:08	3/27/03	~~4/1/03~~ 3/28/03 ②	E1	PCBs	Soil	** Aroclor 1260 (1)	15.7	—	~~[illegible]~~ ② LCS, MB	~~N/A~~ None
↓		↓				(2)	17.0	—	↓	↓
						↓ (3)	20.4	—		
21:44		↓	↓			Aroclor 1260 (3)	15.1	—	↓	see below ***
17:47		4/1/03	E1			Aroclor 1260 (2)	16.4	—	SB-6/0-1, SB-6/5-7, SB-6/14-16, KSB-6/14-16,	see below *
	↓	↓	↓	↓	↓	↓ (3)	16.6	—	SB-7/0-1, SB-7/7-9, SB-5/0-1, SB-5/9-11	↓

Comments: ~~* No action necessary, results reported from other column, which had acceptable CCAL %D, Average = 15.~~ BAT 5/25/03
(UJ) in all associate samples

** Average = 17.7
*** - OK, average of 3 points = 13.9

Validator:

Date: 5/13/03

12/96

3. **Blank Actions** - List the maximum concentrations of blank compounds.

Compound	Type of Blank	Date Blank Sampled/Originated	Max. Conc. (units)	Action Level (units)	Sample QL	Samples Affected	Action

Comments: * It shall be noted that contamination from the solid phase extraction/fractionation cartridges were subtracted from the ETPH range results per section 11.2.6 of the MADEP method.

Validator:

Date: 5/13/03

EPA-NE - Data Validation Worksheet
VOA-VI

PCB
VI. ~~VOA~~ **SURROGATE SPIKE RECOVERIES** - List all surrogate compound recoveries that are outside method QC acceptance criteria.

Method	Volatile Method QC Acceptance Criteria DAT 5/25/03				
	Toluene-d8	BFB	DCE-d4	Other: ~~TCX~~ DCB1	
OLM03.2	Water 88-110 Soil 84-138	Water 86-115 Soil 59-113	Water 76-114 Soil 70-121		
OLC02.1	NA	80-120	NA	DAT 5/25/03	
Other:				~~42-147~~ 29-155	
Sample Number/Matrix	% Recovery	% Recovery	% Recovery	% Recovery	Action
SB-6/5-7				687	~~J results, UJ nondetects~~ Ⓟ No Action 1 of 4
SB-7/7-9				236	
SB-4/5-7				361	

all TCX and DCB2 surrogates met recovery criteria
(TCX limits 42-147)

Validator: Robert

Date: 5/13/03

PCB MS/MSD (MSB-5/14-16)

EPA-NE - Data Validation Worksheet
VOA/SV - Pest/PCB-VIII

VIII. **MATRIX SPIKE/MATRIX SPIKE DUPLICATE** - List all MS/MSD analytes that are outside method QC acceptance criteria.

Use a separate worksheet for each MS/MSD pair.

Sample # SB-4/13-15 Matrix Soil Concentration Level low

Parameter	Compound	MS %Rec	MSD %Rec	RPD	Method QC Limits		Concentration			% RSD	Action
					% Rec	RPD	Unspiked Sample	MS	MSD		
MADEP EPH	$C_9 - C_{18}$ Aliphatics	39	34	14	40-140%	50%	Data Not Provided			→	J pos result

Validator: Date: 5/13/02

REGION I
Data Review Worksheets

Site Name Oxford Paper Mill
Reference Number 036200799, 0001, 004

REGION I REVIEW OF INORGANIC CONTRACT LABORATORY DATA PACKAGE

The hardcopied (laboratory name) MITKEM data package received at Region I has been reviewed and the quality assurance and performance data summarized. The data review included:

Case No. NA
SAS No. NA
Sampling Date(s) 3/13/03, 3/14/03, 3/17/03
SDG. No. R0428
Matrix Soil
Shipping Date(s) 3/14/03, 3/17/03
No. of Samples 12
Date Rec'd by Lab 3/14/03, 3/17/03

Traffic Report Nos: SB-6/0-1, SB-6/5-7, SB-6/14-16, KSB-6/14-16, SB-7/0-1, SB-7/7-
SB-5/0-1, SB-5/9-11, ~~M~~SB-5/14-16, ~~MSB-5/14-16~~, SB-4/0-1, SB-4/5-7, SB-4/13-15
Trip Blank No.: NA
Equipment Blank No.: NA
Field Dup Nos: SB-6/14-16 + KSB-6/14-16
SW-846 6010B + 7471A

SOW No. ↓ requires that specific analytical work be done and that associated reports be provided by the laboratory to the Regions, EMSL-LV, and SMO. The general criteria used to determine the performance were based on an examination of:

- -Data Completeness
- -Holding Times
- -Calibrations
- -Blanks
- -ICP Interference Check Results
- -Matrix Spike Recoveries
- -Laboratory Duplicates
- -Field Duplicates
- -Lab Control Sample Results
- ~~-Furnace AA Results~~
- -ICP Serial Dilution Results
- -Detection Limit Results
- -Sample Quantitation

Overall Comments: ______

Definitions and Qualifiers:

A - Acceptable data.
J - Approximate data due to quality control criteria.
R - Reject data due to quality control criteria.
U - Analyte not detected.

Reviewer: ______ Date: 5/13/03

REGION I
Data Review Worksheets

I. DATA COMPLETENESS

MISSING INFORMATION	DATE LAB CONTACTED	DATE REC'D
All results, data for Ba + V	4/28/03	5/5/03
Revised Form IV	4/22/03	4/25/03
ICS A data	4/28/03	5/5/03
Revised Form XII + Form I for SB-5/14/16	5/12/03	5/15/03

REGION I
Data Review worksheets

III A. INSTRUMENT CALIBRATION (Section 1)

Recovery Criteria

List the analytes which did not meet the percent recovery (%R) criteria for Initial or Continuing Calibration.

DATE	ICV/CCV#	ANALYTE	%R	ACTION	SAMPLES AFFECTED
3/21/03	ICV	Hg	34.6	R	SB-4/0-1, SB-4/5-7, SB-4/1

ACTIONS:

If any analyte does not meet the %R criteria follow the actions stated below:

For Positive Results:

	Accept	Estimate (J)	Reject (R)
Metals	90-110%R	75-89%R, 111-125%R	<75%R, >125%R
Mercury	80-120%R	65-79%R, 121-135%R	<65%R, >135%R
Cyanide	85-115%R	70-84%R, 116-130%R	<70%R, >130%R

For Non-detected Results:

	Accept	Estimate (UJ)	Reject (R)
Metals	90-125%R	75-89%R	<75%R, >125%R
Mercury	80-135%R	65-79%R	<65%R, >135%R
Cyanide	85-130%R	70-84%R	<70%R, >130%R

REGION I
Data Review Worksheet

IV A. BLANK ANALYSIS RESULTS (Sections 1-3)

List the blank contamination in Sections 1 & 2 below. A separate worksheet should be used for soil and water blanks.

1. Laboratory Blanks MATRIX: Soil

DATE	ICB/CCB#	PREP BL	ANALYTE	CONC./UNITS
3/18/03	CCB1	—	Zn	-8.0 ug/L ** ✓
↓	CCB2	—	↓	-8.2 ↓ ** ✓
	—	PBS		2.291 mg/kg ✓
	CCB4	—		-10.5 ug/L ** ✓
↓ ✓	CCB5	—	↓	-8.4 ↓ ** ✓

2. Equipment/Trip Blanks

DATE	EQUIP BL#	ANALYTE	CONC./UNITS

3. Frequency Requirements

A. Was a preparation blank analyzed for each matrix, for every 20 samples and for each digestion batch? [✓ Yes] or No

B. Was a calibration blank run every 10 samples or every 2 hours whichever is more frequent? [✓ Yes] or No

If No,

The data may be affected. Use professional judgement to determine the severity of the effect and qualify the data accordingly. Discuss any actions below, and list the samples affected.

** - ≤ 2*IDL

REGION I
Data Review Worksheet

IV A. BLANK ANALYSIS RESULTS (Sections 1-3)

List the blank contamination in Sections 1 & 2 below. A separate worksheet should be used for soil and water blanks.

1. Laboratory Blanks MATRIX: Soil

DATE	ICB/CCB#	PREP BL	ANALYTE	CONC./UNITS
3/18/03	CCB4	—	Sb	-3.4 ug/L ** ✓
3/24/03	—	PBS	↓	0.203 mg/kg ✓
3/17/03	CCB4	—	As	-3.0 ug/L ** ✓
↓	~~CCB1~~ ICB	—	Be	-0.6 ↓ ** ✓
↓	CCB1	—	↓	-0.8 ** ✓
3/18/03	CCB2		Be	-1.0 ug/L ** ✓

2. Equipment/Trip Blanks

DATE	EQUIP BL#	ANALYTE	CONC./UNITS

3. Frequency Requirements

A. Was a preparation blank analyzed for each matrix, for every 20 samples and for each digestion batch? [✓ Yes] or No

B. Was a calibration blank run every 10 samples or every 2 hours whichever is more frequent? [✓ Yes] or No

If No,

The data may be affected. Use professional judgement to determine the severity of the effect and qualify the data accordingly. Discuss any actions below, and list the samples affected.

** - < 2x IDL

REGION I
Data Review Worksheet

IV A. BLANK ANALYSIS RESULTS (Sections 1-3)

List the blank contamination in Sections 1 & 2 below. A separate worksheet should be used for soil and water blanks.

1. Laboratory Blanks

MATRIX: Soil

DATE	ICB/CCB#	PREP BL	ANALYTE	CONC./UNITS	
3/18/03	CCB3	—	Be	-1.2 ug/L	✓
↓	PBS (AD)	PBS	↓	-0.049 mg/kg	✓
	CCB4	—		-1.2 ug/L	✓
	CCB5	—	↓	-1.2 ↓	✓
↓	CCB4	—	Cd	-0.8 ↓ **	✓

2. Equipment/Trip Blanks

DATE	EQUIP BL#	ANALYTE	CONC./UNITS

3. Frequency Requirements

A. Was a preparation blank analyzed for each matrix, for every 20 samples and for each digestion batch? [✓ Yes] or No

B. Was a calibration blank run every 10 samples or every 2 hours whichever is more frequent? [✓ Yes] or No

If No,

The data may be affected. Use professional judgement to determine the severity of the effect and qualify the data accordingly. Discuss any actions below, and list the samples affected.

** - ≤ 2x IDL

REGION I
Data Review Worksheet

IV A. BLANK ANALYSIS RESULTS (Sections 1-3)

List the blank contamination in Sections 1 & 2 below. A separate worksheet should be used for soil and water blanks.

1. Laboratory Blanks

MATRIX: Soil

DATE	ICB/CCB#	PREP BL	ANALYTE	CONC./UNITS
3/24/03	—	PBS	Cr	0.039 mg/kg ✓
3/18/03	CCB1	—	Cu	-6.9 ug/L ** ✓
↓	CCB2	—	↓	-7.1 ↓ ** ✓
	CCB3	—		-7.3 ** ✓
	~~PBS~~	PBS		2.272 mg/kg ✓

2. Equipment/Trip Blanks

DATE	EQUIP BL#	ANALYTE	CONC./UNITS

3. Frequency Requirements

A. Was a preparation blank analyzed for each matrix, for every 20 samples and for each digestion batch? [✓ Yes] or No

B. Was a calibration blank run every 10 samples or every 2 hours whichever is more frequent? [✓ Yes] or No

If No,

The data may be affected. Use professional judgement to determine the severity of the effect and qualify the data accordingly. Discuss any actions below, and list the samples affected.

** - ≤ 2*IDL

REGION I
Data Review Worksheet

IV A. BLANK ANALYSIS RESULTS (Sections 1-3)

List the blank contamination in Sections 1 & 2 below. A separate worksheet should be used for soil and water blanks.

1. Laboratory Blanks

MATRIX: Soil

DATE	ICB/CCB#	PREP BL	ANALYTE	CONC./UNITS
3/18/03	CCB4	—	Cu	-10.4 ug/L ✓
↓	CCB5	—		-7.9 ↓ ** ✓
3/24/03	—	PBS		1,189 mg/kg ✓
	ICB	—		13.7 ug/L K
↓	CCB1	—	↓	4.7 ↓ —

2. Equipment/Trip Blanks

DATE	EQUIP BL#	ANALYTE	CONC./UNITS

3. Frequency Requirements

A. Was a preparation blank analyzed for each matrix, for every 20 samples and for each digestion batch? [✓ Yes] or No

B. Was a calibration blank run every 10 samples or every 2 hours whichever is more frequent? [✓ Yes] or No

If No,

The data may be affected. Use professional judgement to determine the severity of the effect and qualify the data accordingly. Discuss any actions below, and list the samples affected.

** - ≤ 2x IDL

REGION I
Data Review Worksheet

IV A. BLANK ANALYSIS RESULTS (Sections 1-3)

List the blank contamination in Sections 1 & 2 below. A separate worksheet should be used for soil and water blanks.

1. Laboratory Blanks

MATRIX: Soil

DATE	ICB/CCB#	PREP BL	ANALYTE	CONC./UNITS
3/24/03	CCB2	—	Cu	4.2 ug/L ✓
↓	ICB	—	Hg	-0.2 ↓ ** ✓
	CCB1	—	↓	-0.2 ** ✓
	CCB2	—		-0.2 ** ✓
	CCB3	—		-0.2 ** ✓

2. Equipment/Trip Blanks

DATE	EQUIP BL#	ANALYTE	CONC./UNITS

3. Frequency Requirements

A. Was a preparation blank analyzed for each matrix, for every 20 samples and for each digestion batch? [✓ Yes] or No

B. Was a calibration blank run every 10 samples or every 2 hours whichever is more frequent? [✓ Yes] or No

If No,

The data may be affected. Use professional judgement to determine the severity of the effect and qualify the data accordingly. Discuss any actions below, and list the samples affected.

** - ≤ 2* IDL

REGION I
Data Review Worksheet

IV A. BLANK ANALYSIS RESULTS (Sections 1-3)

List the blank contamination in Sections 1 & 2 below. A separate worksheet should be used for soil and water blanks.

1. Laboratory Blanks

MATRIX: Soil

DATE	ICB/CCB#	PREP BL	ANALYTE	CONC./UNITS
3/24/03	—	PBS	Hg	-0.027 mg/kg ** ✓
3/18/03	CCB1	—	Ni	0.8 ug/L ✓
↓	CCB2	—	↓	-0.8 ↓ ** ✓
↓	CCB3	—	↓	-1.3 ↓ ** ✓
↓	—	PBS	↓	0.133 mg/kg ✓

2. Equipment/Trip Blanks

DATE	EQUIP BL#	ANALYTE	CONC./UNITS

3. Frequency Requirements

A. Was a preparation blank analyzed for each matrix, for every 20 samples and for each digestion batch? [✓ Yes] or No

B. Was a calibration blank run every 10 samples or every 2 hours whichever is more frequent? [✓ Yes] or No

If No,

The data may be affected. Use professional judgement to determine the severity of the effect and qualify the data accordingly. Discuss any actions below, and list the samples affected.

** - ≤ 2x IDL

IV A. BLANK ANALYSIS RESULTS (Sections 1-3)

List the blank contamination in Sections 1 & 2 below. A separate worksheet should be used for soil and water blanks.

1. Laboratory Blanks

MATRIX: Soil

DATE	ICB/CCB#	PREP BL	ANALYTE	CONC./UNITS
~~3/24/03~~ 3/18/03	CCB4	—	Ni	-1.4 ug/L **
↓	CCB5	—	↓	-1.9 ↓ ✓
3/24/03	—	PBS	↓	0.408 mg/kg ✓
3/18/03	ICB	—	Ag	3.6 ug/L ✓
↓	—	PBS	↓	0.256 mg/kg ✓

2. Equipment/Trip Blanks

DATE	EQUIP BL#	ANALYTE	CONC./UNITS

3. Frequency Requirements

A. Was a preparation blank analyzed for each matrix, for every 20 samples and for each digestion batch? [✓ Yes] or No

B. Was a calibration blank run every 10 samples or every 2 hours whichever is more frequent? [✓ Yes] or No

If No,

The data may be affected. Use professional judgement to determine the severity of the effect and qualify the data accordingly. Discuss any actions below, and list the samples affected.

** ≤ 2*IDL

IV A. BLANK ANALYSIS RESULTS (Sections 1-3)

List the blank contamination in Sections 1 & 2 below. A separate worksheet should be used for soil and water blanks.

1. Laboratory Blanks

MATRIX: Soil

DATE	ICB/CCB#	PREP BL	ANALYTE	CONC./UNITS
	—	PBS	Ba	0.365 mg/kg ✓
	—	PBS	↓	0.257 ✓
	—	PBS	↓	-0.066 ** ✓
	CCB4	—	↓	1.1 ug/L ✓
	CCB5	—	↓	1.0 ✓

2. Equipment/Trip Blanks

DATE	EQUIP BL#	ANALYTE	CONC./UNITS

3. Frequency Requirements

A. Was a preparation blank analyzed for each matrix, for every 20 samples and for each digestion batch? [✓ Yes] or No

B. Was a calibration blank run every 10 samples or every 2 hours whichever is more frequent? [✓ Yes] or No

If No,

The data may be affected. Use professional judgement to determine the severity of the effect and qualify the data accordingly. Discuss any actions below, and list the samples affected.

** ≤ 2x Ia

REGION I
Data Review Worksheets

IV B. BLANK ANALYSIS RESULTS (Section 4)

4. Blank Actions

The Action Levels for any analyte is equal to five times the highest concentration of that element's contamination in any blank. The action level for samples which have been concentrated or diluted should be multiplied by the concentration/dilution factor. No positive sample result should be reported unless the concentration of the analyte in the sample exceeds the Action Level (AL). Specific actions are as follows:

1. When the concentration is greater than the IDL, but less than the Action Level, report the sample concentration detected with a U.

2. When the sample concentration is greater than the Action Level, report the sample concentration unqualified.

MATRIX: Soil

ELEMENT	MAX. CONC./ UNITS	AL/ UNITS
Sb	-3.4ug/L / 0.203 mg/kg	-0.85 / 1.0 mg/kg
Be	-1.2 ug/L	0.30
Cr	0.039 mg/kg	0.20
Cu	2.272 mg/kg	11.4
Cu	-10.4 ug/L	2.6
Ni	0.408 mg/kg	2.0
Ni	-1.9 ug/L	0.48 ↓

MATRIX: Soil

ELEMENT	MAX. CONC./ UNITS	AL/ UNITS
Ag	0.256 mg/kg	1.3 mg/kg
Zn	-10.5ug/L / 2.291 mg/kg	-2.6 / 11.5 ↓
Ba	2.365 mg/kg	1.8 mg/kg
V	-0.066mg/kg / 1.1 ug/L	-0.33 / 0.28 ↓
As	-3ug/L	-0.75mg/kg
Cd	-0.8ug/L	-0.2 mg/kg
Hg	-0.2ug/L	-0.167mg/kg

Sb - KSB-6/14-16, SB-5/0-1, SB-5/14-16, SB-7/0-1 - all ND and (R) for <10% MS; no further action
↓ - SB-4/0-1, SB-6/5-7, SB-7/7-9 (U) at reported value
↓ - SB-4/13-15, SB-6/14-16 (U) at neg blank action level
Be - (J) SB-5/0-1, for neg blank

NOTE: Blanks analyzed during a soil case must be converted to mg/kg in order to compare them with the sample results.

Cr - none; all > BAL

Conc. in ug/L X $\frac{\text{Volume diluted to (200ml)}}{\text{Weight digested (1gram)}}$ X $\frac{1L}{1000ml}$ X $\frac{1000gm}{1kg}$ X $\frac{1mg}{1000ug}$ = mg/kg

Cu (U) in KSB-6/14-16, SB-4/13-15, SB-5/0-1, SB-6/14-16

Multiplying this result by 5 to arrive at the action level gives a final result in mg/kg which can then be compared to sample results.

Ni - none; all > BAL
Ag - (U) SB-4/0-1, SB-4/13-15, SB-4/5-7
Zn - none; all > BAL
Ba - none; all > BAL
V - none; all > BAL

As - none; all > BAL
Cd (J) KSB-6/14-16, SB-5/0-1, SB-6/14-16 } for neg bl
↓ (UJ) SB-5/14-16
Hg (UJ) KSB-4/14-16, SB-6/14-16] neg blank
(J) SB-5/14-16

VI. MATRIX SPIKE

TR # SR-6/0-1

MATRIX: Soil

1. Recovery Criteria

List the percent recoveries for analytes which did not meet the required criteria.

S - amount of spike added
SSR - spikes sample result
SR - sample result

Analyte	SSR	SR	S	%R	Action
Sb	9.7185	7.0483	27.78	9.6	J pos results R nondetects
As	98.3934	49.1157	27.78	177.4	J pos results A nondetects
Zn	261.9903	274.1253	138.58	-8.8	J pos results, R nondetects

Matrix Spike Actions apply to all samples of the same matrix.

ACTIONS:

1. If the sample concentration exceeds the spike concentration by a factor of 4 or more, no action is taken.

2. If any analyte does not meet the %R criteria follow the actions stated below:

	PERCENT RECOVERY		
	<30%	30%-74%	>125%
Positive Sample Results	J	J	J
Non-detected Results	R	UJ	A

2. Frequency Criteria

A. Was a matrix spike prepared at the required frequency? [✓ Yes] or No

B. Was a post digestion spike analyzed for elements that did not meet required criteria for matrix spike recovery? [✓ Yes] or No

all > 75
except Zn =
71.3%

A separate worksheet should be used for each matrix spike pair.

VII. LABORATORY DUPLICATES

List the concentrations of any analyte not meeting the criteria for duplicate precision. For soil duplicates, calculate the CRDL in mg/kg using the sample weight, volume and percent solids data for the sample. Indicate what criteria was used to evaluate precision by circling either the RPD or CRDL for each element.

MATRIX: Soil

Element	CRDL water ug/L	CRDL soil mg/kg	Sample # SB-6/0-1	Duplicate# SB-6/0-10	RPD	Action
Aluminum	200					
Antimony	20 ~~60~~	1.0	7.0483	2.7721	87.1	J positive results
Arsenic	10					
Barium	200					
Beryllium	5	0.25	0.9130	0.7306	22.2	No Action Necessary
Cadmium	5					
Calcium	5000					
Chromium	10					
Cobalt	50					
Copper	25					
Iron	100					
Lead	5					
Magnesium	5000					
Manganese	15					
Mercury	0.2					
Nickel	50 ~~40~~	2.5	100.4591	81.5393	20.8	J positive results
Potassium	5000					
Selenium	5					
Silver	10					
Sodium	5000					
Thallium	10					
Vanadium	50	2.5	376.2190	516.3786	31.4	J positive results
Zinc	20					
Cyanide	10					

Laboratory Duplicate Actions should be applied to all other samples of the same matrix type.

ACTIONS:

1. Estimate (J) positive results for elements which have an RPD >20% for waters and >35% for soils.

2. If sample results are less than 5x the CRDL, estimate (J) positive results for elements whose absolute difference is >CRDL, (2xCRDL for soils). If both samples are non-detected, the RPD is not calculated (NC).

IX. LABORATORY CONTROL SAMPLE

Aqueous LCS

List any LCS recoveries not within the 80-120% criteria and the samples affected.

DATE	ELEMENT	%R	ACTION	SAMPLES AFFECTED

2. Solid LCS ✓ ~~All criteria Met~~ (P)

List any analytes that were not within the control windows set by the EPA for the solid LCS sample. The 80-120% criteria is not used to evaluate solid LCS results.

ELEMENT	LCS CONC.	CONTROL WINDOWS	ACTION	SAMPLES AFFECTED
Cr	82.5	84.4-97.4	J pos result UJ nondetects	SB-4/6-1, SB-4/13-15, SB-4/5-
Se	36.1	37.3-46.9	↓	↓

ACTIONS:

AQUEOUS LCS	Percent Recovery <50%	Percent Recovery 51-79%	Percent Recovery >120%
Positive Results	R	J	J
Non-detected Results	R	UJ	A

SOLID LCS	<EPA Control Windows	>EPA Control Windows
Positive Results	J	J
Non-detected Results	UJ	A

3. Frequency Criteria

A. Was an LCS analyzed for every matrix, every digestion batch, and every 20 samples? [✓ Yes] or No

REGION I
Data Review Worksheets

XI. INDUCTIVELY COUPLED PLASMA (ICP) SERIAL DILUTION ANALYSIS

______ Serial Dilutions were performed for each matrix and results of the diluted sample analysis agreed within ten percent of the original undiluted analysis.

______ Serial Dilutions were not performed for the following:

____

______ Serial Dilutions were performed, but analytical results did not agree within 10% for analyte concentrations greater than 50x the IDL before dilution.

Report all results below that do not meet the required laboratory criteria for ICP serial dilution analysis.

MATRIX: Soil SB-6101

ELEMENT	IDL	50xIDL	SAMPLE RESULT	SERIAL DILUTION	%D	ACTION
Arsenic	3.0	150	804.52	898.02	11.6	J pos results ~~No Action Necessary~~
Aluminum						
Barium	4.0	200	2347.72	2654.49	13.1	J pos results
Beryllium						
Cadmium						
Calcium						
Chromium	0.6	32	1030.93	1149.43	11.5	J pos results ~~No Action Necessary~~
Cobalt						
Copper						
Iron						
Lead	4.0	200	2288.52	2709.43	18.4	J pos results
Magnesium						
Manganese						
Nickel	0.8	40	1645.52	1918.08	16.6	J pos results
Potassium						
Silver						
Sodium						
Vanadium	0.7	35	6162.47	6775.08	9.9	No Action Necessary
Zinc	7.0	350	4490.17	5212.55	16.1	J pos results

Actions apply to all samples of the same matrix.

ACTIONS:

1. Estimate (J) positive results if %D ~~>15~~.
>10%

REGION I
Data Review Worksheets

XII. DETECTION LIMIT RESULTS

Instrument Detection Limits

✓ Instrument Detection Limit results were present and found to be less than the Contract Required Detection Limits.

____ IDLs were not included in the data package on Form XI.

____ IDLs were present, but the criteria was not met for the following elements: ____________________

2. Reporting Requirements

____ Were sample results on Form I reported down to the IDL not the CRDL for all analytes? [✓ Yes] or No

____ Were sample results that were analyzed by ICP for Se, Tl, As, or Pb at least 5x IDL. NA Yes or No

____ Were sample weights, volumes, and dilutions taken into account when reporting detection limits on Form I. [✓ Yes] or No

If No,

The reported results may be inaccurate. Make the necessary changes on the data summary tables and request that the laboratory resubmit the corrected data.

The following results, including those results blank qualified as nondetect, were qualified as estimated, due to sample results that are ~~≤2x IDL~~ <RL but not previously qualified BAT 5/7x

admium: ~~K SB-6/14-16, SB-6/14-16~~ BAT 5/25/93 SB-4/13-15, SB-7/0-1

elenium: SB-5/9-11, SB-5/0-1, SB-7/0-1

ver: SB-4/0-1, SB-4/13-15, SB-4/5-7

allium: SB-6/5-7 SB-4/0-1, SB-4/13-15, SB-4/5-7, SB-5/9-11, SB-7/0-1

All silver results were previously considered to be nondetect (u) due to blank contamination

MITKEM
CORPORATION

Analysis Report: Volatile Petroleum Hydrocarbons

Client: M & E
Analysis: MADEP VPH 98-1
Client ID: MW-1
Lab ID: B0502-01A
Matrix: Aqueous
Concentration in: ug/L

Date Collected: 3/26/03
Date Received: 3/27/03
Date Analyzed: 3/28/03
Aliquot Used for Analysis: 5 ml
Sample pH: ≤ 2
Dilution Factor: 1

SAD
5/16/03

VPH Ranges	Results	Reporting Limit
C5 - C8 Aliphatics	ND	100
C9 - C12 Aliphatics	ND	20
C9 - C10 Aromatics	40 U	30

Target Analytes		
MTBE	ND	15
Benzene	ND	5
Toluene	ND	15
Ethylbenzene	ND	5
m- and p-Xylenes	ND	20
o-Xylene	ND	10
Naphthalene	ND	10

QC Batch: V4B0328A

Surrogate Recovery (%):	
Bromofluorobenzene (FID)	111
2,5-Dibromotoluene (FID)	103
Bromofluorobenzene (PID)	113
2,5-Dibromotoluene (PID)	105

ND = Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the VPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

No significant modifications were made to this method.

VPH ranges are adjusted to exclude the concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Volatile Petroleum Hydrocarbons

Client:	M & E	Date Collected:	3/26/03
Analysis:	MADEP VPH 98-1	Date Received:	3/27/03
Client ID:	MW-5	Date Analyzed:	3/29/03
Lab ID:	B0502-02A	Aliquot Used for Analysis:	5 ml
Matrix:	Aqueous	Sample pH:	≤ 2
Concentration in:	ug/L	Dilution Factor:	1

VPH Ranges	Results	Reporting Limit
C5 - C8 Aliphatics	ND	100
C9 - C12 Aliphatics	ND	20
C9 - C10 Aromatics	ND	30

EAD
5/16/03

Target Analytes		
MTBE	ND	15
Benzene	ND	5
Toluene	ND	15
Ethylbenzene	ND	5
m- and p-Xylenes	ND	20
o-Xylene	ND	10
Naphthalene	ND	10

QC Batch: V4B0329A

Surrogate Recovery (%):	
Bromofluorobenzene (FID)	78
2,5-Dibromotoluene (FID)	90
Bromofluorobenzene (PID)	76
2,5-Dibromotoluene (PID)	88

ND = Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the VPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

No significant modifications were made to this method.

VPH ranges are adjusted to exclude the concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Volatile Petroleum Hydrocarbons

Client:	M & E	Date Collected:	3/26/03
Analysis:	MADEP VPH 98-1	Date Received:	3/27/03
Client ID:	KMW-5	Date Analyzed:	3/28/03
Lab ID:	B0502-03A	Aliquot Used for Analysis:	5 ml
Matrix:	Aqueous	Sample pH:	≤ 2
Concentration in:	ug/L	Dilution Factor:	1

EAD
5/16/03

VPH Ranges	Results	Reporting Limit
C5 - C8 Aliphatics	ND	100
C9 - C12 Aliphatics	ND	20
C9 - C10 Aromatics	34 U	30

Target Analytes		
MTBE	ND	15
Benzene	ND	5
Toluene	ND	15
Ethylbenzene	ND	5
m- and p-Xylenes	ND	20
o-Xylene	ND	10
Naphthalene	ND	10

QC Batch: V4B0328A

Surrogate Recovery (%):	
Bromofluorobenzene (FID)	90
2,5-Dibromotoluene (FID)	93
Bromofluorobenzene (PID)	92
2,5-Dibromotoluene (PID)	95

ND = Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the VPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

No significant modifications were made to this method.

VPH ranges are adjusted to exclude the concentration of target and QC (surrogate) analytes.

MITKEM
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Analysis Report: Volatile Petroleum Hydrocarbons

Client:	M & E	Date Collected:	3/27/03
Analysis:	MADEP VPH 98-1	Date Received:	3/27/03
Client ID:	MW-3	Date Analyzed:	3/28/03
Lab ID:	B0502-04A	Aliquot Used for Analysis:	5 ml
Matrix:	Aqueous	Sample pH:	≤ 2
Concentration in:	ug/L	Dilution Factor:	1

VPH Ranges	Results	Reporting Limit
C5 - C8 Aliphatics	ND	100
C9 - C12 Aliphatics	ND	20
C9 - C10 Aromatics	45 U	30

SD
5/16/03

Target Analytes		
MTBE	ND	15
Benzene	ND	5
Toluene	ND	15
Ethylbenzene	ND	5
m- and p-Xylenes	ND	20
o-Xylene	ND	10
Naphthalene	ND	10

QC Batch: V4B0328A

Surrogate Recovery (%):

Bromofluorobenzene (FID)	108
2,5-Dibromotoluene (FID)	92
Bromofluorobenzene (PID)	110
2,5-Dibromotoluene (PID)	90

ND = Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the VPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

No significant modifications were made to this method.

VPH ranges are adjusted to exclude the concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Volatile Petroleum Hydrocarbons

Client:	M & E	Date Collected:	3/27/03
Analysis:	MADEP VPH 98-1	Date Received:	3/27/03
Client ID:	MW-6	Date Analyzed:	3/28/03
Lab ID:	B0502-05A	Aliquot Used for Analysis:	5 ml
Matrix:	Aqueous	Sample pH:	≤ 2
Concentration in: ug/L		Dilution Factor:	1

SAD
5/16/03

VPH Ranges	Results	Reporting Limit
C5 - C8 Aliphatics	ND	100
C9 - C12 Aliphatics	ND	20
C9 - C10 Aromatics	46 U	30

Target Analytes		
MTBE	ND	15
Benzene	ND	5
Toluene	ND	15
Ethylbenzene	ND	5
m- and p-Xylenes	ND	20
o-Xylene	ND	10
Naphthalene	ND	10

QC Batch: V4B0328A

Surrogate Recovery (%):	
Bromofluorobenzene (FID)	108
2,5-Dibromotoluene (FID)	108
Bromofluorobenzene (PID)	109
2,5-Dibromotoluene (PID)	107

ND = Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the VPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

No significant modifications were made to this method.

VPH ranges are adjusted to exclude the concentration of target and QC (surrogate) analytes.

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7,00

Analysis Report: Volatile Petroleum Hydrocarbons

Client:	M & E	Date Collected:	3/27/03
Analysis:	MADEP VPH 98-1	Date Received:	3/27/03
Client ID:	TRIPBLANK	Date Analyzed:	3/28/03
Lab ID:	B0502-06A	Aliquot Used for Analysis:	5 ml
Matrix:	Aqueous	Sample pH:	≤ 2
Concentration in:	ug/L	Dilution Factor:	1

VPH Ranges	Results	Reporting Limit
C5 - C8 Aliphatics	ND	100
C9 - C12 Aliphatics	ND	20
C9 - C10 Aromatics	37	30

ELD
5/16/03

Target Analytes		
MTBE	ND	15
Benzene	ND	5
Toluene	ND	15
Ethylbenzene	ND	5
m- and p-Xylenes	ND	20
o-Xylene	ND	10
Naphthalene	ND	10

QC Batch: V4B0328A

Surrogate Recovery (%):	
Bromofluorobenzene (FID)	109
2,5-Dibromotoluene (FID)	99
Bromofluorobenzene (PID)	109
2,5-Dibromotoluene (PID)	99

ND = Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the VPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

No significant modifications were made to this method.

VPH ranges are adjusted to exclude the concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Volatile Petroleum Hydrocarbons

Client:	M & E	Date Collected:	3/27/03
Analysis:	MADEP VPH 98-1	Date Received:	3/27/03
Client ID:	MW-10	Date Analyzed:	3/28/03
Lab ID:	B0502-07A	Aliquot Used for Analysis:	5 ml
Matrix:	Aqueous	Sample pH:	≤ 2
Concentration in:	ug/L	Dilution Factor:	1

VPH Ranges	Results	Reporting Limit
C5 - C8 Aliphatics	ND	100
C9 - C12 Aliphatics	ND	20
C9 - C10 Aromatics	46 U	30

EAD
5/16/03

Target Analytes		
MTBE	ND	15
Benzene	ND	5
Toluene	ND	15
Ethylbenzene	ND	5
m- and p-Xylenes	ND	20
o-Xylene	ND	10
Naphthalene	ND	10

QC Batch: V4B0328A

Surrogate Recovery (%):	
Bromofluorobenzene (FID)	89
2,5-Dibromotoluene (FID)	93
Bromofluorobenzene (PID)	89
2,5-Dibromotoluene (PID)	93

ND = Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the VPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

No significant modifications were made to this method.

VPH ranges are adjusted to exclude the concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: MW-1
Lab ID: B0502-01C
Matrix: Aqueous
Concentration in: ug/L

Date Collected: 3/26/03
Date Received: 3/27/03
Date Extracted: 4/8/03
Date Analyzed: 4/23/06 F1, 4/23/03 F:
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	ND UJ	30
C19 - C36 Aliphatics	45	40
C11 - C22 Aromatics	ND	85
Target Analytes		
Acenaphthene	ND	5
Acenaphthylene	ND	5
Anthracene	ND	5
Benzo(a)anthracene	ND	5
Benzo(a)pyrene	ND	5
Benzo(b)fluoranthene	ND	5
Benzo(ghi)perylene	ND	5
Benzo(k)fluoranthene	ND	5
Chrysene	ND	5
Dibenzo(a,h)anthracene	ND	5
Fluoranthene	ND	5
Fluorene	ND	5
Indeno(1,2,3-cd)pyrene	ND	5
Naphthalene	ND	5
Phenanthrene	ND	5
Pyrene	ND	5
2-Methylnaphthalene	ND	5

EAD
5/16/03

QC Batch: MB-6544

Surrogate Recovery (%):	
Chlorooctadecane	53%
o-Terphenyl	64%
2-Fluorobiphenyl	87%
2-Bromonaphthalene	90%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: MW-5
Lab ID: B0502-02C
Matrix: Aqueous
Concentration in: ug/L

Date Collected: 3/26/03
Date Received: 3/27/03
Date Extracted: 4/8/03
Date Analyzed: 4/23/06 F1, 4/23/03 F:
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	ND	30
C19 - C36 Aliphatics	ND	40
C11 - C22 Aromatics	ND	85
Target Analytes		
Acenaphthene	ND	5
Acenaphthylene	ND	5
Anthracene	ND	5
Benzo(a)anthracene	ND	5
Benzo(a)pyrene	ND	5
Benzo(b)fluoranthene	ND	5
Benzo(ghi)perylene	ND	5
Benzo(k)fluoranthene	ND	5
Chrysene	ND	5
Dibenzo(a,h)anthracene	ND	5
Fluoranthene	ND	5
Fluorene	ND	5
Indeno(1,2,3-cd)pyrene	ND	5
Naphthalene	ND	5
Phenanthrene	ND	5
Pyrene	ND	5
2-Methylnaphthalene	ND	5

EAD
5/16/03

QC Batch: MB-6544

Surrogate Recovery (%):	
Chlorooctadecane	52%
o-Terphenyl	66%
2-Fluorobiphenyl	83%
2-Bromonaphthalene	96%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: KMW-5
Lab ID: B0502-03C
Matrix: Aqueous
Concentration in: ug/L

Date Collected: 3/26/03
Date Received: 3/27/03
Date Extracted: 4/8/03
Date Analyzed: 4/23/06 F1, 4/23/03 F:
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	ND	30
C19 - C36 Aliphatics	ND	40
C11 - C22 Aromatics	ND	85
Target Analytes		
Acenaphthene	ND	5
Acenaphthylene	ND	5
Anthracene	ND	5
Benzo(a)anthracene	ND	5
Benzo(a)pyrene	ND	5
Benzo(b)fluoranthene	ND	5
Benzo(ghi)perylene	ND	5
Benzo(k)fluoranthene	ND	5
Chrysene	ND	5
Dibenzo(a,h)anthracene	ND	5
Fluoranthene	ND	5
Fluorene	ND	5
Indeno(1,2,3-cd)pyrene	ND	5
Naphthalene	ND	5
Phenanthrene	ND	5
Pyrene	ND	5
2-Methylnaphthalene	ND	5

EAD
5/16/03

QC Batch: MB-6544

Surrogate Recovery (%):	
Chlorooctadecane	58%
o-Terphenyl	70%
2-Fluorobiphenyl	88%
2-Bromonaphthalene	91%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: MW-3
Lab ID: B0502-04C
Matrix: Aqueous
Concentration in: ug/L

Date Collected: 3/27/03
Date Received: 3/27/03
Date Extracted: 4/8/03
Date Analyzed: 4/23/06 F1, 4/23/03 F:
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	35	30
C19 - C36 Aliphatics	44	40
C11 - C22 Aromatics	ND	85
Target Analytes		
Acenaphthene	ND	5
Acenaphthylene	ND	5
Anthracene	ND	5
Benzo(a)anthracene	ND	5
Benzo(a)pyrene	ND	5
Benzo(b)fluoranthene	ND	5
Benzo(ghi)perylene	ND	5
Benzo(k)fluoranthene	ND	5
Chrysene	ND	5
Dibenzo(a,h)anthracene	ND	5
Fluoranthene	ND	5
Fluorene	ND	5
Indeno(1,2,3-cd)pyrene	ND	5
Naphthalene	ND	5
Phenanthrene	ND	5
Pyrene	ND	5
2-Methylnaphthalene	ND	5

SAD
5/16/03

QC Batch: MB-6544

Surrogate Recovery (%):	
Chlorooctadecane	42%
o-Terphenyl	57%
2-Fluorobiphenyl	89%
2-Bromonaphthalene	96%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: MW-6
Lab ID: B0502-05C
Matrix: Aqueous
Concentration in: ug/L

Date Collected: 3/27/03
Date Received: 3/27/03
Date Extracted: 4/8/03
Date Analyzed: 4/23/06 F1, 4/23/03 F:
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	40 J	30
C19 - C36 Aliphatics	49 J	40
C11 - C22 Aromatics	ND	85
Target Analytes		
Acenaphthene	ND	5
Acenaphthylene	ND	5
Anthracene	ND	5
Benzo(a)anthracene	ND	5
Benzo(a)pyrene	ND	5
Benzo(b)fluoranthene	ND	5
Benzo(ghi)perylene	ND	5
Benzo(k)fluoranthene	ND	5
Chrysene	ND	5
Dibenzo(a,h)anthracene	ND	5
Fluoranthene	ND	5
Fluorene	ND	5
Indeno(1,2,3-cd)pyrene	ND	5
Naphthalene	ND	5
Phenanthrene	ND	5
Pyrene	ND	5
2-Methylnaphthalene	ND	5

EAD
5/16/03

QC Batch: MB-6544

Surrogate Recovery (%):	
Chlorooctadecane	34%
o-Terphenyl	46%
2-Fluorobiphenyl	91%
2-Bromonaphthalene	98%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

MITKEM
CORPORATION

Analysis Report: Extractable Petroleum Hydrocarbons

Client: Metcalf & Eddy, Inc.
Analysis: MADEP EPH 98-1
Client ID: MW-10
Lab ID: B0502-07C
Matrix: Aqueous
Concentration in: ug/L

Date Collected: 3/27/03
Date Received: 3/27/03
Date Extracted: 4/8/03
Date Analyzed: 4/23/06 F1, 4/23/03 F:
Dilution: 1

EPH Ranges	Results	Reporting Limits
C9 - C18 Aliphatics	44	30
C19 - C36 Aliphatics	45	40
C11 - C22 Aromatics	ND	85
Target Analytes		
Acenaphthene	ND	5
Acenaphthylene	ND	5
Anthracene	ND	5
Benzo(a)anthracene	ND	5
Benzo(a)pyrene	ND	5
Benzo(b)fluoranthene	ND	5
Benzo(ghi)perylene	ND	5
Benzo(k)fluoranthene	ND	5
Chrysene	ND	5
Dibenzo(a,h)anthracene	ND	5
Fluoranthene	ND	5
Fluorene	ND	5
Indeno(1,2,3-cd)pyrene	ND	5
Naphthalene	ND	5
Phenanthrene	ND	5
Pyrene	ND	5
2-Methylnaphthalene	ND	5

SAD
8/16/03

QC Batch: MB-6544

Surrogate Recovery (%):	
Chlorooctadecane	53%
o-Terphenyl	69%
2-Fluorobiphenyl	94%
2-Bromonaphthalene	88%

ND= Not Detected

Except where noted in the Project Narrative, all QA/QC procedures required by the EPH method were followed, and all performance/acceptance standards for the required QA/QC procedures were achieved.

The only significant modification made to this method is the subtraction of SPE cartridge contamination from the EPH ranges per Section 11.2.6 of the method.

EPH ranges are adjusted to exclude concentration of target and QC (surrogate) analytes.

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW-1

Lab Name: MITKEM CORPORATION   Contract:

Lab Code: MITKEM   Case No.:   SAS No.:   SDG No.: B0502

Matrix: (soil/water) WATER   Lab Sample ID: B0502-01D

Sample wt/vol: 1000 (g/ml) ML   Lab File ID: B1E0749F

% Moisture: ______ decanted: (Y/N)___   Date Received: 03/27/03

Extraction: (SepF/Cont/Sonc) CONT   Date Extracted: 04/01/03

Concentrated Extract Volume: 10000(uL)   Date Analyzed: 04/18/03

Injection Volume: 1.0(uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: ___   Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
12674-11-2	------Aroclor-1016	1.0	U
11104-28-2	------Aroclor-1221	1.0	U
11141-16-5	------Aroclor-1232	1.0	U
53469-21-9	------Aroclor-1242	1.0	U
12672-29-6	------Aroclor-1248	1.0	U
11097-69-1	------Aroclor-1254	1.0	U
11096-82-5	------Aroclor-1260	1.0	U

EAD
5/16/03

FORM I PCB

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW-5

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0502

Matrix: (soil/water) WATER Lab Sample ID: B0502-02D

Sample wt/vol: 1000 (g/ml) ML Lab File ID: E1E0752F

% Moisture: ______ decanted: (Y/N)___ Date Received: 03/27/03

Extraction: (SepF/Cont/Sonc) CONT Date Extracted: 04/01/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 04/18/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
12674-11-2	Aroclor-1016	1.0	U
11104-28-2	Aroclor-1221	1.0	U
11141-16-5	Aroclor-1232	1.0	U
53469-21-9	Aroclor-1242	1.0	U
12672-29-6	Aroclor-1248	1.0	U
11097-69-1	Aroclor-1254	1.0	U
11096-82-5	Aroclor-1260	1.0	U

SAD
5/16/03

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

KMW-5

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0502

Matrix: (soil/water) WATER Lab Sample ID: B0502-03D

Sample wt/vol: 1000 (g/ml) ML Lab File ID: R1E0753F

% Moisture: ______ decanted: (Y/N)___ Date Received: 03/27/03

Extraction: (SepF/Cont/Sonc) CONT Date Extracted: 04/01/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 04/18/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
12674-11-2	Aroclor-1016	1.0	U
11104-28-2	Aroclor-1221	1.0	U
11141-16-5	Aroclor-1232	1.0	U
53469-21-9	Aroclor-1242	1.0	U
12672-29-6	Aroclor-1248	1.0	U
11097-69-1	Aroclor-1254	1.0	U
11096-82-5	Aroclor-1260	1.0	U

SD
5/16/03

FORM 1
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW-3

Lab Name: MITKEM CORPORATION   Contract:

Lab Code: MITKEM   Case No.:   SAS No.:   SDG No.: B0502

Matrix: (soil/water) WATER   Lab Sample ID: B0502-04D

Sample wt/vol: 1000 (g/ml) ML   Lab File ID: E1E0764F

% Moisture: ______ decanted: (Y/N)___   Date Received: 03/27/03

Extraction: (SepF/Cont/Sonc) CONT   Date Extracted: 04/01/03

Concentrated Extract Volume: 10000 (uL)   Date Analyzed: 04/19/03

Injection Volume: 1.0 (uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: ___   Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
12674-11-2	Aroclor-1016	1.0	U
11104-28-2	Aroclor-1221	1.0	U
11141-16-5	Aroclor-1232	1.0	U
53469-21-9	Aroclor-1242	1.0	U
12672-29-6	Aroclor-1248	1.0	U
11097-69-1	Aroclor-1254	1.0	U
11096-82-5	Aroclor-1260	1.0	U

SD
5/16/03

FORM I
PCB ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.
MW-6

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0502

Matrix: (soil/water) WATER Lab Sample ID: B0502-05D

Sample wt/vol: 1000 (g/ml) ML Lab File ID: E1E0765F

% Moisture: ______ decanted: (Y/N)___ Date Received: 03/27/03

Extraction: (SepF/Cont/Sonc) CONT Date Extracted: 04/01/03

Concentrated Extract Volume: 10000 (uL) Date Analyzed: 04/19/03

Injection Volume: 1.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
12674-11-2	Aroclor-1016	1.0	U
11104-28-2	Aroclor-1221	1.0	U
11141-16-5	Aroclor-1232	1.0	U
53469-21-9	Aroclor-1242	1.0	U
12672-29-6	Aroclor-1248	1.0	U
11097-69-1	Aroclor-1254	1.0	U
11096-82-5	Aroclor-1260	1.0	U

ELD
5/16/0

FORM I CLIENT SAMPLE NO.

PCB ORGANICS ANALYSIS DATA SHEET

MW-10

Lab Name: MITKEM CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0502

Matrix: (soil/water) WATER Lab Sample ID: B0502-07D

Sample wt/vol: 1000 (g/ml) ML Lab File ID: E1E0766F

% Moisture: _____ decanted: (Y/N)___ Date Received: 03/27/03

Extraction: (SepF/Cont/Sonc) CONT Date Extracted: 04/01/03

Concentrated Extract Volume: 10000(uL) Date Analyzed: 04/19/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) Y

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
12674-11-2	Aroclor-1016	1.0	U
11104-28-2	Aroclor-1221	1.0	U
11141-16-5	Aroclor-1232	1.0	U
53469-21-9	Aroclor-1242	1.0	U
12672-29-6	Aroclor-1248	1.0	U
11097-69-1	Aroclor-1254	1.0	U
11096-82-5	Aroclor-1260	1.0	U

ED 5/16/0

FORM I PCB

U.S. EPA - CLP

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

MW-3

Lab Name: MITKEM_CORPORATION Contract:

Lab Code: MITKEM Case No.: SAS No.: SDG No.: B0502

Matrix (soil/water): WATER Lab Sample ID: B0502-04B

Level (low/med): MED Date Received: 03/27/03

% Solids:

Concentration Units (ug/L or mg/kg dry weight): UG/L

SAD
5/16/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	6.7 UJ	~~B~~		P
7440-38-2	Arsenic	4.2 J	~~B~~		P
7440-39-3	Barium	83.4 J	~~B~~		P
7440-41-7	Beryllium	0.50	U		P
7440-43-9	Cadmium	0.70	U		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	1.0 J	~~B~~		P
7440-48-4	Cobalt				NR
7440-50-8	Copper	4.0	U		P
7439-89-6	Iron				NR
7439-92-1	Lead	4.0	U		P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.14	U		CV
7440-02-0	Nickel	4.0 J	~~B~~	5/16/03	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	188			P
7440-22-4	Silver	2.0	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	3.0	U		P
7440-62-2	Vanadium	158			P
7440-66-6	Zinc	7.0	U		P
	Cyanide				NR

Color Before: Clarity Before: Texture:

Color After: Clarity After: Artifacts:

Comments:

73a

U.S. EPA - CLP

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

KMW-5

Lab Name: MITKEM_CORPORATION________ Contract: __________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0502__

Matrix (soil/water): WATER_ Lab Sample ID: B0502-03B_____

Level (low/med): MED____ Date Received: 03/27/03____

% Solids: ________

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	4.3 UJ	~~B~~		P
7440-38-2	Arsenic	4.8 J	~~B~~		P
7440-39-3	Barium	81.6	~~B~~		P
7440-41-7	Beryllium	0.71 J	~~B~~		P
7440-43-9	Cadmium	0.70	U		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	0.97 J	~~B~~		P
7440-48-4	Cobalt				NR
7440-50-8	Copper	4.5 UJ	~~B~~		P
7439-89-6	Iron				NR
7439-92-1	Lead	4.0	U		P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.13	U		CV
7440-02-0	Nickel	20.3 J	~~B~~	5/16	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	16.0 J	~~B~~		P
7440-22-4	Silver	2.0	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	3.0	U		P
7440-62-2	Vanadium	11.1 J	~~B~~		P
7440-66-6	Zinc	15.9 J	~~B~~		P
	Cyanide				NR

ELD
5/16/03

Color Before: ________ Clarity Before: ________ Texture: ________

Color After: ________ Clarity After: ________ Artifacts: ________

Comments:

FORM I - IN SW846

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1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

MW-1

Lab Name: MITKEM_CORPORATION________ Contract: __________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0502__

Matrix (soil/water): WATER_ Lab Sample ID: B0502-01B_____

Level (low/med): MED___ Date Received: 03/27/03____

% Solids: ________

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	3.4 UJ	~~B~~		P
7440-38-2	Arsenic	3.0	U		P
7440-39-3	Barium	76.8 J	~~B~~		P
7440-41-7	Beryllium	0.50	U		P
7440-43-9	Cadmium	0.70	U		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	1.1 J	~~B~~		P
7440-48-4	Cobalt				NR
7440-50-8	Copper	4.0	U		P
7439-89-6	Iron				NR
7439-92-1	Lead	4.0	U		P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.12	U		CV
7440-02-0	Nickel	1.1 J	~~B~~	[illegible]	P
7440-09-7	Potassium				NR
7782-49-2	Selenium	9.0	U	[illegible]	P
7440-22-4	Silver	2.0	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	3.0	U		P
7440-62-2	Vanadium	1.2 J	~~B~~		P
7440-66-6	Zinc	7.0	U		P
	Cyanide				NR

EAD
5/16/03

Color Before: ________ Clarity Before: ________ Texture: ________

Color After: ________ Clarity After: ________ Artifacts: ________

Comments:

75R

U.S. EPA - CLP

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

MW-10

Lab Name: MITKEM_CORPORATION________ Contract: ________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0502__

Matrix (soil/water): WATER_ Lab Sample ID: B0502-07B_____

Level (low/med): MED____ Date Received: 03/27/03____

% Solids: ________

Concentration Units (ug/L or mg/kg dry weight): UG/L

SAD
5/16/03

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	4.7 UJ	~~B~~		P
7440-38-2	Arsenic	4.4 J	~~B~~		P
7440-39-3	Barium	14.7 UJ	~~B~~		P
7440-41-7	Beryllium	0.50	U		P
7440-43-9	Cadmium	0.70	U		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	0.85 J	~~B~~		P
7440-48-4	Cobalt				NR
7440-50-8	Copper	4.0	U		P
7439-89-6	Iron				NR
7439-92-1	Lead	4.0	U		P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.14	U		CV
7440-02-0	Nickel	0.94 J	~~B~~		P
7440-09-7	Potassium			[illegible]	NR
7782-49-2	Selenium	9.0	U	5/2/07	P
7440-22-4	Silver	2.0	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	3.0	U		P
7440-62-2	Vanadium	15.0 J	~~B~~		P
7440-66-6	Zinc	7.0	U		P
	Cyanide				NR

Color Before: ________ Clarity Before: ________ Texture: ________

Color After: ________ Clarity After: ________ Artifacts: ________

Comments:

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1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

MW-5

Lab Name: MITKEM_CORPORATION

Contract:

Lab Code: MITKEM

Case No.:

SAS No.:

SDG No.: B0502

Matrix (soil/water): WATER

Lab Sample ID: B0502-02B

Level (low/med): MED

Date Received: 03/27/03

% Solids:

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	6.8 UJ	~~B~~		P
7440-38-2	Arsenic	7.9 J	~~B~~		P
7440-39-3	Barium	34.2 J	~~B~~		P
7440-41-7	Beryllium	0.50	U		P
7440-43-9	Cadmium	0.70	U		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	1.0 J	~~B~~		P
7440-48-4	Cobalt				NR
7440-50-8	Copper	11.1 UJ	~~B~~		P
7439-89-6	Iron				NR
7439-92-1	Lead	4.0	U		P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.13	U		CV
7440-02-0	Nickel	2.6 J	~~B~~		P
7440-09-7	Potassium			E 5/16/03	NR
7782-49-2	Selenium	9.0	U		P
7440-22-4	Silver	2.0	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	3.0	U		P
7440-62-2	Vanadium	0.70	U		P
7440-66-6	Zinc	18.9 J	~~B~~		P
	Cyanide				NR

EAD
5/16/03

Color Before:

Clarity Before:

Texture:

Color After:

Clarity After:

Artifacts:

Comments:

FORM I - IN

SW846

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1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

MW-6

Lab Name: MITKEM_CORPORATION________ Contract: __________

Lab Code: MITKEM Case No.: ______ SAS No.: ______ SDG No.: B0502___

Matrix (soil/water): WATER_ Lab Sample ID: B0502-05B_____

Level (low/med): MED____ Date Received: 03/27/03____

% Solids: ________

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum				NR
7440-36-0	Antimony	7.1 UJ	~~B~~		P
7440-38-2	Arsenic	11.0 J	~~B~~		P
7440-39-3	Barium	44.0 J	~~B~~		P
7440-41-7	Beryllium	0.50	U		P
7440-43-9	Cadmium	0.70	U		P
7440-70-2	Calcium				NR
7440-47-3	Chromium	0.60	U		P
7440-48-4	Cobalt				NR
7440-50-8	Copper	4.0	U		P
7439-89-6	Iron				NR
7439-92-1	Lead	4.0	U		P
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury	0.12	U		CV
7440-02-0	Nickel	5.6 J	~~B~~		P
7440-09-7	Potassium				NR
7782-49-2	Selenium	12.1 J	~~B~~	[illegible]	P
7440-22-4	Silver	2.0	U		P
7440-23-5	Sodium				NR
7440-28-0	Thallium	3.0	U		P
7440-62-2	Vanadium	3710			P
7440-66-6	Zinc	7.0	U		P
	Cyanide				NR

EAD
5/16/03

Color Before: __________ Clarity Before: __________ Texture: __________

Color After: __________ Clarity After: __________ Artifacts: __________

Comments:

M&E Metcalf & Eddy

CHAIN OF CUSTODY FORM

Job/Project Name: OXFORD PAPER MILL	Job/Project Location: LAWRENCE, MA	Job/Project Number: 200299-1-2
Samplers: (Signature)	Recorder: (Signature)	Date: 3/27/03
Lab (Samples Sent To): MITKEM		

SAMPLING		SAMPLE NUMBER	SAMPLE LOCATION	MATRIX					COMPOSITE/GRAB	PRESERVATIVE (Y/N)	ANALYSIS REQUESTED								Total #	COMMENTS
Date	Time			Water	Soil						PCBs 1L Amber ICE	MADEP 1L Amber EPH HCl	PPMETALS 500 mL [illegible] HNO3	MADEP 40mL VOA VPH HCl						
3/26/03	1135	mw-1	mw-1	X					G	Y	2	2	1	2					7	
↓	1147	mw-1	mw-1	↓					↓	↓	4	4	1	4					13	ms/msd
	1232	mw-5	mw-5								2	2	1	2					7	
	1345	kmw-5	kmw-5								2	2	1	2					7	
3/27/03	0955	mw-3	mw-3	X					G	Y	2	2	1	2					7	
↓	1040	mw-6	mw-6	↓					↓	↓	2	2	1	2					7	
		TRIP BLANK												1					1	1 cooler contain all VAH
		Temp Blank																		1 per cooler
3/27/03	1155	MW-10	MW-10	X					G	Y	2	2	1	2					7	

Relinquished By: (Signature)	Date: 3/27/03 Time: 1415	Received By: (Signature)	Relinquished By: (Signature)	Date: Time:	Received By: (Signature)
Relinquished By: (Signature)	Date: Time:	Received By: (Signature)	Relinquished By: (Signature)	Date: Time:	Received By: (Signature)
Relinquished By: (Signature)	Date: Time:	Received for Lab By: (Signature)	Date: Time:	Comments: Complete Group #5 COOLERS	
Method of Shipment:					

Distribution: **Original to Lab. Copy 1 to Field Files, Copy 2 to Project Manager**

Metcalf & Eddy

Memorandum

PROJECT NO: 036200299.0001.00003 **DATE:** May 16, 2003
TO: Oxford Paper Mill File **OFFICE:** Wakefield
FROM: E. DeCola EAD **COMPANY:** Metcalf & Eddy, Inc.
REVIEWED BY: D. Truini
CC: B. Weir, N. Thurber, D. Laferte (memo only)

SUBJECT: Limited QC Review/Modified Tier II-Like Review
PCB, EPH, VPH and Priority Pollutant Metals Analytical Results
Mitkem Corporation, Warwick, Rhode Island
Lab Project # B0502

On March 26 and 27, 2003, 6 groundwater samples and 1 trip blank sample were collected at the Oxford Paper Mill site, located in Lawrence, Massachusetts by Shaw Environmental & Infrastructure, Inc. (Shaw) and Metcalf & Eddy, Inc. (M&E) field personnel. The sampling was performed as part of Shaw's contract with the City of Lawrence, MA and Shaw's contract with M&E (Shaw Project Number 608134, M&E Project Number 200299-0001).

The samples were submitted to Mitkem Corporation, located in Warwick, Rhode Island for the analysis of Polychlorinated Biphenyls (PCB) using EPA SW-846 Method 8082, Volatile Petroleum Hydrocarbons (VPH) using MADEP *Method for the Determination of Volatile Petroleum Hydrocarbons (VPH) (January 1998)*, Extractable Petroleum Hydrocarbons (EPH) using the MADEP *Method for the Determination of Extractable Petroleum Hydrocarbons (EPH) (January 1998)*, and Priority Pollutant Metals using EPA SW-846 Methods 6010B and 7471A. All samples were received by the laboratory on March 27, 2003. The data package was received in the M&E office on April 28, 2003.

In accordance with M&E's contract with Shaw, and the EPA and MADEP-approved work plan for the subject site dated January 2003, M&E reviewed the data using EPA Region I Tier II level guidelines, as modified by M&E/EPA for the Targeted Brownfields Assessment Program (EPA Response Action Contract, Work Assignment Number 106-SIBZ-0100). The data deliverables, and the modified Tier II level data validation guidelines used to evaluate the data, are also consistent with MADEP's Presumptive Certainty guidelines for the usability of analytical data. The data review included:

- Data Completeness
- * Preservation and Technical Holding Times
- NA GC/ECD Instrument Performance Checks

- Initial and Continuing Calibrations
- Blanks
- Surrogate Recoveries and Retention Time Shifts
- * Inductively Coupled Plasma (ICP) Interference Check Sample
- NA Internal Standards
- * Internal Standards
- Matrix Spike/Matrix Spike Duplicate
- * Laboratory Duplicates
- * Field Duplicates
- * ICP Serial Dilution Analysis Results
- NA Sensitivity Check
- * Performance Evaluation Samples/Accuracy Check
- NA Target Compound Identification
- Compound Quantitation and Reported Quantitation Limits
- * System Performance

* = All criteria met for this parameter
NA = Not applicable and/or no information was provided by the laboratory

Note: Worksheets are not included for parameters that have met criteria or for criteria that are not applicable to the method and/or to the modified Tier II-like review.

Included in Attachment I is a copy of the chain-of-custody (COC) record. Included in Attachment II are the result summary sheets, annotated with qualifiers, if necessary, as detailed in this memorandum. Included in Attachment III are the data validation worksheets.

Data Completeness

Priority Pollutant Metals

The following items were missing or incorrectly reported.

1) Barium and vanadium were not reported for any groundwater samples as requested on the chain-of-custody.
2) Unspiked analytes were not reported in the ICSA Form 4 for metals.
A resubmital request was sent to Mitkem on April 28, 2003 and a response was received on May 5, 2003 with the revised forms.

The data package was complete for PCB, VPH, and EPH analysis.

Initial and Continuing Calibrations

PCB

The following table summarizes the continuing calibration (CC) analysis results that failed to meet the CC criterion of percent difference (%D) ≤15. Note that the 3 peaks used to quantitate the PCB results were averaged to determine %D exceedances.

Instrument/Column	RTXCLP/ pest2	RTXCLP/ pest2
Calibration Date	CC 4/21/03 @ 13:45	CC 4/22/03 @ 00:46
Compound	Average %D	Average %D
Aroclor- 1260	16.4	17.2
Associated Samples and Action.	None. No action is taken on QC samples.	None. No action is taken on QC samples.

All initial and continuing calibration criteria was met for EPH, VPH and priority pollutant metals. However, it should be noted that the laboratory did not follow method requirements for calculation of the VPH and EPH range continuing calibration calibration factors. Per the MADEP method, the range calibration factor is calculated by summation of the peak areas of all component standards in each range fraction against the total mass injected. The laboratory calculated calibration factors for each individual peak rather than a summation. No action was taken since the individual calibration factors were all <25 relative percent difference.

Blanks

VPH

There was one trip blank associated with the VPH samples in this package. Blank contaminants were detected in the trip blank and the laboratory blanks. The following table summarizes the level of blank contamination detected in the blanks. If a contaminant was detected in more than one blank, the highest concentration was used to qualify associated sample results.

Compound	Blank	Maximum Concentration (µg/L)	BAL (µg/L)	Sample QL (µg/L)	Samples Affected
C_9-C_{10} Aromatics	trip (Trip Blank)	37	185	30	Qualify as nondetect (U) at the reported value for samples MW-1, MW-3, KMW-5. MW-6 and MW-10

BAL - blank action level
QL -- quantitation limit

Sample results were qualified as follows:

- If sample result was ≥QL and <BAL, the result was qualified as a nondetect (U) at the reported concentration
- If the sample result was <QL and <BAL, the results was qualified as a nondetect (U) at the QL
- If the sample result was >BAL, qualification of the data was not required

Priority Pollutant Metals

A review of laboratory blank results indicates the presence of positive laboratory contamination for the analyte listed below.

Analyte	Max. Conc. Contaminant (µg/L)	BAL (µg/L)	Affected Samples/Action
antimony	6.2	31.0	Qualify the reported value as "U" in all samples in this package.
barium	5.448	27.24	Qualify the reported value as "U" in samples MW-10.
copper	11.208	56.04	Qualify the reported value as "U" in samples KMW-5 and MW-5.
silver	8.986	44.93	None, all sample results are nondetect.

BAL - blank action level

Blank actions for analytes associated with positive blank contamination:

- concentration ≤ BAL; report value on summary table as U.
- concentration > BAL; report value unqualified.

No blank contamination was detected in the PCB and EPH analyses. However, it should be noted that the laboratory blank corrected the EPH range results for contamination from the solid phase extraction/fractionation cartridges.

Surrogate Recoveries and Retention Time Shifts

<u>EPH</u>

The EPH surrogate compounds that did not meet the acceptance criterion of percent recovery (%R) of 40-140% for chlorooctadecane are summarized in the following table:

Sample ID	chlorooctadecane %	Action
MW-6	34	Estimate(J) the positive C_9-C_{18} Aliphatic and C_{19}-C_{36} Aliphatic results in sample MW-6. The result may be biased low.

Surrogate criteria was met for PCB and VPH analysis. Surrogate criteria is not applicable for priority pollutant metals analysis.

Matrix Spike/Matrix Spike Duplicate

<u>EPH</u>

The EPH compounds for the groundwater samples that did not meet acceptance criteria of 40-140 percent recovery (%R) in matrix spike/matrix spike duplicate (MS/MSD) MW-1 are summarized in the table below:

Compound	MS % R	MSD %R	RPD	Affected Samples/Action
C_9-C_{18} Aliphatics	34	34	-	Estimate (J) the positive C_9-C_{18} Aliphatics in the EPH result in sample MW-1.

- indicates all criteria met

All criteria was met for PCB, VPH and priority pollutant metals matrix spike/matrix spike duplicates.

Compound Quantitation and Reported Quantitation Limits

Priority Pollutant Metals

The following table summarizes the priority pollutants metal results that are less than the reporting limit (RL) but greater than the instrument detection limit (IDL) and were not previously qualified as estimated (J) due to quality control parameters discussed above. The listed results are qualified as estimated (J) due to uncertainty in the quantitation:

Analyte	Affected Samples/Action
antimony	MW-3, KMW-5, MW-10, MW-1, MW-5 and MW-6
arsenic	MW-3, KMW-5, MW-10, MW-5 and MW-6
barium	MW-3, KMW-5, MW-1, MW-5, MW-6, and MW-10
beryllium	KMW-5
chromium	MW-3, KMW-5, MW-10, MW-1 and MW-5
copper	KMW-5 and MW-5
nickel	MW-3, KMW-5, MW-10, MW-1, MW-5 and MW-6
selenium	KMW-5 and MW-6
vanadium	KMW-5, MW-10 and MW-1
zinc	KMW-5 and MW-5

The positive results for antimony and copper in all samples listed above and the barium result in sample MW-10 were previously qualified as nondetect (U) due to blank contamination. These results are further qualified as estimated, nondetect (UJ) due to blank contamination and uncertainty in quantitation.

All criteria was met for PCB, VPH and EPH analyses for compound quantitation and reported quantitation limits.

Mitkem Project B0502C

REGION I ORGANIC DATA VALIDATION

The following data package has been validated:

Lab Name Mitkem
Case/Project No.
SDG No. B0502
No. of Samples/Matrix 7/GW (including TB

SOW/Method No. MADEP VPH+EPH; SW846 PCBs
Sampling Date(s) 3/26-3/27/03
Shipping Date(s) 3/27/03
Date Rec'd by lab 3/27/03

Traffic Report Sample Nos. MW-1, MW-5, KMW-5, MW-3, MW-6, MW-10

Trip Blank No. Trip Blank
Equipment Blank No. none
Bottle Blank No. none
Field Duplicate Nos. KMW-5 + MW-5
PES Nos. none

The Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses, revision 12/96 with Mods was used to evaluate the data and/or approved modifications to the EPA-NE Functional Guidelines were used to evaluate the data and are attached to this cover page: (attach modified criteria from EPA approved QAPjP or amendment to QAPjP).

A [✓ Tier II] or Tier III evaluation was used to validate the data (circle one). If a Tier II validation with a partial Tier III was used, then identify samples, parameters, etc. that received partial Tier III validation

PCBs by 8082, VPH/EPH by MADEP method.

The data were evaluated based upon the following parameters:

- Overall Evaluation of Data
- Data Completeness (CSF Audit - Tier I)
- Preservation & Technical Holding Times
- GC/MS & GC/ECD Instrument Performance Check
- Initial & Continuing Calibrations
- Blanks
- Surrogate Compounds
- Internal Standards
- Matrix Spike/Matrix Spike Duplicate
- Field Duplicates
- Sensitivity Check
- PE Samples/Accuracy Check
- Target Compound Identification
- Compound Quantitation and Reported Quantitation Limits
- TICs
- Semivolatile and Pesticide/PCB Cleanup
- System Performance

Region I Definitions and Qualifiers:

A - Acceptable Data
J - Numerical value associated with compound is an estimated quantity.
R - The data are rejected as unusable. The R replaces the numerical value or sample quantitation limit.
U - Compound not detected at that numerical sample quantitation limit.
UJ - The sample quantitation limit is an estimated quantity.
TB, BB, EB - Compound detected in aqueous trip blank, aqueous bottle blank, or aqueous equipment blank associated with soil/sediment samples.

Validator's Name E. DeCola Company Name MTE Phone Number 781-246-5200
Date Validation Started 4/28/03 Date Validation Completed 4/29/03

Check if all criteria are met and no hard copy worksheet provided. Indicate NA if worksheet is not applicable to analytical method. Note: there is no standard worksheet for System Performance, however, the validator must document all system performance issues in the Data Validation Memorandum.

VOA/SV worksheets:

VOA/SV-Pest/PCB	COMPLETE SDG FILE (CSF) AUDIT	NA
VOA/SV-Pest/PCB-I	PRESERVATION AND HOLDING TIMES	│
VOA/SV-II	GC/MS INSTRUMENT PERFORMANCE CHECK (TUNING)	│
VOA/SV-III	INITIAL CALIBRATION	│
VOA/SV-IV	CONTINUING CALIBRATION	│
VOA/SV-Pest/PCB-V-A	BLANK ANALYSIS	│
VOA/SV-Pest/PCB-V-B	BLANK ANALYSIS	│
VOA-VI	VOA SURROGATE SPIKE RECOVERIES	│
SV-VI	SV SURROGATE SPIKE RECOVERIES	│
VOA/SV-VII	INTERNAL STANDARD PERFORMANCE	│
VOA/SV-Pest/PCB-VIII	MATRIX SPIKE/MATRIX SPIKE DUPLICATE	│
VOA/SV-Pest/PCB-IX	FIELD DUPLICATE PRECISION	│
VOA/SV-Pest/PCB-X	SENSITIVITY CHECK	│
VOA/SV-Pest/PCB-XI	ACCURACY CHECK	│
VOA/SV-Pest/PCB-XII	TARGET COMPOUND IDENTIFICATION	│
VOA/SV-Pest/PCB-XIII	SAMPLE QUANTITATION	│
VOA/SV-XIV	TENTATIVELY IDENTIFIED COMPOUNDS	│
VOA/SV-XV	SEMIVOLATILE CLEANUP	│
TABLE II-WORKSHEET	OVERALL EVALUATION OF DATA	↓

Pest/PCB worksheets:

VOA/SV-Pest/PCB	COMPLETE SDG FILE (CSF) AUDIT	NA
VOA/SV-Pest/PCB-I	PRESERVATION AND HOLDING TIMES	✓
Pest/PCB-IIA	GC/ECD INSTRUMENT PERFORMANCE CHECK-RESOLUTION	NA
Pest/PCB-IIB	GC/ECD INSTRUMENT PERFORMANCE CHECK-RETENTION TIMES	NA
Pest/PCB-IIC	GC/ECD INSTRUMENT PERFORMANCE CHECK-ACCURACY CHECK OF INITIAL CALIBRATION	NA
Pest/PCB-IID	GC/ECD INSTRUMENT PERFORMANCE CHECK-PESTICIDE DEGRADATION	NA
Pest/PCB-III	INITIAL CALIBRATION	✓
Pest/PCB-IV	CONTINUING CALIBRATION	
VOA/SV-Pest/PCB-V-A	BLANK ANALYSIS	✓
VOA/SV-Pest/PCB-V-B	BLANK ANALYSIS	✓
Pest/PCB-VI	SURROGATE COMPOUNDS: SPIKE RECOVERIES AND RETENTION TIME SHIFT	✓
Pest/PCB-VII	PESTICIDE CLEANUP	NA
VOA/SV-Pest/PCB-VIII	MATRIX SPIKE/MATRIX SPIKE DUPLICATE	✓
VOA/SV-Pest/PCB-IX	FIELD DUPLICATE PRECISION	✓
VOA/SV-Pest/PCB-X	SENSITIVITY CHECK	NA
VOA/SV-Pest/PCB-XI	ACCURACY CHECK	✓
Pest/PCB-XII	COMPOUND IDENTIFICATION	NA
VOA/SV-Pest/PCB-XIII	SAMPLE QUANTITATION	NA
TABLE II-WORKSHEET	OVERALL EVALUATION OF DATA	NA

I certify that all criteria were met for the worksheets checked above.

gnature: Elizabeth DeCola

Name: Elizabeth DeCola

Date: 4/29/03

EPA-NE - Data Validation Worksheet
VOA/SV - Pest/PCB

COMPLETE SDG FILE (CSF) AUDIT

~~Organic Fractions~~: Metals

Missing Information **Date Lab Contacted** **Date Received**

The lab was contacted regarding missing metals,
1/28/03 Vanadium + Barium as well as an incomplete
Form 4. ~~the~~

1/29/03 the lab was also contacted about a unexpected high
selenium result.

Validator: E. DeCola **Date:** 4/29/03

EPA-NE - Data Validation Worksheet
VOA/SV - Pest/PCB-V-A

V. BLANK ANALYSIS

List the blank contamination below. Concentration Level: Low

Sampler: Bill A-D Company: M+E Contacted: Yes [✓ No] Date:

1. Laboratory: Method, Storage and Instrument Blanks

Date Extracted	Date Analyzed	Parameter/ Matrix	Sample No. (Blank Type)	Instrument/ Column	Compound	Conc. (units)
—	3/28/03	VPH	Lab VBLK4L	—	C_9-C_{10} aromatics	30
	3/29/03	VPH	Lab VBLK4M	=	C_9-C_{10} aromatics	30
	3/27/03	VPH	Trip Blank	—	C_9-C_{10} aromatics	37

2. Field: Equipment (Rinsate), Trip and Bottle Blanks

Date Extracted	Date Analyzed	Parameter/ Matrix	Sample No. (Blank Type)	Instrument/ Column	Compound	Conc. (units)

Validator: E. DeColca Date: 4/28/03

no Blank contamination for EPH + PCB
MB-6544 BBLK1D

EPA-NE - Data Validation Worksheet
VOA/SV - Pest/PCB-V-B

3. **Blank Actions - List the maximum concentrations of blank compounds.**

2xQ DAT 5/12/03

DAT 9/8/03

Compound	Type of Blank	Date Blank Sampled/Originated	Max. Conc. (units)	Action Level (units)	Sample QL	Samples Affected	Action
~~C9 C10 aromatics~~	~~Lab~~	~~3/28/03 + 3/29/03~~	~~30~~	185			~~reports as U at Q~~
C9-C10 aromatic	Trip Blank	3/27/03	37	74	30	MW-1, MW-5, MW-3	Report as U to SR
						MW-6, MW-10	

Greater than QL, but > BAL

Comments: ____________________

Validator: E. Decola

Date: 4/28/03

EPA-NE - Data Validation Worksheet
VOA-VI

VI. ~~VOA~~ **SURROGATE SPIKE RECOVERIES** - List all surrogate compound recoveries that are outside method QC acceptance criteria.

EPH

Method	Volatile Method QC Acceptance Criteria				
	~~Toluene-d$_8$~~	BFB	DCE-d$_4$	Other:	
OLM03.2	Water 88-110 Soil 84-138	Water 86-115 Soil 59-113	Water 76-114 Soil 70-121		
OLC02.1	40-140 NA	80-120	NA		
Other:	Chlorooctadecane				
Sample Number/Matrix	% Recovery	% Recovery	% Recovery	% Recovery	Action
EPH MW-6	34%				J+UJ(ND)

C9-C18 and
C19-C36
aliphatics

Validator: E. Decola

Date: 4/29/03

all criteria met for VPH and PCB

EPA-NE - Data Validation Worksheet
~~VOA/SV - Pest/PCB-VIII~~ EPH

VIII. MATRIX SPIKE/MATRIX SPIKE DUPLICATE - List all MS/MSD analytes that are outside method QC acceptance criteria.

Use a separate worksheet for each MS/MSD pair.

Sample # MW-1 Matrix Aq Concentration Level Low

Parameter	Compound	MS %Rec	MSD %Rec	RPD	Method QC Limits		Concentration			% RSD	Action
					% Rec	RPD	Unspiked Sample	MS	MSD		DAT 5/10/03
EPH	C_9-C_{18} Aliphatics	34	34	0	40-140	–					~~J~~ + UJ

results in MW

Validator: E. DeCola Date: 4/29/03

all criteria met for VPH + PCB

PESTICIDE RESOLUTION CHECK
(CLP FORM 6G)

NA

List the resolution between adjacent single peak pesticides in the resolution check mix that are less than 60.0% on either chromatographic column.

Analysis Date	Column	Compounds	%Resolution	Affected Samples

List the validation actions taken below. If there were no positive results for the poorly resolved peaks no action is required.

PCB Calibration

~~PESTICIDE CALIBRATION~~ VERIFICATION
~~(CONTINUING CALIBRATION CLP FORMS 7D,7E)~~

IC ≥ 20 RSD
CC ≥ 15 %D

List the percent difference for the pesticide compounds that exceed 25%. List the percent breakdown for 4,4'-DDT or Endrin that exceed 20.0% or the combined breakdown of these two compounds that exceed 30.0%.

averaged 3 results for each Aroclor only averages with %D > 15% were listed

Analysis Date	Column	Compound	~~%D/Breakdown~~ average %D	Affected Samples
@3:26 4/21/03	RTXCLPest2	Aroclor-1260	16.37	Lab Blank + LCS
@0046 4/22/03	RTXCLPest2	Aroclor-1260	17.2	↓
				no action required

List the validation actions taken below.

no action is taken on QC samples.

breakdown not applicable to PCBs

Region I
Data Review Worksheet

Site Name: Oxford Mill
Reference Number: ____________

REGION I REVIEW OF INORGANIC
CONTRACT LABORATORY DATA PACKAGE

The hardcopied (laboratory name) MitKem data package received at Region I has been reviewed and the quality assurance and performance data summarized. The data review included:

Case No.	Same as	SAS No.		Sampling Date (s)	Same as organic
SDG No.	organic	Matrix		Shipping Date (s)	↓
No. of Samples	6			Date(s) rec'd by lab	

Traffic Report Numbers: Same as organic page

Trip Blank No.: none
Equipment Blank Number: none
Field Duplicate Numbers: KMW-5 + MW-5

SOW No. Method 6010B and 7471 requires that specific analytical work be done and that associated reports be provided by the laboratory to the Regions, EMSL-LV, and SMO. The general criteria used to determine the performance were based on an examination of:

- -Data Completeness
- -Holding Times
- -Calibrations
- -Blanks
- -ICP Interference Check Results
- -Matrix Spike Recoveries
- -Laboratory Duplicates
- -Field Duplicates
- -Lab Control Sample Results
- -Furnace AA results
- -ICP Serial Dilution Results
- -Detection Limit Results
- -Sample Quantitation

Overall Comments: priority pollutant metals

Definitions and Qualifiers:
A - Acceptable data
J - Approximate data due to quality control criteria
R - Reject data due to quality control criteria
U - Analyte not detected

Reviewer: E. DeCola

Date: 4/29/03

I. DATA COMPLETENESS

MISSING INFORMATION	DATE LAB CONTACTED	DATE RECEIVED
See organics sheet for info		

III B. INSTRUMENT CALIBRATION (Section 2)

2. Analytical Sequence

A. Did the laboratory use the proper number of standards for calibration as described in the SOW? [✓ Yes] or No

B. Were calibrations performed at the beginning of each analysis? [✓ Yes] or No

C. Were calibration standards analyzed at the beginning of sample analysis and at a minimum frequency of ten percent or every two hours during analysis, whichever is more frequent? [✓ Yes] or No not provided

D. Were the correlation coefficients for the calibration curve for AA, Hg, and CN ≥ 0.995? Yes or No NA

E. Was a standard at 2X CRDL analyzed for all ICP analyses. ~~[✓ Yes]~~ or [✓ No] not required by 6010B

DAT 5/10/03

If no, the data may be affected. Use professional judgment to determine the severity of the effect and qualify the data accordingly. Discuss any actions below and list the samples affected.

IV A. BLANK ANALYSIS RESULTS (Sections 1-3)

List the blank contamination in sections 1 and 2 below. A separate worksheet should be used for soil and water blanks.

1. Laboratory Blanks

Matrix: Aq

DATE:	ICB/CCB#	PREP BL	ANALYTE	CONC./UNITS
	CCB		Antimony	6.2 ug/L
		prepBlank	Copper	11.208 ug/l
		prep.	Silver	8.986 ug/L
		prep.	Berilum	5488 B ug/L

2. Equipment/Trip Blanks – none

DATE:	EQUIP BL #	ANALYTE	CONC./UNITS

3. Frequency Requirements

A. Was a preparation blank analyzed for each matrix, for every 20 samples, and for each digestion batch? [✓ Yes] or No

B. Was a calibration blank run at the beginning of the run, and every 10 samples or every 2 hours whichever is more frequent? [✓ Yes] or No

If no, the data may be affected. Use professional judgment to determine the severity of the effect and qualify the data accordingly. Discuss any actions below, and list the samples affected:

IV B. BLANK ANALYSIS RESULTS (Section 4)

4. Blank Actions

The Action Level for any analyte is equal to 5X the highest concentration of that analyte found in any blank. (Use 5X the absolute value for any negative blank results). The Action Level for samples which have been concentrated or diluted should be multiplied by the concentration/dilution factor. No positive result should be reported unless the concentration of the analyte in the sample exceeds the Action Level (AL) for that analyte. Specific actions are as follows:

1. When the concentration is greater than the IDL, but less than the Action Level, report the sample concentration detected with a U.

2. When the sample concentration is greater than the Action Level, report the sample concentration unqualified.

Matrix: Aq. Matrix:

DL	ELEMENT	MAX. CONC. /UNITS	AL /UNITS	ELEMENT	MAX. CONC/ UNITS	AL/ UNIT
.0	Antimony	6.2 ug/L	31			
4.0	Copper	11,208 ug/L	56.04			
2.0	Silver	8,986 ug/L	44.93			
4.0	Barium	5.448 ug/L	27.24			

NOTE: Blanks analyzed during a soil case must be converted to mg/kg in order to compare them with the sample results.

$$\text{conc. in ug/l} \times \frac{\text{Volume diluted to (200ml)}}{\text{Weight digested (1gram)}} \times \frac{1L}{1000ml} \times \frac{1000g}{1kg} \times \frac{1mg}{1000ug} = \text{mg/kg}$$

Multiplying this result by 5 to arrive at the Action Level gives a final result in mg/kg which can then be compared to sample results

Sb: U ~~at IDL~~ SD - MW-3; KMW-5, MW-1, MW-10, MW-5, MW-6

Cu: U ; KMW-5 ; MW-5

Aq: U: None.

Ba: U: MW-10

V B. ICP INTERFERENCE CHECK SAMPLE (Section 3) NA

3. Report the concentration of any elements detected in the ICS A solution > 2X IDL that should not be present.

ELEMENT	CONC. DETECTED IN THE ICS	CONC. OF INTERFERENTS IN THE ICS			
		AL	CA	FE	MG

Estimate the concentration produced by the interfering element in all affected samples. See the guidelines for examples. List the samples affected by the interferences below:

SAMPLE AFFECTED	ELEMENT AFFECTED	SAMPLE CONC. (µg/L)	SAMPLE INTERFERENT CONC. (µg/L)				ESTIMATED. INTERF (µg/L)
			AL	CA	FE	MG	

ACTIONS:

1. In general, the sample data can be accepted without qualification if the sample concentrations of Al, Ca, Fe, and Mg are less than 50% of their respective levels in the ICS solution.
2. Estimate (J) positive results for affected elements for samples with levels of interferents 50% or more of that in the ICS solution.
3. Reject (R) positive results if the reported concentration is due entirely to the interfering element.
4. Estimate (UJ) non-detected results for which false negatives are suspect.

Give an explanation for any actions taken below:

XIII. SAMPLE QUANTITATION (continued)

List the positive sample results that were reported at concentrations less than 2xIDL and have not already been qualified. The positive results have been estimated (J) due to uncertainty in the quantitation near the IDL.

Analyte	Samples Affected
Arsenic	MW-3, KMW-5; MW-10; MW-5; MW-6
Beryllium	KMW-5
Chromium	MW-3; KMW-5; MW-1; MW-10; MW-5
Nickel	MW-3; KMW-5; MW-1; MW-10; MW-5; MW-6
Selenium	KMW-5; MW-6
Zinc	KMW-5; MW-5
Antimony:	MW-3; KMW-5; MW-1; MW-10; MW-5; MW-6
Copper:	KMW-5; MW-5
Barium:	MW-10
Barium	MW-3; KMW-5; MW-1; MW-5; MW-6, MW-10
Vanadium	KMW-5; MW-10; MW-1;

these were blank qualified as U + further estimated (J) due to uncertainty near the IDL

Appendix K

MCP Method 3 Risk Characterization / Stage I Environmental Screening
Metcalf & Eddy - 2003

Technical Memorandum
and
Method 3 Risk Characterization
Oxford Paper Mill Site - Area North of Raceway and North of Bridge Construction Area

Volume II:
Attachment I – MCP Method 3 Risk Characterization
Attachment J – Statement of Limitations

RTN 3-2691

August 2003

Prepared By:

Metcalf & Eddy
30 Harvard Mill Square
Wakefield, Massachusetts

Prepared Under Contract to:

Stone & Webster Massachusetts, Inc.
A Shaw Group Company
100 Technology Center Drive
Stoughton, Massachusetts
Shaw Project No. 608134

Prepared for:

City of Lawrence, Massachusetts
Office of Planning and Economic Development

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ATTACHMENT I

MCP METHOD 3 RISK CHARACTERIZATION

METHOD 3 RISK CHARACTERIZATION
OXFORD PAPER MILL
LAWRENCE, MASSACHUSETTS

This report presents the findings of a Method 3 risk characterization conducted for the Oxford Paper Mill property. Only the northern portion of the property (i.e., north of the raceway) has been included in this evaluation. The raceway and the area to the south of the raceway are being characterized and remediated separately. It is anticipated that a "wedge" of soil will need to be removed from the northern portion of the property to facilitate the Massachusetts Highway Department's bridge construction project. However, since the design plans for the bridge have not been firmly established, all soils have been assumed to remain on-site for the purposes of this risk evaluation.

This evaluation assumes that an Activity and Use Limitation (AUL) will be placed on the property to prevent future residential and/or commercial land use including the construction of occupied buildings. Therefore, the risk characterization has not included these receptors or the pathways by which these receptors may be exposed to site-related contaminants. In addition, asbestos-contaminated soils exist on-site that, if contacted, would present a potential risk to human receptors. It is assumed that contact with these soils will need to be prevented as part of the AUL at the Site.

This risk characterization is intended to be an evaluation of baseline conditions at the site and has been conducted in a manner consistent with the requirements of 310 CMR 40.0900, guidelines laid out in MADEP's *Guidance for Disposal Site Risk Characterization* (MADEP, 1995 and 2002 technical updates), MADEP petroleum policies (MADEP, 2002) and current risk assessment practices. Risk of harm to human health, welfare, safety and the environment from potential exposures to the detected contaminants has been characterized to provide information that will be used to select the appropriate Response Action Outcome (RAO) pursuant to 310 CMR 40.1000.

The risk characterization for the property north of the raceway proceeds by the characterization of human health risks (Section 1.0) including the presentation of site background information (Section 1.1), the identification of chemicals of potential concern (COPCs) in Section 1.2 (Hazard Identification); the selection of toxicity information for the COPCs in Section 1.3 (Dose-Response Assessment); the identification of potential receptors, exposure pathways, exposure assumptions, and exposure point concentrations (EPCs) in Section 1.4 (Exposure Assessment); and the calculation of noncarcinogenic and carcinogenic risk in Section 1.5 (Risk Characterization). A discussion of risk characterization uncertainties can be found in Section 1.6. The public welfare risk characterization is included as Section 2.0. The characterization of risk to safety is presented in Section 3.0. A Stage I Environmental Screening is provided in Section 4.0. Conclusions and recommendations are included in Section 5.0.

1.0 HUMAN HEALTH RISK CHARACTERIZATION

For the human health risk characterization, both current and potential future uses of the Site are considered with the exception of future residential and commercial uses of the property. The human health risk characterization evaluates direct exposures to soils and groundwater as well as the inhalation of volatile compounds in outdoor air. The surface water exposure pathway has been characterized through the use of groundwater discharge modeling.

1.1 Site Background Information

The Site is in an area of commercial development within downtown Lawrence, Massachusetts. The property does not contain any buildings or structures and is not currently covered with asphalt or paving material. Access to the property is not restricted by secure fencing on all sides. Fencing is present along the western boundary; however, trespassers can access the Site from the Spicket River or via an exit of the O'Gara Building. A Site Plan is presented as Figure 1. The property is anticipated to be used in the future partially as a passive recreational park.

The Site is bounded to the north and east by the Spicket River, to the west by commercial property (the O'Gara Building), and to the south by the raceway. The southern portion of the property is located south of the raceway and is bordered by Canal Street to its south. A hospital is located across the Spicket River to the north of the Site.

The average annual depth to groundwater at the Site is between 6 and 16 feet below ground surface. During normal flow conditions, groundwater at the Site appears to flow toward the Spicket River which immediately abuts the Site. The MADEP Bureau of Waste Site Cleanup Site Scoring Map is presented as Figure 2. Estimated Habitats of Rare Wetlands Wildlife, High Priority Sites of Rare Species Habitats and Exemplary Natural Communities, or Certified Vernal Pools are not located within a 0.5-mile radius of the Site.

1.1.1 Site History. Historically, the property was used as a paper mill until 1974. Contaminants expected to be associated with former paper mill operations include polycyclic aromatic hydrocarbons (PAHs) from combustion operations, chlorinated organic compounds that may have formed during pulp bleaching operations and sulfides from chemical pulp residues. In addition, underground storage tanks containing fuel oils and transformers containing polychlorinated biphenyls (PCBs) have historically been present on-site. Investigations conducted in 2002 and 2003 by M&E indicate the presence of elevated levels of PCBs, PAHs, extractable petroleum hydrocarbons and inorganics in surface and subsurface soils. Extractable petroleum hydrocarbons and inorganics have also been detected in groundwater.

1.1.2 Current Site Activities and Uses. The Site is currently abandoned and exposed surface soils are present on-site. Since access to the Site is not completely restricted by the presence of secure fencing on all sides, humans may gain entry to the Site and incur exposures to contaminants present in surface soils.

The Spicket River is an urban surface water body that abuts the Site. This surface water body may be used for recreational activities (e.g., wading and boating). Groundwater from the Site likely discharges to the river during normal flow periods.

Persons who may currently be present at the Site include the following:

- adolescents trespassing onto the Site; and
- adolescent users of the Spicket River.

Direct exposures of human receptors to contaminants detected in surface soil at the Site is considered a potentially complete exposure pathway under current site conditions since contamination is present at depths less than three feet below ground surface in unpaved areas. Therefore, direct contact surface soil exposures (ingestion and dermal contact) and the inhalation of soil-derived dust are evaluated as current exposure pathways for adolescent trespassers.

The potential for indirect exposures of human receptors to volatile contaminants detected in soil and groundwater through inhalation of impacted outdoor air is considered negligible under current Site conditions due to dilution and dispersion of any released vapors in ambient air.

Based on the direction of groundwater flow across the Site, potential exposures of adolescent receptors to contaminants in the surface waters of the Spicket River via dermal contact and ingestion are possible. This assumption is consistent with MADEP's requirement that groundwater shall be considered a potential source of discharge to surface water (310 CMR 40.0932(3)). Therefore, this pathway was evaluated in terms of impact of surface water contaminants exposures on human health and the environment.

The Site is not located within a designated Zone II, Interim Wellhead Protection Area, a Potentially Productive Aquifer, or the Zone A of a Class A Surface Water Body. Therefore, potential exposures of human receptors to contaminants in groundwater used directly as a potable water supply or for irrigation purposes are considered highly unlikely. Consequently, the use of Site groundwater as a source of potable water was not further evaluated.

1.1.3 Current and Reasonably Foreseeable Site Activities and Uses. Under future foreseeable Site activities and uses, the most likely exposures to contaminants are expected to occur during subsurface excavations through contaminated soils at the Site. Principal receptors are expected to be workers involved in grading the site for the MHD bridge project, or in trenching activities for the installation of utility connections.

The most likely pathways and routes of exposure to contaminants for workers during these invasive activities are direct dermal contact, incidental ingestion and inhalation of fugitive dusts and volatiles from contaminated soils as a result of subsurface activities. It is also possible for these workers to come in contact with contaminants detected in shallow groundwater during excavations, resulting in exposure through incidental ingestion, dermal contact and inhalation of volatiles.

Future excavation/construction work could result in the movement and mixing of subsurface contaminants with surficial contaminants and subsequent exposures to future receptors. Should the Site [illegible] developed as a park, young child and adult recreational users could potentially be exposed to contaminants in soil (following movement of these soils to the surface during excavation activities) through dermal contact, incidental ingestion and inhalation of fugitive dusts entrained from friable soils. In addition, exposures to surface water in the Spicket River, via direct dermal contact and incidental ingestion, are possible under future recreational Site use and have been evaluated as part of the recreational exposure scenario. Since dilution and dispersion of the low levels of vapors migrating from soil and groundwater into ambient air are expected to mitigate any significant exposures through inhalation, this pathway was not evaluated further.

Should the Site not undergo development in the future as a park, future adolescent trespassers may be exposed by the same pathways as current adolescent trespassers.

1.1.4 Soil and Groundwater Category Classification. Soil contamination is present at depths less than 3 feet below the surface and access to the Site by children is currently not restricted by the presence of a chain link fence. However, children would not be found at the Site with high frequency. Based on these considerations, and in accordance with the MCP soil category selection matrix, the following soil classifications apply to current site conditions:

<u>S-2:</u> unpaved soil within the property, 0-15 feet deep

Since the Site may undergo future development as a park, the S-1 category is applicable to soils on the Site in the future. It is anticipated that the Site will be used for a passive recreational park area, and hence have a low intensity of use. The frequency of use is also likely to be low, which could potentially allow for classification as S-2. However, because the city does not plan to regulate the frequency of use, the more protective classification of S-1 has been selected as more appropriate for evaluating future risk.

Based on a review of the MADEP Bureau of Waste Site Cleanup Site Scoring Map, the Site is not located within a designated Zone II, Interim Wellhead Protection Area, a Potentially Productive Aquifer, or the Zone A of a Class A Surface Water Body (Figure 2). In addition, the Site and surrounding area are serviced by municipal water and is not indicated to be within 500 feet of any private wells. Therefore, a MCP GW-1 Groundwater Category classification is not considered applicable to this Site.

Since no currently occupied buildings exist on-site and an AUL will prevent future building construction, the current and future classification of Site groundwater in the GW-2 category (as defined in 310 CMR 40.0932(2)) is not considered applicable.

The Spicket River, which abuts the Site, is a potential surface water receiving body for site-related groundwater. Therefore, completion of an exposure pathway between contaminants in groundwater and this nearby surface water body is considered possible. Consequently, consistent with the requirements of 310 CMR 40.0932(3), where all groundwater is assumed to eventually discharge to surface waters, the groundwater at the Site is classified as a GW-3 Groundwater Category.

In summary, based on the above soil and groundwater categorizations, applicable MCP Categories are S-1 and S-2 for soil and GW-3 for groundwater.

1.2 Hazard Identification

For the Hazard Identification, the analytical soil and groundwater data were reviewed to evaluate the nature and extent of impacts at the Site and to identify COPCs.

1.2.1 Data Evaluation. Analytical soil and groundwater data include soil samples collected in May 2002 and March 2003, and groundwater data collected in March 2003. Data sets for all media were reviewed for the identification of hot spots (i.e., discrete areas with contaminant levels 10- to 100-fold higher than surrounding areas). No "hot spots" were identified.

Soil. Analytical surface soil data (0 to 3 feet in depth) from May 2002 samples 4S, 6S, 8S, 10S, 12S, 14S, 4A, 5A, 6A, 7A, 10A, 14A, 6B, 7B, 10B, 11B, 16B and March 2003 samples SB-1 through SB-10 were tabulated to evaluate outdoor exposures for the current use scenario.

Analytical subsurface soil data (3 to 15 feet in depth) from May 2002 samples 4D, 6D, 8D, 10D, 12D, 14D, 4C, 8F, 12H, 14C, 14G, and March 2003 samples SB-1 through SB-10 in conjunction with the surface soil samples listed above, were tabulated to evaluate outdoor exposures under the assumption that future activities result in the movement of soil contaminants to equally accessible locations. Tables A-1 and A-2 in Appendix A present the analytical results for these surface and subsurface soil samples. Table A-1 presents the results of samples analyzed by the EPA Office of Environmental Measurement and Evaluation (OEME) laboratory. Table A-2 presents the off-site, non-EPA laboratory results.

Subsurface soil sample SB-1 (17' to 19') has been excluded since its depth exceeds that which a human receptor is likely to be exposed. In addition, subsurface soil sample 10H has been excluded since it was non-detect for all parameters and is likely below the extent of contamination.

Data for surface soil contaminants are presented in Table 1 in the form of the frequency of detection, arithmetic average, range of detection limits and range of detected levels. These data were used in the development of the soil exposure point concentrations for the current adolescent trespasser scenario. For the future scenarios, data for surface and subsurface soil contaminants are combined and presented in Table 2. These data were used in the development of the soil exposure point concentrations for the future adolescent trespasser, construction/utility worker and child/adult recreational user exposure scenarios.

Groundwater. Groundwater analytical data collected from five shallow (i.e., less than 16 feet below ground surface) monitoring wells on-site were reviewed (Appendix A, Table A-3). For the direct contact scenario for the future construction/utility worker, maximum detected results from all monitoring wells combined were used to represent the worst-case exposure.

The average results from all on-site wells combined were used to model future groundwater contaminant discharge to the surface waters of the Spicket River for the current/future adolescent trespasser and future child/adult recreational scenario. The maximum and average results from all wells combined are summarized in Table 3.

1.2.2 Chemicals of Potential Concern. COPCs for the Risk Characterization may be identified by: a) screening contaminant levels against available or applicable background values, b) eliminating contaminants with low detection frequencies and low concentrations, and c) eliminating contaminants that are considered laboratory contaminants and not related to the contaminant release. In addition, contaminants that are not detected above laboratory reporting limits may also be removed from further consideration as COPCs. Even though the Site contains fill material with visible coal ash and wood ash, MADEP "natural" soil background levels were selected as applicable values. Comparison of soil concentrations to background concentrations for soils containing fill material has not been performed, but a cursory comparison indicates that the conclusions of the risk assessment would not be altered by comparison to the less stringent background concentrations. Also, because the intended future use of the site is for passive recreation, the more conservative approach of applying "natural" soil background levels was considered appropriate.

All contaminants detected in surface soil (Table 1), surface and subsurface soils combined (Table 2), and groundwater (Table 3) were considered COPCs for the evaluation of risk of harm to human and environmental receptors.

Atmospheric concentrations of volatile compounds were modeled from soil and groundwater data to outdoor air concentrations (Appendix A; Tables A-4 and A-5). No MADEP outdoor air background values are available. Therefore, all volatile compounds detected were considered COPCs for the outdoor air exposure pathway. The modeled atmospheric concentrations are presented in Table 4. These modeled concentrations were used for the evaluation of risk of harm to construction/utility workers.

1.3 Dose-Response Assessment

The Dose-Response Assessment is designed to evaluate the potential non-carcinogenic (threshold) and carcinogenic (non-threshold) effects of the COPCs and describes the effects observed in humans and/or laboratory animals following the intake of a specific dose of the compound. The information from the Dose-Response Assessment is used in conjunction with information from the Exposure Assessment (Section 1.4) to estimate the risk generated by each COPC from an exposure (Section 1.5). Toxicity profiles for each of the COPCs are provided in Appendix B.

1.3.1 Non-Carcinogenic Dose-Response Assessment. The toxicity values used in this Dose-Response Assessment of COPCs producing non-carcinogenic effects are the Reference Doses

(RfDs) for oral and dermal exposures and the Reference Concentrations (RfCs) for inhalation exposures. RfD and RfC values provide an estimate of the daily dose of the COPC to which an individual may be exposed without an appreciable risk of adverse health effects, including organ damage or reproductive effects, appearing during their lifetime. RfD and RfC values assume that a threshold dose exists below which there will be minimal risk for adverse effects to occur.

The chronic RfD and RfC values are based upon a 70-year lifetime exposure, and are approximate doses derived from an available No Observed Adverse Effect Level (NOAEL) or the Lowest Observed Adverse Effect Level (LOAEL). Subchronic RfD values are based on defined, less than lifetime exposures.

Uncertainty factors, which account for varying sensitivities among populations and extrapolation of data from animal studies to humans, and modifying factors, which reflect professional judgment of the toxicity information available, are applied to the NOAEL or LOAEL to determine RfD and RfC values. These safety factors reflect the quality of the data used and build conservatism into the Dose-Response Assessment.

Relative Absorption Factors (RAFs) are used to account for differences between the method of administration in the study on which the RfD or RfC is based and the site-specific routes of exposure. These values vary with the medium and with the route of exposure.

The RfD and RfC values used in this Risk Characterization were obtained from the *U.S. EPA's Integrated Risk Information System (IRIS)* (USEPA, 2003), the *Health Effects Assessment Summary tables* (USEPA, 1997) and the *Bureau of Waste Site Cleanup and Office of Research and Standards, Background Documentation for the Development of the MCP Numerical Standards, April 1994*. RfCs, RfDs and RAFs for the VPH/EPH fractions were obtained from MADEP's *Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of the MA DEP VPH/EPH Approach* (MADEP, 2002). The chronic and subchronic RfDs and RfCs are listed in Tables 5 and 6, respectively, and the RAFs are listed in Table 7. Chemical and physical property information for groundwater COPCs is summarized in Appendix A, Table A-6.

1.3.2 Carcinogenic Dose-Response Assessment. The U.S. EPA has developed a system for classifying chemicals according to the likelihood that the compound is a human carcinogen. This system groups chemicals into five classes based upon the weight-of-evidence (of carcinogenicity) of the available data. Consistent with current risk assessment practices in the geographical area and MADEP risk characterization guidelines, only class A or B carcinogens are evaluated in a Method 3 Risk Characterization. Based on the classification of the COPCs (Tables 5 and 6 for oral and inhalation exposures, respectively), the oral carcinogenic effects of the carcinogenic PAHs, PCBs and arsenic were evaluated in this risk characterization. Beryllium, cadmium and chromium were additionally evaluated for carcinogenic effects via the inhalation route of exposure.

1.4 Exposure Assessment

To characterize the risk of harm from contact with a COPC, an exposure assessment is conducted to identify exposure profiles and to estimate the EPCs.

Consistent with the requirements of 310 CMR 40.0923, the exposure assessment requires the identification of all current and reasonable foreseeable activities and uses associated with a site and its surrounding environment, and a description of how these uses and activities could result in the exposure of human receptors to the COPCs present. The descriptions are known as exposure profiles and are developed to provide an estimate of the type and magnitude of potential exposures to COPCs, the frequency and intensity of the exposure, and the pathways and routes by which receptors may be exposed to the COPC, and to provide an estimate of the EPC.

For the characterization of risk of harm to human health under a Method 3 Risk Characterization, the exposure profile and EPC are used to estimate chemical intake from which the hazard index and excess lifetime cancer risk may be calculated. The exposure profiles and the estimation of chemical intake are integral parts of the exposure assessment and are discussed separately below.

1.4.1 Exposure Profiles. Exposure Profiles for potential receptors are presented here, based on actual and anticipated site activities and uses.

Under current site conditions, the most-likely routes and pathways of exposure to COPCs for the adolescent trespasser are:

- incidental ingestion of and dermal contact with surface soils;
- inhalation of fugitive dust entrained from friable surface soils; and
- incidental ingestion of and dermal contact with surface water.

Under future site conditions, involving subsurface excavations, the most-likely routes and pathways of exposure to COPCs are:

- incidental ingestion of and dermal contact with soil;
- inhalation of vapors from soil and groundwater in outdoor air;
- inhalation of fugitive dust entrained from friable soils; and
- incidental ingestion of and dermal contact with shallow groundwater.

Future child/adult recreational users and future adolescent trespassers may be exposed via the same routes and pathways described for the current adolescent trespasser.

The exposure points, routes, and pathways evaluated in this risk characterization for the current/future adolescent trespasser, future child/adult recreational user and future construction/utility worker are summarized in Table 8.

1.4.2 Exposure Assumptions and Quantitative Estimates of Exposure. Based on the site-specific exposure profiles discussed in Section 1.4.1, the following exposure assumptions were developed, and quantitative estimates of exposure identified for use in the calculation of the chemical intake values. Exposure assumptions are provided in Table 9 for the adolescent trespasser (current and future), recreational user (future), construction worker (future) and utility worker (future). Appendix A, Table A-7, provides documentation for the calculation of receptor-specific Normalized Average Daily Contact Rates (NADSCRs) and Normalized Average Daily Intake Rates (NADSIRs) used in exposure estimation for noncarcinogenic effects. For carcinogenic effects, Normalized Lifetime Average Daily Contacts Rates (NLADCRs) and Normalized Lifetime Average Daily Intake Rates (NLADIRs) were used to estimate exposure. These receptor-specific values are calculated in Appendix A, Table A-8.

Exposure assumption values listed represent either actual site-specific information, U.S. EPA values from the *Office of Solid Waste and Emergency Response (OSWER) Directives*, or values considered either consistent with or those listed in the *MADEP Guidance For Disposal Site Risk Characterization, July 1995, MADEP's Background Documentation for the Development of MCP Numerical Standards Document, April 1994* or values provided in MADEP Technical Updates (1997 and 2002).

Current/Future Adolescent Trespasser Under current and future site activities and uses, exposures to COPCs could occur as a result of recreational exposure to soil on-site and surface water in the Spicket River. Principal receptors are expected to be adolescent children trespassing and/or playing on-site and in this surface water body. Current receptors are assumed to be exposed to surface soils only. Future receptors could be exposed to all soils after mixing of the soils during future site development.

The primary routes of COPC exposure are expected to be incidental ingestion and dermal contact with impacted soil and surface water. The average trespasser is identified as a child, age 11-16 years, 51.8 kg average body weight. Potential exposures to COPCs in surface water are assumed to occur 1 hr/day for 26 days/year. The latter represents an exposure frequency of 1 day/week for the warmest six months of the year. The incidental ingestion rate was set at 50 ml/day for surface water and 50 mg/day for soil. Dermal contact with both media was assumed to be likely via hands, forearms and feet. Inhalation of fugitive dusts outdoors by children was evaluated using a PM_{10} of 32 ug/m^3 and an inhalation rate of 0.8 m^3/hr. The exposure duration for non-cancer endpoints of toxicity was averaged over 7 years for the trespasser.

Future Construction/Utility Worker Under future foreseeable site activities and uses, exposures to COPCs could occur during subsurface excavations that expose impacted soils. Principal receptors are expected to be workers involved in trenching activities for the installation or repair of utilities.

Assumptions used in the modeling of COPCs from soil and groundwater to soil gas to outdoor air include the construction/utility worker working close to the bottom of a trench (2 feet), with dimensions of 30 feet long and 10 feet deep, and a wind speed of 3 m/sec (Appendix A; Tables A-4 and A-5).

Under a worst-case scenario, potential exposures to COPCs are assumed to occur 8 hr/day over 125 days/year for a construction worker and 15 days/year for a utility worker. The period of 125 days/year represents the typical number of outdoor workdays in one year in this area. The period of 15 days/year represents the maximum number of days of exposure during a three-week utility project. The exposure duration for non-cancer endpoints was averaged over 1 year. The primary routes of COPC exposure are expected to be incidental ingestion and dermal contact for impacted soil and inhalation of fugitive dusts entrained from COPC-impacted friable soils. Workers are identified as adult males, 70 kg average body weight, involved in physical activities equivalent to an average inhalation rate of 3.6 m^3/hr. The incidental ingestion rate of soil was conservatively set at 100 mg/day and dermal contact with COPCs likely via the hands, forearms, feet and face for soil. Inhalation of fugitive dusts outdoors by adult workers was evaluated using a PM_{10} of 60 ug/m^3 and an inhalation rate of 3.6 m^3/hr. Excavations were assumed to proceed down to the water table. The incidental groundwater ingestion rate was set at 6.25 ml/hr (total 50 ml/incident), and dermal contact likely via the hands, forearms, feet and face.

Future Adult and Child Recreational User Under a future recreational land use scenario, exposures to COPCs could occur through recreational activities at the park, and recreational activities (e.g., wading) in the nearby Spicket River.

For the adult recreational user, outdoor exposures to COPCs in soil are assumed to occur 1 hr/day for 78 days/yr. The latter period represents an exposure frequency of 3 days/wk for the warmest 6 months of the year. For the child outdoor scenario, potential exposures to COPCs in soil are assumed to occur 1.5 hr/day for 78 days/yr. Inhalation of fugitive dusts outdoors by adults and children was evaluated using a PM_{10} of 32 ug/m^3 and inhalation rates of 1.2 m^3/hr and 0.36 m^3/hr, respectively. Incidental ingestion of soil was set at 50 mg/day and 100 mg/day for the adult and child, respectively. Dermal contact with COPCs in soil was considered likely via the hands, arms, legs, face and feet for the child; hands, forearms, lower legs, feet and face for the adult. Potential exposures to surface water COPCs are assumed to occur 1 hr/day for 78 days/year for both the adult and child. The incidental ingestion rate of surface water was set at 50 ml/day and dermal contact likely via the same body areas as described above.

The exposure duration for non-cancer endpoints of toxicity was averaged over 30 years for the adult and 7 years for the child. The average weight of the adult and child were set at 70 kg and 15 kg, respectively.

1.4.3 Exposure Point Concentrations. Exposure Point Concentrations (EPCs) represent the COPC concentrations in a medium that a receptor may come in contact with at the exposure point. Depending on the exposure scenario, the exposure point may consist of an area or zone of potential exposure, or a single exposure point. EPCs for this risk characterization were derived from the analytical soil data tabulated in Tables 1 and 2, and groundwater data tabulated in Table 3.

The analytical data for soil and groundwater were averaged by calculating the sum of the levels of COPCs detected then dividing by the total number of times the compound was analyzed. Consistent with current MADEP guidance, levels of COPCs reported as "below the reporting limit" were assigned a value of one-half the reporting limit. Average surface soil COPC levels detected were used to evaluate surficial exposures for the current adolescent trespasser scenario. Average surface and subsurface soil COPC levels detected were used to evaluate surface and subsurface exposures for the future trespasser, recreational and construction/utility worker scenarios. Average soil levels were also used to estimate airborne concentrations of COPCs entrained from friable soils to evaluate inhalation exposures of fugitive dust.

To evaluate the potential impact of groundwater to surface water discharge of COPCs into the Spicket River, the average COPC concentrations detected in all monitoring wells were evaluated. In the absence of information on the hydrological properties of the river, EPCs were derived by dividing the average COPC groundwater concentrations by 10 to account for the dilution/attenuation that would occur prior to discharge. The diluted groundwater concentrations are presented on Table 3. Use of this default dilution factor is consistent with its use in the calculation of MADEP's GW-3 standards (*MADEP's Background Documentation for the Development of MCP Numerical Standards Document, April 1994*).

The maximum detected COPC groundwater concentrations were used to evaluate direct contact exposures for the construction/utility worker scenario during excavation down to the water table.

1.4.4 Estimation of Chemical Intake. To evaluate the risk of harm to human health, the intake of each COPC must be estimated and involves assessing the amount of material in contact with the receptor and the amount actually available for absorption by the body. This assessment is achieved through the calculation of an average daily dose (ADD) for each COPC and for each route of exposure. Compound-specific and exposure route-specific RAFs are used in the ADD equations to convert an exposure (amount) to a dose (amount per unit body weight). The RAFs are listed in Table 7.

The general ADD equation is as follows and is consistent with those provided in MADEP's *Guidance for Disposal Site Risk Characterization (July, 1995)*:

$$\text{ADD} = \frac{\text{Total Amount of Chemical Taken In}}{(\text{Body Weight}) * (\text{Averaging Period})}$$

The specific ADD equations for the various exposure pathways evaluated are provided below:

Inhalation of Outdoor Air

$$\text{ADD} = \frac{(\text{EPC})*(\text{Exposure Time})*(\text{Exposure Frequency})*(\text{Exposure Duration})}{(\text{Averaging Period})}$$

Incidental Ingestion of Soil, Groundwater or Surface Water

$$\text{ADD} = \frac{(\text{EPC})*(\text{Ingestion Rate})*(\text{Exposure Frequency})*(\text{Exposure Duration})*\text{RAF}}{(\text{Body Weight})*(\text{Averaging Period})}$$

Dermal Contact with Soil

$$\text{ADD} = \frac{(\text{EPC})*(\text{Surface Area})*(\text{Exposure Frequency})*(\text{Exposure Duration})*(\text{Adherence Factor})*\text{RAF}}{(\text{Body Weight})*(\text{Averaging Period})}$$

Dermal Contact with Groundwater or Surface Water

$$\text{ADD} = \frac{(\text{EPC})*(\text{Surface Area})*(\text{Exposure Frequency})*(\text{Exposure Time})*(\text{Exposure Duration})*\text{RAF}*K_p}{(\text{Body Weight})*(\text{Averaging Period})}$$

For the fugitive dust pathway, equations presented in *Characterization of risks due to inhalation of particulates by construction workers (Final Technical Update; 2002)* were used. The equations used are as follows:

Inhalation of Fugitive Dust – GI System

$$\text{ADD/LADD} = \frac{(\text{EPC})*2*(\text{InhalationRate})*\text{RAF}*(\text{ExposureTime})*(\text{ExposureFrequency})*(\text{ExposureDuration})*\text{PM}_{10}}{(\text{Body Weight})*(\text{Averaging Period})}$$

Inhalation of Fugitive Dust – Respiratory System

$$\text{ADD/LADD} = \frac{(\text{EPC})*0.5*(\text{InhalationRate})*\text{RAF}*(\text{ExposureTime})*(\text{ExposureFrequency})*(\text{ExposureDuration})*\text{PM}_{10}}{(\text{Body Weight})*(\text{Averaging Period})}$$

The averaging period (AP), or period of time over which the total intake of contaminant is averaged, can be adjusted to calculate the ADD for an acute exposure (AP = 1 day or less), for a subchronic exposure (AP = few days - several months), for a chronic exposure (AP = several months - somewhat less than lifetime), and for a lifetime exposure (AP = 70 years). The exposure frequencies, exposure durations and averaging periods used in this risk characterization for the scenarios are listed in Table 9 for the current/future adolescent trespasser, future adult/child recreational user, future construction worker and future utility worker.

The ADD values calculated for chronic/subchronic exposures were compared to the toxicity values (e.g., RfDs and RfCs) discussed in Section 1.3. This comparison provides a numerical estimate of the levels of risk and the potential for adverse health effects to occur due to exposure to COPCs, as described in the next subsection.

1.5 Risk Characterization

To characterize the risk of harm to human health from potential exposures to the COPCs identified at the site, non-carcinogenic and carcinogenic risks were characterized for each COPC present at each exposure point for each receptor, and the cumulative receptor risk values compared to the MADEP risk limits to assess whether a condition of no significant risk exists at the site. In addition, the condition of no significant risk was evaluated through comparison of EPCs for the COPCs to Applicable, Available or Suitably Analogous Public Health Standards.

1.5.1 Non-Carcinogenic Risk Characterization. To estimate non-carcinogenic risk, the hazard quotient for each COPC was calculated by dividing the average daily dose (ADD) computed in the Exposure Assessment by the RfD or RfC identified in the Dose-Response Assessment. The total site risk for each receptor was subsequently calculated by summing the hazard indices (HIs) for the applicable exposure scenarios. The value was then compared to the total site non-carcinogenic risk limit (total site HI) of 1 (310 CMR 40.0993(6)) to characterize the risk of harm to human health, and to establish whether a condition of no significant risk exists as defined in 310 CMR 40.0993(7).

A summary of the risk findings for the receptors is shown in Table 10.

Hazard Index for the Current Adolescent Trespasser. The Total Site HI for the current adolescent trespasser is 0.04, which does not exceed the MADEP Risk Limit of 1. The Total Site HI consists of 0.03 for the incidental ingestion of surface soil; 0.01 for dermal contact with surface soil; 0.00005 for the inhalation of fugitive dust; 0.001 for incidental ingestion of surface water; and 0.00005 for dermal contact with surface water. Individual COPC pathway and route-specific Hazard Quotients are shown in Appendix A, Tables A-9, A-11 and A-13.

Hazard Index for the Future Adolescent Trespasser. The Total Site HI for the future adolescent trespasser is 0.03, which does not exceed the MADEP Risk Limit of 1. The Total Site HI consists of 0.02 for the incidental ingestion of soil; 0.01 for dermal contact with soil; 0.00004 for the inhalation of fugitive dust; 0.001 for incidental ingestion of surface water; and 0.00005 for dermal contact with surface water. Individual COPC pathway and route-specific Hazard Quotients are shown in Appendix A, Tables A-15, A-17 and A-19.

Hazard Index for the Future Construction Worker. The Total Site HI calculated for the construction worker is 0.5, which does not exceed the MADEP Risk Limit of 1. The Total Site HI consists of 0.2 for the incidental ingestion of soil; 0.09 for dermal contact with soil; 0.006 for the inhalation of fugitive dust; 0.2 for incidental ingestion of groundwater; 0.07 for dermal contact with groundwater; and 0.0008 for the inhalation of outdoor air. Individual COPC pathway and route-specific Hazard Quotients are shown in Appendix A, Tables A-21, A-23, A-25 and A-27.

Hazard Index for the Future Utility Worker. The Total Site HI calculated for the utility worker is 0.06, which does not exceed the MADEP Risk Limit of 1. The Total Site HI consists of 0.02 for the incidental ingestion of soil; 0.01 for dermal contact with soil; 0.0007 for the inhalation of fugitive dust; 0.03 for incidental ingestion of groundwater; 0.008 for dermal contact with groundwater; and 0.0001 for the inhalation of outdoor air. Individual COPC pathway and route-specific Hazard Quotients are shown in Appendix A, Tables A-29, A-31, A-33 and A-35.

Hazard Index for the Future Child Recreational User. The Total Site HI for the future child recreational user is 0.7, which does not exceed the MADEP Risk Limit of 1. The Total Site HI consists of 0.4 for the incidental ingestion of soil; 0.2 for dermal contact with soil; 0.0003 for the inhalation of fugitive dust; 0.01 for incidental ingestion of surface water; and 0.0004 for dermal contact with surface water. Individual COPC pathway and route-specific Hazard Quotients are shown in Appendix A, Tables A-37, A-39 and A-41.

Hazard Index for the Future Adult Recreational user. The Total Site HI for the future adult recreational user is 0.1, which does not exceed the MADEP Risk Limit of 1. The Total Site HI consists of 0.05 for the incidental ingestion of soil; 0.04 for dermal contact with soil; 0.0001 for the inhalation of fugitive dust; 0.003 for incidental ingestion of surface water; and 0.0002 for dermal contact with surface water. Individual COPC pathway and route-specific Hazard Quotients are shown in Appendix A, Tables A-43, A-45 and A-47.

1.5.2 Carcinogenic Risk Characterization. To calculate the Excess Lifetime Cancer Risk (ELCR) for each COPC, the Lifetime Average Daily Dose (LADD) estimated in the Exposure Assessment was multiplied by the Cancer Slope Factor (CSF) or Inhalation Unit Risk identified in the Dose-Response Assessment. The ELCR for each COPC was then summed to calculate the Total ELCR for each exposure scenario. The Total Site Cancer Risk for each receptor was subsequently computed by summing the Total ELCR values for the applicable exposure scenarios. The Total Site Cancer Risk was then compared to the MADEP Total Site Cancer Risk Limit of 1E-05 (310 CMR 40.0993(6)) to characterize the risk of harm to human health, and to establish whether a condition of no significant risk exists at the site, as defined in 310 CMR 40.0993(7).

A summary of the risk findings is shown in Table 10.

Carcinogenic Risk for the Current Adolescent Trespasser. The Total Site ELCR calculated for the current adolescent trespasser scenario is 2E-06, which does not exceed the MADEP Risk Limit of 1E-05. The Total Site ELCR consists of 9E-07 for incidental ingestion of surface soil; 8E-07 for dermal contact with surface soil; 2E-09 for inhalation of fugitive dusts; 5E-09 for incidental ingestion of surface water; and 3E-10 for dermal contact with surface water. Individual COPC pathway and route-specific ELCRs are shown in Appendix A, Tables A-10, A-12 and A-14.

Carcinogenic Risk for the Future Adolescent Trespasser. The Total Site ELCR for the future adolescent trespasser is 1E-06, which does not exceed the MADEP Risk Limit of 1E-05. The Total Site ELCR consists of 7E-07 for incidental ingestion of soil; 7E-07 for dermal contact with soil; 1E-09 for inhalation of fugitive dusts; 5E-09 for incidental ingestion of surface water; and 3E-10 for dermal contact with surface water. Individual COPC pathway and route-specific ELCRs are shown in Appendix A, Tables A-16, A-18 and A-20.

Carcinogenic Risk for the Future Construction Worker. The Total Site ELCR for the future construction worker is 2E-06, which does not exceed the MADEP Risk Limit of 1E-05. The Total Site ELCR consists of 7E-07 for incidental ingestion of soil; 8E-07 for dermal contact with soil; 4E-08 for inhalation of fugitive dusts; 5E-08 for incidental ingestion of groundwater; and 3E-08 for dermal contact with groundwater. No carcinogenic COPCs were identified in outdoor air. Individual COPC pathway and route-specific ELCRs are shown in Appendix A, Tables A-22, A-24, A-26 and A-28.

Carcinogenic Risk for the Future Utility Worker. The Total Site ELCR for the future utility worker is 2E-07, which does not exceed the MADEP Risk Limit of 1E-05. The Total Site ELCR consists of 9E-08 for incidental ingestion of soil; 1E-07 for dermal contact with soil; 5E-09 for inhalation of fugitive dusts; 6E-09 for incidental ingestion of groundwater; and 4E-09 for dermal contact with groundwater. No carcinogenic COPCs were identified in outdoor air. Individual

COPC pathway and route-specific ELCRs are shown in Appendix A, Tables A-30, A-32, A-34 and A-36.

Carcinogenic Risk for the Future Child Recreational User. The Total Site ELCR for the child recreational user is 3E-05 which exceeds the MADEP Risk Limit of 1E-05. The Total Site ELCR consists of 2E-05 for incidental ingestion of soil; 1E-05 for dermal contact with soil; 9E-09 for inhalation of fugitive dusts; 5E-08 for incidental ingestion of surface water; and 3E-09 for dermal contact with surface water. The exceedance of the MADEP Risk Limit is primarily due to the presence of carcinogenic PAHs and arsenic in soil. Individual COPC pathway and route-specific ELCRs are shown in Appendix A, Tables A-38, A-40 and A-42.

Carcinogenic Risk for the Future Adult Recreational User. The Total Site ELCR for the adult recreational user is 2E-05 which exceeds the MADEP Risk Limit of 1E-05. The Total Site ELCR consists of 7E-06 for incidental ingestion of soil; 1E-05 for dermal contact with soil; 2E-08 for inhalation of fugitive dusts; 5E-08 for incidental ingestion of surface water; and 6E-09 for dermal contact with surface water. The exceedance of the MADEP Risk Limit is primarily due to the presence of carcinogenic PAHs and arsenic in soil. Individual COPC pathway and route-specific ELCRs are shown in Appendix A, Tables A-44, A-46 and A-48.

1.5.3 Applicable or Suitably Analogous Public Health Standards. As part of the evaluation of the condition of no significant risk of harm to human health, as defined in 310 CMR 40.0993(7), the MCP requires a comparison of COPC EPCs to Applicable or Suitably Analogous Public Health Standards (310 CMR 40.0993(3)). Such standards include, but are not limited to, Massachusetts *Air Quality Standards* promulgated in 310 CMR 6.00, Massachusetts *Surface Water Quality Standards* promulgated in 314 CMR 4.00, and Massachusetts *Drinking Water Quality Standards* promulgated in 310 CMR 22.00.

The Site is not considered to be part of a Potential Drinking Water Source Area. Because of this, comparison of COPC groundwater concentrations to MADEP *Drinking Water Standards* as Applicable Standards (consistent with the requirements of 310 CMR 40.0993(3)) is not required for the evaluation of significant risk of harm to human health since the drinking water standards are not considered applicable.

In addition, since the surface water body at the Site is not classified as Class A or B surface water bodies, comparison of COPC surface water EPCs to *Massachusetts Surface Water Quality Standards* promulgated in 314 CMR 4.00 is not required. In addition, comparison of surface water COPC concentrations to U.S. EPA *Ambient Water Quality Criteria* for the human consumption of fish was not considered applicable for this Site.

1.6 Uncertainty Analysis

Risk characterizations are subject to a number of uncertainties. As a result, risk estimates derived from the equations and assumptions in this risk characterization should not be interpreted as absolute estimates of the risks of harm to human health, safety, public welfare or the environment posed by potential exposures to COPCs detected at the Site.

General sources of uncertainty include:

- adequacy of the site characterization;
- adequacy of the sampling plan;
- quality and treatment of the analytical data;
- modeling of EPCs;
- accuracy of the exposure assumptions; and
- development of toxicity values (RfDs, RfCs).

Specific uncertainties and steps to reduce the level of uncertainty are discussed below:

1.6.1 Hazard Identification. As described previously, it is anticipated that a "wedge" of soil will need to be removed from the northern portion of the property to facilitate MHD's bridge construction project. However, since the design plans for the bridge have not been firmly established, all soils have been assumed to remain on-site for the purposes of this risk evaluation. This assumption may lead to an over-estimate or under-estimate of risk depending on whether the soils removed contain lower or higher contaminant levels than present on average at the Site. In addition, asbestos-contaminated soils are present on-site. Due to a lack of toxicity values, asbestos has not been quantitatively evaluated in the human health risk assessment which results in an underestimate of risk.

1.6.2 Dose-Response Assessment. In the Dose-Response Assessment, the use of an Uncertainty Factor and a Modifying Factor, which are applied by the U.S. EPA to toxicity information to obtain RfD and RfC values, are used to account for the following uncertainties, which, in turn, can add to the overall uncertainty of the risk characterization findings:

- the use of dose-response information from effects observed at high doses to predict the adverse health effects that may occur following exposure to the low levels expected from human contact with the COPCs in the environment;
- the use of dose-response information from short-term exposure studies to predict the effects of long-term exposures, and vice-versa;
- the use of dose-response information from animal studies to predict adverse health effects in humans;
- the use of dose-response information from homogeneous animal populations or healthy human populations to predict the adverse health effects likely to be observed in the general population, consisting of individuals with a wide range of sensitivities;
- the assumption that the COPC exerts the same toxic effect regardless of the route of exposure;
- the use of toxicity values for hexavalent chromium to evaluate total chromium analyses in the absence of speciation data; and
- the use of default values for daily ingestion rates, breathing rates, average body weights, surface areas, and skin permeability constants, etc.

1.6.3 Exposure Assessment. The Exposure Assessment focuses on the evaluation of non-carcinogenic and carcinogenic effects for an individual who is maximally exposed to the COPC. Generally, conservative exposure assumptions are used for exposure concentrations, frequency and duration of exposure. These conservative assumptions can potentially overestimate and result in compounding conservatism in the estimate of the risk of harm from exposure to the COPC and contribute to the uncertainty of the risk characterization.

In the absence of monitoring data for outdoor air quality at the site, models were used to predict atmospheric COPC concentrations. Although commonly accepted models were used to estimate volatilization of COPCs from soil and groundwater, and dilution and dispersion in air, conservative input variables were used, which can introduce uncertainty into the risk findings. In addition, modeling was performed to estimate predicted surface water concentrations after groundwater discharge to the nearby surface water bodies. However, use of these models with conservative assumptions tends to be overprotective of human health, rather than underestimating potential risk.

2.0 PUBLIC WELFARE RISK CHARACTERIZATION

Risk of harm to public welfare from exposures to COPCs detected at the Site was characterized in accordance with 310 CMR 40.0994, under the current and reasonably foreseeable Site activities and uses. Factors evaluated included: nuisance conditions (e.g., odors), unilateral restrictions on the use of other properties and degradation of public or private drinking water resources as a result of the COPC release. In addition, average COPC soil and maximum COPC groundwater concentrations detected at the Site were compared to their respective Upper Concentration Limits (UCLs) listed in 310 CMR 40.0996(4) (Tables 11 and 12). None of the average COPC soil or maximum groundwater concentrations exceeded their respective UCLs.

Based on the observation that UCLs are not exceeded, the Site is considered to meet the condition of no significant risk of harm to public welfare as defined in 310 CMR 40.0994.

3.0 CHARACTERIZATION OF RISK TO SAFETY

Risk of harm to safety, associated with the release of COPCs at the Site, was evaluated in accordance with the requirements of 310 CMR 40.0941(2) and 40.960, and was based on a Site visit and on observations made consistent with MCP Response Action Performance Standards (RAPS) as defined in 310 CMR 40.0191. COPC-related safety hazards evaluated under current and future foreseeable Site conditions included: the presence of open pits; uncontained corrosive, flammable/ignitable, reactive, or infectious materials; threat of fire or explosion, including the presence of explosive vapors; and rusted or corroded drums or containers.

Qualitative observations did not reveal hazards associated with the COPC release likely to pose a threat of physical harm or bodily injury to people, and a condition of no significant risk of harm to safety was considered to exist at the Site.

Evaluation of risk of harm to safety through comparison of Site conditions to applicable or suitably analogous safety standards (e.g., Lower Explosive Limits) was not considered applicable to this Site.

4.0 STAGE I ENVIRONMENTAL SCREENING

The following observations about the Site and its environs may be made:

- The Site is not located within a one-half mile radius of or adjacent to an inland Area of Critical Environmental Concern (MADEP Bureau of Waste Site Cleanup Site Scoring Map; Figure 2).

- The U.S. EPA Region 1 List of Priority Wetlands/Water Bodies in New England does not indicate the presence of specific priority wetlands/water bodies at or in the vicinity of the Site.

- The Massachusetts Natural Heritage Atlas does not show High Priority Sites of Rare Species Habitats and Exemplary Natural Communities or Estimated Habitats of Rare Wetlands Wildlife and Certified Vernal Pools within a one-half mile radius of the Site.

- The MADEP Bureau of Waste Site Cleanup Site Scoring Map (Figure 2) indicates that the closest surface water body (the Spicket River) is located immediately adjacent to the Site.

Based upon a review of available data and the aforementioned observations, the potential media of concern for ecological receptors were identified as on-site surface soils and surface water (as impacted by groundwater discharge).

Terrestrial Receptors The principal exposure pathway for terrestrial receptors includes contact with COPCs in on-site surface soils. However, given the small size (<2.0 acres) of undeveloped impacted property on the Site and the limited vegetated cover (i.e., lack of suitable habitat), the Site appears to qualify for exclusion from assessment of risk of harm to terrestrial life under MCP guidance (MADEP, 1995).

Aquatic Receptors For discharge of groundwater to surface water, the most likely environmental receptors are aquatic organisms living in the Spicket River. Terrestrial organisms may drink from the river; however, this is likely to occur from multiple locations along the river and other water bodies in the area. Potential EPCs for aquatic life in the Spicket River were modeled using average groundwater concentrations and conservative dispersion modeling (i.e., MADEP default 10-fold dilution factor). The modeled surface water EPCs are presented in Table 13.

Risk of harm to the aquatic organisms was evaluated by comparison of the modeled surface water EPCs to Massachusetts Ambient Water Quality Criteria provided by MADEP (MADEP, 1994). COPC EPCs are below the corresponding AWQCs, and thus pose no significant risk of harm to aquatic receptors.

Based on the findings of the above Stage I Environmental Screening, current and future foreseeable site conditions pose no significant risk of harm to the environment, as defined in 310 CMR 40.09. In addition, a Stage II Environmental Risk Characterization (as defined in 310 CMR 40.0995(4)) is not indicated.

5.0 CONCLUSIONS AND RECOMMENDATIONS

A MCP Method 3 Human Health Risk Characterization and a Stage I Environmental Screening have been conducted at the Site in accordance with the requirements of 310 CMR 40.0990, using applicable soil and groundwater analytical sampling data. Airborne particulate data were derived from soil data using default MADEP PM_{10} values for the adolescent trespasser, construction/utility worker, and recreational (adult and child) exposure scenarios. Current and future surface water data for the Spicket River were derived from average groundwater data using MADEP default dilution factors. Outdoor atmospheric data were derived from soil and groundwater data using vapor migration and air dispersion/dilution models.

The human health risk characterization assumed that an Activity and Use Limitation (AUL) would be placed on the property to prevent future residential and/or commercial land use including the construction of occupied buildings. Therefore, the risk characterization has not included these receptors or the pathways by which these receptors may be exposed to site-related contaminants. In addition, asbestos-contaminated soils exist on-site that, if contacted, would present a potential risk to human receptors. It is assumed that contact with these soils will need to be prevented as part of the AUL at the Site.

Under current site activities and uses, potential exposures to COPCs in soil and surface water, following groundwater discharge, pose no significant risk of harm to current adolescent trespassers.

Under future foreseeable site activities and uses, potential direct contact exposures to COPCs in soil pose a significant risk of harm to human health. Significant risk of harm is posed to: (1) the future hypothetical young child recreational user; and (2) the future hypothetical adult recreational user. The risks are primarily attributable to the presence of carcinogenic PAHs and arsenic in soil. Future exposures to construction/utility workers or adolescent trespassers pose no significant risk of harm to health.

Risk of harm to safety is not significant under both current and future foreseeable site conditions. No visible signs of physical (e.g., lagoons, pits, rusted drums) or chemical hazards (e.g., corrosive, flammable/ignitable, reactive materials) are present at the Site.

There is currently no condition of unilateral restrictions on the uses of the abutting property, negative impacts on properties downgradient of the site, or reports of significant degradation of public or private drinking water resources as a result of the COPC release. In addition, average soil and maximum groundwater levels do not exceed their respective UCLs Therefore, it is concluded that the Site does not pose a significant risk to public welfare.

Since surface water EPCs, modeled from groundwater contaminant concentrations, do not exceed AWQCs for aquatic receptors, it is concluded that the Site does not pose a significant risk to the environment.

Based on these findings, Site conditions are considered to pose significant risk of harm to human health under future foreseeable site activities and uses. To protect risk of harm to human health under future foreseeable site activities and uses and to achieve a condition of no significant risk, response actions may be implemented to reduce the levels of arsenic and carcinogenic PAHs to acceptable levels, or an Activity and Use Limitation (AUL) preventing the use of the property as a passive recreational area is indicated.

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TABLES FOR ATTACHMENT I

TABLE 1
SUMMARY STATISTICS FOR SURFACE SOILS
OXFORD PAPER MILL, LAWRENCE, MA

Analytes	Frequency of Detection	Range of Detection Limits	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration[4]	Soil Background	COPC? Y/N[2]	EPC[3]
EPH (mg/Kg)								
C9-C18 Aliphatics	10 / 16	3.3 - 4.2	4.3	26	8.2	NA	Y	8.2
C19-C36 Aliphatics	15 / 16	4.3 - 4.3	5.2	270	59	NA	Y	59
C11-C22 Aromatics	16 / 16	NA	16	460	143	NA	Y	143
2-Methylnaphthalene	2 / 16	0.54 - 1.4	1.1	1.4	0.48	0.5	Y	0.48
Acenaphthene	5 / 16	0.54 - 1.4	0.70	6.4	1.3	0.5	Y	1.3
Acenphthylene	1 / 16	0.54 - 1.4	1.0	1.0	0.42	0.5	Y	0.42
Anthracene	11 / 16	0.54 - 1.4	0.58	14	2.7	1	Y	2.7
Benzo(a)anthracene	14 / 16	0.54 - 0.71	1.2	35	7.1	2	Y	7.1
Benzo(a)pyrene	13 / 16	0.54 - 0.71	1.0	24	5.5	2	Y	5.5
Benzo(b)fluoranthene	15 / 16	0.54 - 0.54	0.90	35	8.0	2	Y	8.0
Benzo(g,h,i)perylene	6 / 16	0.54 - 1.4	1.4	13	2.7	1	Y	2.7
Benzo(k)fluoranthene	13 / 16	0.54 - 1.4	0.64	12	3.2	1	Y	3.2
Chrysene	16 / 16	NA	0.66	38	7.5	2	Y	7.5
Dibenz(a,h)anthracene	7 / 16	0.58 - 1.4	0.69	22	3.7	0.5	Y	3.7
Fluoranthene	16 / 16	NA	1.0	74	15	4	Y	15
Fluorene	5 / 16	0.54 - 1.4	0.65	6.3	1.2	1	Y	1.2
Indeno(1,2,3-cd)pyrene	10 / 16	0.58 - 1.4	0.69	22	4.5	1	Y	4.5
Naphthalene	4 / 16	0.54 - 1.4	0.74	2.0	0.63	0.5	Y	0.63
Phenanthrene	16 / 16	NA	0.66	58	10	3	Y	10
Pyrene	16 / 16	NA	1.0	73	15	4	Y	15
PCBs (mg/kg)								
Aroclor-1248	1 / 16	0.038 - 1.1	1.2	1.2	0.22	NA	Y	0.22
Aroclor-1254	13 / 16	0.04 - 0.047	0.071	1.8	0.52	NA	Y	0.52
Metals (mg/Kg)								
Antimony	8 / 14	0.64 - 1.7	0.22	8.8	1.7	1	Y	1.7
Arsenic	20 / 22	41 - 42	6.6	135	37	20	Y	37
Barium	16 / 16	NA	16	150	74	50	Y	74
Beryllium	16 / 16	NA	0.14	1.0	0.62	0.4	Y	0.62
Cadmium	12 / 16	0.21 - 0.51	0.15	46	10	2	Y	10
Chromium	22 / 22	NA	0.16	63	23	30	Y	23
Copper	14 / 16	9 - 16.2	8.7	91	34	40	Y	34
Lead	22 / 22	NA	13.2	1970	197	100	Y	197
Mercury	15 / 15	NA	0.073	5.3	1.2	0.3	Y	1.2
Nickel	16 / 16	NA	11.8	130	41	20	Y	41
Selenium	5 / 16	0.22 - 0.55	0.76	1.8	0.54	0.5	Y	0.54
Silver	7 / 16	0.097 - 0.13	0.04	0.87	0.14	0.6	Y	0.14
Thallium	8 / 16	0.18 - 1.3	0.063	1.3	0.46	0.6	Y	0.46
Vanadium	16 / 16	NA	20	520	140	30	Y	140
Zinc	16 / 16	NA	24.1	390	114	100	Y	114

1. Data were collected in May 2002 and March 2003. Samples utilized include: SB-1/0-1, SB-2/0-1, SB-3/0-1, SB-4/0-1, SB-5/0-1, SB-6/0-1, SB-7/0-1, SB-8/0-1, SB-9/0-1, and SB-10/0-1 for PCBs, EPH, and metals; 4S, 6S, 8S, 10S, 12S, and 14S for EPH and metals; 5A, 6B, 7B, 10B, 11B, and 16B for PCBs; and 4A, 5A, 6A (and field duplicate), 7A, 10A, and 14A for metals (arsenic, chromium, and lead only).
2. Analytes excluded as COPCs when maximum detected concentration is less than MADEP "natural" soil background concentration.
3. Average concentration selected as EPC unless greater than maximum, in which case maximum is selected.
4. One-half the detection limit has been used for non-detect values in the calculation of average concentrations.

EPC - Exposure Point Concentration

NA - Not applicable or not available

TABLE 2
SUMMARY STATISTICS FOR SURFACE AND SUBSURFACE SOILS
OXFORD PAPER MILL, LAWRENCE, MASSACHUSETTS

Analytes	Frequency of Detection	Range of Detection Limits	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration[4]	Soil Background	COPC? Y/N[2]	EPC[3]
EPH (mg/Kg)								
C9-C18 Aliphatics	23 / 39	3.3 - 4.2	4	460	22	NA	Y	22
C19-C36 Aliphatics	34 / 39	4.3 - 5	5	270	39	NA	Y	39
C11-C22 Aromatics	36 / 39	9.6 - 11	10	460	122	NA	Y	122
2-Methylnaphthalene	8 / 39	0.52 - 1.4	0.72	2.0	0.50	0.5	Y	0.50
Acenaphthene	17 / 39	0.52 - 1.4	0.54	6.4	1.2	0.5	Y	1.2
Acenaphthylene	3 / 39	0.52 - 1.4	0.95	1.1	0.39	0.5	Y	0.39
Anthracene	22 / 39	0.52 - 1.4	0.58	14	2.5	1	Y	2.5
Benzo(a)anthracene	30 / 39	0.54 - 0.71	0.59	35	6.0	2	Y	6.0
Benzo(a)pyrene	28 / 39	0.52 - 0.71	0.54	24	4.6	2	Y	4.6
Benzo(b)fluoranthene	31 / 39	0.54 - 0.65	0.74	35	6.7	2	Y	6.7
Benzo(g,h,i)perylene	16 / 39	0.52 - 1.4	1.4	14	2.5	1	Y	2.5
Benzo(k)fluoranthene	25 / 39	0.52 - 1.4	0.61	16	2.7	1	Y	2.7
Chrysene	32 / 39	0.56 - 0.65	0.66	38	6.3	2	Y	6.3
Dibenz(a,h)anthracene	17 / 39	0.52 - 1.4	0.61	22	3.2	0.5	Y	3.2
Fluoranthene	33 / 39	0.56 - 0.65	0.74	74	13	4	Y	13
Fluorene	18 / 39	0.52 - 1.4	0.55	6.3	1.2	1	Y	1.2
Indeno(1,2,3-cd)pyrene	21 / 39	0.52 - 4.1	0.69	22	3.9	1	Y	3.9
Naphthalene	13 / 39	0.52 - 1.4	0.62	2.4	0.62	0.5	Y	0.62
Phenanthrene	33 / 39	0.56 - 0.65	0.66	58	9.6	3	Y	9.6
Pyrene	33 / 39	0.56 - 0.65	0.63	73	12	4	Y	12
PCBs (mg/kg)								
Aroclor-1248	4 / 39	0.036 - 2.3	0.12	6.0	0.32	NA	Y	0.32
Aroclor-1254	24 / 39	0.036 - 0.5	0.04	16	0.79	NA	Y	0.79
Metals (mg/Kg)								
Antimony	16 / 34	0.17 - 2.1	0.22	8.8	1.2	1	Y	1.2
Arsenic	43 / 45	41 - 42	2.5	135	29	20	Y	29
Barium	39 / 39	NA	13	300	74	50	Y	74
Beryllium	39 / 39	0.83 - 0.98	0.14	1.1	0.65	0.4	Y	0.65
Cadmium	24 / 39	0.038 - 1.2	0.056	50	8.6	2	Y	8.6
Chromium	45 / 45	20.4 - 25.2	0.14	63	19	30	Y	19
Copper	34 / 39	2.8 - 16.2	6.5	140	35	40	Y	35
Lead	45 / 45	NA	2.4	1,970	135	100	Y	135
Mercury	31 / 36	0.016 - 0.53	0.039	17	1.2	0.3	Y	1.2
Nickel	39 / 39	NA	10	130	35	20	Y	35
Selenium	9 / 39	0.11 - 0.55	0.50	1.8	0.39	0.5	Y	0.39
Silver	13 / 39	0.092 - 0.33	0.040	0.89	0.12	0.6	Y	0.12
Thallium	18 / 39	0.16 - 1.3	0.063	1.3	0.45	0.6	Y	0.45
Vanadium	39 / 39	NA	12	598	137	30	Y	137
Zinc	39 / 39	NA	15	560	122	100	Y	122

1. Data were collected in May 2002 and March 2003. Samples utilized include: SB-1/0-1, SB-1/5-7,SB-2/0-1, SB-2/7-9, SB-2/11-13, SB-3/0-1, SB-3/7-9, SB-3/13-15, SB-4/0-1, SB-4/5-7, SB-4/13-15, SB-5/0-1, SB-5/9-11, SB-5/14-16, SB-6/0-1, SB-6/5-7, SB-6/14-16 (and field duplicate), SB-7/0-1, SB-7/7-9, SB-8/0-1, SB-8/7-9, SB-9/0-1, SB-9/5-7, SB-9/13-15, SB-10/0-1, SB-10/9-11 (and field duplicate), and SB-10/13-15 for PCBs, EPH, and metals; 4S, 4D, 6S, 6D, 8S, 8D, 10S, 10D (and field duplicate), 12S, 12D, 14S, and 14D for EPH and metals; 4C (and field duplicate), 5A, 6B, 7B, 8F, 10B, 11B, 12D, 12H, 14C, 14G, and 16B for PCBs; and 4A, 5A, 6A (and field duplicate), 7A, 10A, and 14A for metals (arsenic, chromium, and lead only).
2. Analytes excluded as COPCs when maximum detected concentration is less than MADEP "natural" soil background concentration.
3. Average concentration selected as EPC unless greater than maximum, in which case maximum is selected.
4. One-half the detection limit has been used for non-detect values in the calculation of average concentrations.

EPC - Exposure Point Concentration

NA - Not applicable or not available

Table 3
Summary of Shallow Groundwater Data
Oxford Paper Mill, Lawrence, Massachusetts

LOCATION NAME	MW-1	MW-3	MW-5	MW-6	MW-10			
M&E SAMPLE ID	MW-1	MW-3	MW-5	MW-6	MW-10			10x Dilution
DATE RECEIVED BY LAB:	3/27/03	3/27/03	3/27/03	3/27/03	3/27/03			of
DEPTH TO WATER FROM GROUND SURFACE:	16.5'	14.3'	14.8'	15'	6.5'	Maximum	Average	Average
COMMENTS			average			Concentration	Concentration	Concentration
PARAMETER/ANALYTE								
EXTRACTABLE PETROLEUM HYDROCARBONS - MADEP EPH-98-1 (ug/L)								
C_9-C_{18} Aliphatics	30 UJ	35	30 U	40 J	44	44	30	3.0
C_{19}-C_{36} Aliphatics	45	44	40 U	49 J	45	49	41	4.1
Priority Pollutant Metals Plus Barium and Vanadium (ug/L)								
Arsenic	3 U	4.2 J	6.4 J	11 J	4.4 J	11	5.5	0.55
Barium	76.8 J	83.4 J	57.9 J	44 J	14.7 UJ	83.4	54	5.4
Beryllium	0.5 U	0.5 U	0.48 J	0.5 U	0.5 U	0.48	0.30	0.030
Chromium	1.1 J	1 J	0.99 J	0.6 U	0.85 J	1.1	0.85	0.085
Nickel	1.1 J	4 J	11.5 J	5.6 J	0.94 J	11.5	4.6	0.46
Selenium	9 U	188	10 J	12.1 J	9 U	188	44	4.4
Vanadium	1.2 J	158	5.7 J	3710	15 J	3710	778	78
Zinc	7 U	7 U	17.4 J	7 U	7 U	17.4	6.3	0.63

TABLE 4
SUMMARY OF MODELED AIR DATA FOR FUTURE EXPOSURES
OXFORD PAPER MILL, LAWRENCE, MASSACHUSETTS

	FUTURE CONSTRUCTION/UTILITY WORKER Outdoor Air		
	Soil	GW	Sum
	mg/m^3		
Analyte			
C9-C18 Aliphatics	1.7E-03	1.1E-02	▨
C11-C22 Aromatics	5.5E-04		▨
2-Methylnaphthalene	5.7E-06		▨
Naphthalene	1.4E-06		▨

NOTES:

a Shading indicates analyte was selected as a COPC. All analytes are COPCs for outdoor air.

TABLE 5
ORAL DOSE-RESPONSE VALUES FOR CHEMICALS OF POTENTIAL CONCERN
OXFORD PAPER MILL SITE

CHEMICAL (a)	CHRONIC ORAL RfD (mg/kg/day)	CRITICAL EFFECTS	ORAL RfD CONFIDENCE	REF	SUBCHRONIC ORAL RfD (mg/kg/day)	REF	ORAL SLOPE FACTOR 1/(mg/kg/day)		WEIGHT OF EVIDENCE	REF
Aroclor-1248	0.00002	immunological effects	Med.	IRIS '03	0.00002	(b)	2.0		B2	IRIS '03
Aroclor-1254	0.00002	immunological effects	Med.	IRIS '03	0.00002	(b)	2.0		B2	IRIS '03
C9-C18 Aliphatics	0.1	hepatotoxicity	NA	MADEP '02	1.0	MADEP '02	NA		NA	MADEP '02
C19-C36 Aliphatics	2.0	hepatotoxicity	NA	MADEP '02	6	MADEP '02	NA		NA	MADEP '02
C11-C22 Aromatics	0.03	nephrotoxicity for pyrene	NA	MADEP '02	0.30	MADEP '02	NA		NA	MADEP '02
Acenaphthene	0.06	liver toxicity	Low	IRIS '03	0.6	HEAST '97	NA		D	IRIS '03
Acenaphthylene	0.04	NA	NA	MADEP '94	0.04	MADEP '94 (b)	NA		D	IRIS '03
Anthracene	0.3	none observed	Low	IRIS '03	3	HEAST '97	NA		D	IRIS '03
Benzo(a)anthracene	0.04	NA	NA	MADEP '94	0.04	MADEP '94 (b)	0.73	(c)	B2	IRIS '03
Benzo(a)pyrene	0.04	NA	NA	MADEP '94	0.04	MADEP '94 (b)	7.3		B2	IRIS '03
Benzo(b)fluoranthene	0.04	NA	NA	MADEP '94	0.04	MADEP '94 (b)	0.73	(c)	B2	IRIS '03
Benzo(g,h,i)perylene	0.04	NA	NA	MADEP '94	0.04	MADEP '94 (b)	NA		D	MADEP '95
Benzo(k)fluoranthene	0.04	NA	NA	MADEP '94	0.04	MADEP '94 (b)	0.073	(c)	B2	MADEP '95
Chrysene	0.04	NA	NA	MADEP '94	0.04	MADEP '94 (b)	0.073	(c)	B2	MADEP '95
Dibenz(a,h)anthracene	0.04	NA	NA	MADEP '94	0.04	MADEP '94	7.3		B2	MADEP '95
Fluoranthene	0.04	kidney, liver, and blood cell effects	Low	IRIS '03	0.40	HEAST '97	NA		D	IRIS '03
Fluorene	0.40	decreased volume of red blood cells	Low	IRIS '03	0.4	HEAST '97	NA		D	IRIS '03
Indeno(1,2,3-cd)pyrene	0.04	NA	NA	MADEP '94	0.04	MADEP '94 (b)	0.73	(c)	B2	IRIS '03
Naphthalene	0.020	nasal effects	Med.	IRIS '03	0.02	(b)	NA		C	IRIS '03
Phenanthrene	0.04	NA	NA	MADEP '94	0.04	MADEP '94 (b)	NA		D	IRIS '03
Pyrene	0.03	kidney effects	Low	IRIS '03	0.30	HEAST '97	NA		D	IRIS '03
2-Methylnaphthalene	0.04	NA	NA	MADEP '94	0.04	MADEP '94 (b)	NA		D	MADEP '94
Antimony	0.0004	longevity	Low	IRIS '03	0.0004	MADEP '94 (b)	NA		D	IRIS '03
Arsenic	0.0003	skin effects	Med.	IRIS '03	0.0003	MADEP '94 (b)	1.5		A	IRIS '03
Barium	0.07	NOEL	Med.	IRIS '03	0.07	(b)	NA		D	IRIS '03
Beryllium	0.002	gastrointestinal lesions	Low-med.	IRIS '03	0.002	(b)	NA		D	IRIS '03
Cadmium	0.001	kidney effects	High	IRIS '03	0.001	(b)	NA		D	IRIS '03
Chromium	0.003	NOEL	Low	IRIS '03	0.003	(b)	NA		D	IRIS '03
Copper	0.04	NA	NA	HEAST '97	0.04	(b)	NA		D	IRIS '03
Lead	0.00075	NA	NA	MADEP '94	0.00075	MADEP '94 (b)	NA		B2	IRIS '03
Mercury	0.0003	autoimmune effects	High	IRIS '03	0.0003	MADEP '94 (b)	NA		C	IRIS '03
Nickel	0.002	decrease body weight	Med.	IRIS '03	0.002	MADEP '94 (b)	NA		D	IRIS '03
Selenium	0.005	selenosis	High	IRIS '03	0.005	MADEP '94 (b)	NA		D	IRIS '03
Silver	0.005	argyria	Low	IRIS '03	0.005	MADEP '94 (b)	NA		D	IRIS '03
Thallium	0.00008	NOEL	Low	IRIS '03	0.00008	(b)	NA		D	IRIS '03
Vanadium	0.009	Decreased hair cystine	Low	IRIS '03	0.009	(b)	NA		D	IRIS '03
Zinc	0.3	Decreased enzyme activity	Med.	IRIS '03	0.3	MADEP '94 (b)	NA		D	IRIS '03

NOTES:
(a) This table includes analytes detected in all media.
(b) Chronic RfD selected as subchronic RfD
(c) Slope factor calculated based on potency relative to benzo(a)pyrene.

ABBREVIATIONS:
RfD - Reference dose or MADEP substitute for reference dose
NA - Not applicable, not available, no data, or not determined
REF - References

REFERENCES (in order of priority):
IRIS. USEPA, 2003. Integrated Risk Information System.
HEAST. USEPA, 1997. *Health Effects Assessment Summary Tables.*
MADEP, 2002. *Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of MADEP VPH/EPH Approach. Final Policy*
MADEP, 1995. *Guidance for Disposal Site Risk Characterization.*
MADEP, 1994. *Background Documentation for the Development of the MCP Numerical Standards.*
NCEA. National Center for Environmental Assessment

TABLE 6
INHALATION DOSE-RESPONSE VALUES FOR CHEMICALS OF POTENTIAL CONCERN
OXFORD PAPER MILL SITE

CHEMICAL (a)	INHALATION RfC (mg/m^3)	CRITICAL EFFECTS	INHALATION RfC CONFIDENCE	REF	INHALATION UNIT RISK 1/(mg/m^3)	WEIGHT OF EVIDENCE	REF
Aroclor-1248	2.E-05	NA	NA	MADEP '94	0.5	B2	IRIS '03
Aroclor-1254	2.E-05	NA	NA	MADEP '94	0.5	B2	IRIS '03
C9-C18 Aliphatics	0.2	neurotoxicity	NA	MADEP '02	NA	NA	MADEP '02
C19-C36 Aliphatics	NA	NA	NA	NA	NA	NA	MADEP '02
C11-C22 Aromatics	0.05	hepatotoxicity	NA	MADEP '02	NA	NA	MADEP '02
Acenaphthene	0.071	(b)	NA	MADEP '94	NA	D	IRIS '03
Acenaphthylene	0.071	(b)	NA	MADEP '94	NA	D	IRIS '03
Anthracene	0.071	(b)	NA	MADEP '94	NA	D	IRIS '03
Benzo(a)anthracene	0.071	(b)	NA	MADEP '94	1.7	B2	MADEP '94
Benzo(a)pyrene	0.071	(b)	NA	MADEP '94	1.7	B2	MADEP '94
Benzo(b)fluoranthene	0.071	(b)	NA	MADEP '94	1.7	B2	MADEP '94
Benzo(g,h,i)perylene	0.071	(b)	NA	MADEP '94	NA	D	IRIS '03
Benzo(k)fluoranthene	0.071	(b)	NA	MADEP '94	1.7	B2	MADEP '94
Chrysene	0.071	(b)	NA	MADEP '94	1.7	B2	MADEP '94
Dibenz(a,h)anthracene	0.071	(b)	NA	MADEP '94	1.7	B2	MADEP '94
Fluoranthene	0.071	(b)	NA	MADEP '94	NA	D	IRIS '03
Fluorene	0.071	(b)	NA	MADEP '94	NA	D	IRIS '03
Indeno(1,2,3-cd)pyrene	0.071	(b)	NA	MADEP '94	1.7	B2	MADEP '94
Naphthalene	0.071	NA	NA	MADEP '94	NA	D	IRIS '03
Phenanthrene	0.071	(b)	NA	MADEP '94	NA	D	IRIS '03
Pyrene	0.071	(b)	NA	MADEP '94	NA	D	IRIS '03
2-Methylnaphthalene	0.071	(b)	NA	MADEP '94	NA	D	MADEP '94
Antimony	NA	NA	NA	IRIS '03	NA	D	IRIS '03
Arsenic	NA	NA	NA	IRIS '03	4.3	A	IRIS '03
Barium	NA	NA	NA	IRIS '03	NA	D	IRIS '03
Beryllium	0.00002	sensitization	Med.	IRIS '03	2.4	B1	IRIS '03
Cadmium	NA	NA	NA	IRIS '03	1.8	B1	IRIS '03
Chromium	1.E-04	enzyme leakage	Med.	IRIS '03	12	A	IRIS '03
Copper	NA	NA	NA	IRIS '03	NA	D	IRIS '03
Lead	NA	NA	NA	IRIS '03	NA	B2	IRIS '03
Mercury	NA	NA	NA	IRIS '03	NA	C	IRIS '03
Nickel	NA	NA	NA	IRIS '03	NA	D	IRIS '03
Selenium	NA	NA	NA	IRIS '03	NA	D	IRIS '03
Silver	NA	NA	NA	IRIS '03	NA	D	IRIS '03
Thallium	NA	NA	NA	IRIS '03	NA	D	IRIS '03
Vanadium	NA	NA	NA	IRIS '03	NA	D	IRIS '03
Zinc	NA	NA	NA	IRIS '03	NA	D	IRIS '03

NOTES:

a. This table includes analytes detected in soil gas and groundwater.

b. RfC for naphthalene used as surrogate for all other PAHs.

c. RfC values are for chronic exposures, subchronic values are a 10-fold adjustment of chronic values.

REFERENCES (in order of priority):

IRIS. USEPA, 2003. Integrated Risk Information System.

HEAST. USEPA, 1997. *Health Effects Assessment Summary Tables.*

MADEP, 2002. *Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of MADEP VPH/EPH Approach. Final Policy*

MADEP, 1994. *Background Documentation for the Development of the MCP Numerical Standards.*

NCEA. National Center for Environmental Assessment

ABBREVIATIONS:

RfC - Reference Concentration

NA - Not available, not applicable, no data, or not determined

REF - References

Weight of Evidence:

- A - Human carcinogen
- B1 - Probable human carcinogen - indicates that limited human data are available
- B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
- C - Possible human carcinogen
- D - Not classifiable as a human carcinogen (by the oral route)
- E - Evidence of noncarcinogenicity

TABLE 7
SUMMARY OF RELATIVE ABSORPTION FACTORS FOR CHEMICALS OF POTENTIAL CONCERN
OXFORD PAPER MILL SITE

Contaminants of Concern	Ingestion, Soil		Dermal Contact, Soil		Ingestion, Surface Water or Groundwater		Dermal Contact, Surface Water or Groundwater		Inhalation	
	Noncancer Chronic RAF	Cancer RAF	Noncancer Chronic RAF	Cancer RAF	Noncancer Chronic RAF	Cancer RAF	Noncancer Chronic RAF	Cancer RAF*	Noncancer Chronic RAF	Cancer RAF
Aroclor-1248	0.85	0.85	0.067	0.067	1	1	1	1	1	1
Aroclor-1254	0.85	0.85	0.067	0.067	1	1	1	1	1	1
C9-C18 Aliphatics	1	NC	0.5	NC	1	NC	1	NC	1	NC
C19-C36 Aliphatics	1	NC	0.10	NC	1	NC	1	NC	1	NC
C11-C22 Aromatics	0.36	NC	0.1	NC	0.91	NC	1	NC	1	NC
Acenaphthene	1	NC	0.2	NC	1	NC	1	NC	1	NC
Acenaphthylene	0.91	NC	0.18	NC	0.91	NC	1	NC	1	NC
Anthracene	1	NC	0.29	NC	1	NC	1	NC	1	NC
Benzo(a)anthracene	0.91	1	0.18	0.2	0.91	1	1	1	1	1
Benzo(a)pyrene	0.91	1	0.18	0.2	0.91	1	1	1	1	1
Benzo(b)fluoranthene	0.91	1	0.18	0.2	0.91	1	1	1	1	1
Benzo(g,h,i)perylene	0.91	NC	0.18	NC	0.91	NC	1	NC	1	NC
Benzo(k)fluoranthene	0.91	1	0.18	0.2	0.91	1	1	1	1	1
Chrysene	0.91	1	0.18	0.2	0.91	1	1	1	1	1
Dibenz(a,h)anthracene	0.91	1	0.08	0.09	0.91	1	1	1	1	1
Fluoranthene	1	NC	0.2	NC	1	NC	1	NC	1	NC
Fluorene	1	NC	0.2	NC	1	NC	1	NC	1	NC
Indeno(1,2,3-cd)pyrene	0.91	1	0.18	0.2	0.91	1	1	1	1	1
Naphthalene	1	NC	0.1	NC	1	NC	1	NC	1	NC
Phenanthrene	0.91	NC	0.18	NC	0.91	NC	1	NC	1	NC
Pyrene	1	NC	0.2	NC	1	NC	1	NC	1	NC
2-Methylnaphthalene	1	NC	0.1	NC	1	NC	1	NC	1	NC
Antimony	1	NC	0.1	NC	1	NC	1	NC	1	NC
Arsenic	1	1	0.03	0.03	1	1	1	1	1	1
Barium	0.39	NC	0.3	NC	1	NC	1	NC	1	NC
Beryllium	1	NC	0.03	NC	1	NC	1	NC	1	1
Cadmium	1	NC	0.14	NC	1	NC	1	NC	1	1
Chromium	1	NC	0.09	NC	1	NC	1	NC	1	1
Copper	1	NC	0.3	NC	1	NC	1	NC	1	NC
Lead	0.5	NC	0.006	NC	0.5	NC	1	NC	1	NC
Mercury	1	NC	0.05	NC	1	NC	1	NC	1	NC
Nickel	1	NC	0.35	NC	1	NC	1	NC	1	NC
Selenium	1	NC	0.002	NC	1	NC	1	NC	1	NC
Silver	1	NC	0.25	NC	1	NC	1	NC	1	NC
Thallium	1	NC	0.01	NC	1	NC	1	NC	1	NC
Vanadium	1.86	NC	0.14	NC	1.9	NC	1	NC	1	NC
Zinc	1	NC	0.02	NC	1	NC	1	NC	1	NC

NC - Not Carcinogenic or Not Calculated

TABLE 8
EXPOSURE PROFILE SUMMARY FOR THE OXFORD PAPER MILL SITE

Receptor	Exposure Point	Exposure Pathway	Exposure Route	Pathway Selected	Reason for Selection or Exclusion
Current Adolescent Trespasser	On-Site	Surface Soil	Dermal Contact Incidental Ingestion	Yes	Soil contamination is less than 3 feet below ground surface.
			Inhalation of VOCs	No	VOCs will disperse and dilute into ambient air.
		Fugitive Dust	Inhalation	Yes	Soil contamination is less than 3 feet below ground surface.
		Groundwater	Inhalation of Volatiles	No	VOCs will disperse and dilute into ambient air.
		Surface Water	Dermal Contact Incidental Ingestion	Yes	Older children may be exposed to contaminated surface water while playing in and around the Spicket River.
Future Construction Worker Adult	On-Site	Surface and Subsurface Soil	Dermal Contact Incidental Ingestion	Yes	Construction workers may be exposed to contaminated soils during future redevelopment activities at the site.
			Inhalation of Volatiles	Yes	Construction workers may be exposed to volatile contaminants eminating from soil to outdoor air.
		Fugitive Dust	Inhalation	Yes	Construction workers may be exposed to contaminants in fugitive dust while excavating.
		Groundwater	Dermal Contact Incidental Ingestion	Yes	Construction workers may encounter contaminated groundwater during trenching activities.
			Inhalation of Volatiles	Yes	Construction workers may be exposed to volatile contaminants eminating from groundwater to outdoor air.

TABLE 8
EXPOSURE PROFILE SUMMARY FOR THE
OXFORD PAPER MILL SITE

Receptor	Exposure Point	Exposure Pathway	Exposure Route	Pathway Selected	Reason for Selection or Exclusion
Future Utility Worker Adult	On-Site	Surface and Subsurface Soil	Dermal Contact Incidental Ingestion	Yes	Utility workers may be exposed to contaminated soils during future activities at the site.
			Inhalation of Volatiles	Yes	Utility workers may be exposed to volatile contaminants eminating from soil to outdoor air.
		Fugitive Dust	Inhalation	Yes	Utility workers may be exposed to contaminants in fugitive dust while excavating.
		Groundwater	Dermal Contact Incidental Ingestion	Yes	Utility workers may encounter contaminated groundwater during trenching activities.
			Inhalation of Volatiles	Yes	Utility workers may be exposed to volatile contaminants eminating from groundwater to outdoor air.
Future Recreational Child/Adult	On-Site	Surface and Subsurface Soil	Dermal Contact Incidental Ingestion	Yes	Recreational users may be exposed to soil contaminants moved to the surface during outdoor activities.
			Inhalation of Volatiles	No	VOCs will disperse and dilute into ambient air.
		Fugitive Dust	Inhalation	Yes	Recreational users may be exposed to soil contaminants during outdoor activities.
		Groundwater	Inhalation of Volatiles	No	VOCs will disperse and dilute into ambient air.
		Surface Water	Dermal Contact Incidental Ingestion	Yes	Recreational users may be exposed after discharge of groundwater contaminants to surface water.
Future Adolescent Trespasser	On-Site	Surface and Subsurface Soil	Dermal Contact Incidental Ingestion	Yes	Soil contamination is less than 3 feet below ground surface.
			Inhalation of VOCs	No	VOCs will disperse and dilute into ambient air.
		Fugitive Dust	Inhalation	Yes	Soil contamination is less than 3 feet below ground surface.
		Groundwater	Inhalation of Volatiles	No	VOCs will disperse and dilute into ambient air.
		Surface Water	Dermal Contact Incidental Ingestion	Yes	Via the discharge of contaminated groundwater, older children may be exposed to contaminated surface water while playing in and around the Spichat River.

TABLE 9
EXPOSURE ASSUMPTIONS FOR THE OXFORD PAPER MILL SITE

Receptor		Adolescent Trespasser		Recreational User				Construction Worker		Utility Worker	
Occurence		Current/Future		Future				Future		Future	
Location		Outdoors		Outdoors				Outdoors		Outdoors	
Exposure		Chronic		Chronic				Subchronic		Subchronic	
Age	yr	Child (11-16)		Child (0-7)		Adult		Adult		Adult	
Body Weight	kg	51.8	(1)	15	(1)	70	(1)	70	(1)	70	(1)
Carcinogenic Averaging Period	yr	75	(1)	75	(1)	75	(1)	75	(1)	75	(1)
Non-Carcinogenic Averaging Period	yr	7	(1)	7	(1)	30	(1)	1	(1)	1	(1)
Soil											
Incidental Ingestion											
Ingestion Rate	mg/day	50	(1)	100	(1)	50	(1)	100	(5)	100	(5)
Exposure Frequency	day/yr	26	(1)	78	(1)	78	(1)	125	(1)	15	(1)
Exposure Duration	yr	7	(1)	7	(1)	30	(1)	1	(1)	1	(1)
Conversion Factor	kg/mg	1.0E-6		1.0E-06		1.0E-06		1.0E-06		1.0E-06	
Dermal Contact											
Skin Surface Area	cm^2	2928	(6d)	2434	(6a)	5657	(6b)	3477	(6c)	3477	(6c)
Soil Adherence Factor	mg/cm^2	0.14	(6)	0.35	(6)	0.13	(6)	0.29	(6)	0.29	(6)
Exposure Frequency	day/yr	26	(1)	78	(1)	78	(1)	125	(1)	15	(1)
Exposure Duration	yr	7	(1)	7	(1)	30	(1)	1	(1)	1	(1)
Conversion Factor	kg/mg	1.0E-6		1.0E-06		1.0E-06		1.0E-06		1.0E-06	
Inhalation of Fugitive Dust											
Respirable Dust - PM_{10}	ug/m^3	32	(1)	32	(1)	32	(1)	60	(1)	60	(1)
Inhalation Rate	m^3/hr	0.8	(1)	0.36	(1)	1.2	(1)	3.6	(1)	3.6	(1)
Exposure Time	hr/day	1	(2)	1.5	(2)	1	(2)	8	(2)	8	(1)
Exposure Frequency	day/yr	26	(1)	78	(1)	78	(1)	125	(1)	15	(1)
Exposure Duration	yr	7	(1)	7	(1)	30	(1)	1	(1)	1	(1)
Conversion Factor	kg/ug	1.0E-09		1.0E-09		1.0E-09		1.0E-09		1.0E-09	
Groundwater and Surface Water											
Incidental Ingestion											
Ingestion Rate	ml/day	50	(1)	50	(1)	50	(1)	50	(1)	50	(1)
Exposure Frequency	day/yr	26	(1)	78	(1)	78	(1)	125	(1)	15	(1)
Exposure Duration	yr	7	(1)	7	(1)	30	(1)	1	(1)	1	(1)
Conversion Factor	L/ml	1.0E-03		1.0E-03		1.0E-03		1.0E-03		1.0E-03	
Conversion Factor	mg/ug	1.0E-03		1.0E-03		1.0E-03		1.0E-03		1.0E-03	
Dermal Contact											
Skin Surface Area	cm^2	2928	(6d)	2434	(6a)	5657	(6b)	3477	(6c)	3477	(6c)
Exposure Time	hr/day	1	(1)	1	(1)	1	(1)	8	(1)	8	(1)
Exposure Frequency	day/yr	26	(1)	78	(1)	78	(1)	125	(1)	15	(1)
Exposure Duration	yr	7	(1)	7	(1)	30	(1)	1	(1)	1	(1)
Conversion Factor	mg/ug	1.0E-03		1.0E-03		1.0E-03		1.0E-03		1.0E-03	
Air											
Inhalation of Indoor or Outdoor Air											
Exposure Time	hr/day	NE		NE		NE		8	(2)	8	(2)
Exposure Frequency	day/yr	NE		NE		NE		125	(1)	15	(1)
Exposure Duration	yr	NE		NE		NE		1	(1)	1	(1)
Conversion Factor	hr/day	NE		NE		NE		24		24	

(1) MADEP, 1995; *Guidance for Disposal Site Risk Characterization.*
(2) USEPA, 1997; *Exposure Factors Handbook.*
(3) MADEP, 1994; *Background Documentation for the Development of the MCP Numerical Standards.*
(4) MADEP, 1997; *Residential Scenario Shortform, December.*
(5) MADEP, 2002; *Calculation of an Enhanced Soil Ingestion Rate - Technical Update.*
(6) MADEP, 2002; *Weighted skin-soil Adherence Factors - Technical Update.*
a Assumes exposure to hands, arms, legs, feet, and face (5<6).
b Assumes exposure to hands, forearms, lower legs, feet, and face.
c Assumes exposure to hands, forearms, face, and feet.
d Assumes exposure to hands, forearms, and feet.
NE Not evaluated

TABLE 10
SUMMARY OF SITE HAZARD INDICES AND EXCESS LIFETIME CANCER RISK ESTIMATES

	CURRENT USE:		FUTURE USE:									
	HI	ELCR	HI	ELCR	HI	ELCR	HI	ELCR	HI	ELCR	HI	ELCR
	ADOLESCENT TRESPASSER		ADOLESCENT TRESPASSER		CHILD RECREATIONAL USER		ADULT RECREATIONAL USER		CONSTRUCTION WORKER		UTILITY WORKER	
SOIL:												
Incidental Ingestion	3E-02	9E-07	2E-02	7E-07	4E-01	[illegible]	5E-02	7E-06	2E-01	7E-07	2E-02	9E-08
Dermal Contact	1E-02	8E-07	1E-02	7E-07	2E-01	1E-05	4E-02	1E-05	9E-02	8E-07	1E-02	1E-07
Inhalation of Fugitive Dust	5E-05	2E-09	4E-05	1E-09	3E-04	9E-09	1E-04	2E-08	6E-03	4E-08	7E-04	5E-09
Total	4E-02	2E-06	3E-02	1E-06	7E-01	[illegible]	9E-02	[illegible]	3E-01	2E-06	3E-02	2E-07
GROUNDWATER:												
Incidental Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	2E-01	5E-08	3E-02	6E-09
Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	7E-02	3E-08	8E-03	4E-09
Total	NA	NA	NA	NA	NA	NA	NA	NA	3E-01	8E-08	3E-02	1E-08
SURFACE WATER:												
Incidental Ingestion	1E-03	5E-09	1E-03	5E-09	1E-02	5E-08	3E-03	5E-08	NA	NA	NA	NA
Dermal Contact	5E-05	3E-10	5E-05	3E-10	4E-04	3E-09	2E-04	6E-09	NA	NA	NA	NA
Total	1E-03	6E-09	1E-03	6E-09	1E-02	6E-08	3E-03	6E-08	NA	NA	NA	NA
INDOOR/OUTDOOR AIR:												
Soil gas	NA	NA	NA	NA	NA	NA	NA	NA	8E-04	NA	1E-04	NA
Total	NA	NA	NA	NA	NA	NA	NA	NA	8E-04	NA	1E-04	NA
SITE TOTAL	4E-03	2E-06	3E-02	1E-06	7E-01	[illegible]	1E-01	[illegible]	5E-01	2E-06	6E-02	2E-07

Total Cancer Risk (Child plus Adult): [illegible]

HI - Hazard Index
ELCR - Excess Lifetime Cancer Risk
NA - Not Applicable

Shaded Hazard Indices and Excess Lifetime Cancer Risks are above the MCP risk limits of 1 for HIs and 1E-05 for ELCRs.

TABLE 11
COMPARISON OF SOIL EXPOSURE POINT CONCENTRATIONS TO UPPER CONCENTRATION LIMITS

COPC	Current Exposure Point Concentration (a) (mg/Kg)	Future Exposure Point Concentration (a) (mg/Kg)	Upper Concentration Limit for Soil (mg/Kg)
Aroclor-1248	0.22	0.32	100
Aroclor-1254	0.52	0.79	100
C9-C18 Aliphatics	8.2	22	20,000
C19-C36 Aliphatics	59	39	20,000
C11-C22 Aromatics	143	122	10,000
2-Methylnaphthalene	0.48	0.50	10,000
Acenaphthene	1.3	1.2	10,000
Acenaphthylene	0.42	0.39	10,000
Anthracene	2.7	2.5	10,000
Benzo(a)anthracene	7.1	6.0	100
Benzo(a)pyrene	5.5	4.6	100
Benzo(b)fluoranthene	8.0	6.7	100
Benzo(g,h,i)perylene	2.7	2.5	10,000
Benzo(k)fluoranthene	3.2	2.7	400
Chrysene	7.5	6.3	400
Dibenz(a,h)anthracene	3.7	3.2	100
Fluoranthene	15	13	10,000
Fluorene	1.2	1.2	10,000
Indeno(1,2,3-cd)pyrene	4.5	3.9	100
Naphthalene	0.63	0.62	10,000
Phenanthrene	10	9.6	10,000
Pyrene	15	12	10,000
Antimony	1.7	1.2	400
Arsenic	37	29	300
Barium	74	74	10,000
Beryllium	0.62	0.65	30
Cadmium	10	8.6	800
Chromium	23	19	10,000
Copper	34	35	NA
Lead	197	135	6,000
Mercury	1.2	1.2	600
Nickel	41	35	7,000
Selenium	0.54	0.39	10,000
Silver	0.14	0.12	2,000
Thallium	0.46	0.45	1,000
Vanadium	140	137	10,000
Zinc	114	122	10,000

NOTES:
Shaded values exceed criteria.
(a) Concentrations taken from Tables 1 and 2.
UCLs obtained from 310CMR 40.0996(7), Table 6, 10/29/99.

TABLE 12
COMPARISON OF GROUNDWATER EXPOSURE POINT CONCENTRATIONS TO UPPER CONCENTRATION LIMITS

COPC	Site-Wide Maximum Groundwater Concentration (a) (ug/L)	Upper Concentration Limit for Groundwater (ug/L)
C9-C18 Aliphatics	44	100,000
C19-C36 Aliphatics	49	100,000
Arsenic	11	4,000
Barium	83	100,000
Beryllium	0.48	500
Chromium	1.1	20,000
Nickel	12	1,000
Selenium	188	800
Vanadium	3710	20,000
Zinc	17	20,000

NOTES:
(a) Concentrations taken from Table 3.
UCLs obtained from 310CMR 40.0996(7), Table 6, October 1999.

TABLE 13
COMPARISON OF AMBIENT WATER QUALITY CRITERIA TO DILUTED GROUNDWATER CONCENTRATIONS

COPC	Site-wide Average Groundwater Concentration (a)	Concentration Diluted 10-fold	Massachusetts AWQC
	ug/L	ug/L	ug/L
C9-C18 Aliphatics	30	3.0	1,800
C19-C36 Aliphatics	41	4.1	2,100
Arsenic	5	0.55	36
Barium	54	5.4	NA
Beryllium	0.30	0.030	5.3
Chromium	0.8	0.085	11
Nickel	5	0.46	8.3
Selenium	44	4.4	5
Vanadium	778	78	NA
Zinc	6	0.63	86

NOTES:

Shaded values exceed criteria.

(a) Concentrations taken from Table 3.

FIGURES FOR ATTACHMENT I

FIGURE 4

MA DEP - Bureau of Waste Site Cleanup

Site Scoring Map: 500 feet & 0.5 Mile Radii

SITE NAME:
Oxford Paper Mill
Canal Street
LAWRENCE, MA
939758n 228732ew

Site Location

The information shown on this map is the best available at the date of printing. Please refer to the data source descriptions document.

MASS GIS
Massachusetts Geographic Information System
Massachusetts Executive Office of Environmental Affairs - 2003

Roads: Limited Access, Divided, Major Road, Connector, Street, Track, Trail

Boundaries: Town, County, DEP Region; Train; Powerline; Pipeline; Aqueduct

Basins: Major, Sub; Streams: Perennial, Intermittent, Man Made Shore, Dams

Potentially Productive Aquifers: Medium, High Yield ....

Non-Potential Drinking Water Source Area: Medium, High Yield

EPA Sole Source Aquifer; FEMA 100-year floodplain ......

Public Water Supplies: Ground, Surface, Non Community

Approved Zone2; IWPA; Surface Water Supply Zone A

Hydrography: Water Features, Public Surface Water Supply ...

Wetlands: Fresh, Salt, NHESP Wetlands Habitat ....

Protected Open Space; ACEC ....

DEP Permitted Solid Waste Facilities; Certified Vernal Pools

SCALE 1:15000

0 1/2 MILES
0 1/2 KILOMETERS

N W E S

May 30, 2003

NRS SCORING MAP DATA SOURCES

AQUIFERS: USGS-WRD/MassGIS, 1:48,000. Automated by MassGIS from the USGS Water Resources Div. Hydrologic Atlas series manuscripts. The definitions of high and medium yield vary among basins. Source dates 1977-1988.

SOLE SOURCE AQUIFERS: US EPA/MA DEP/MassGIS, various scales. They are defined by EPA as aquifers that are the 'sole or principal source' of drinking water for a given aquifer service area. Last updated May 1996.

NON POTENTIAL DRINKING WATER SOURCE AREAS: DEP-BWSC (Bureau of Waste Site Cleanup). Those portions of high and medium yield aquifers, which may not be considered as areas of groundwater conducive to the locations of public water supplies. Please refer to the MCP guidelines for the definitions of these areas.

DEP APPROVED ZONE II's: MA DEP, 1:25,000. As stated in 310 CMR 22.02 'that area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated.' Digitized from data provided to DEP in approved hydrologic engineering reports. Data is updated continuously.

INTERIM WELLHEAD PROTECTION AREAS: DEP-DWS (Division of Water Supply), 1:25,000. These polygons represent an interim Zone II for a groundwater source until an actual one is approved by the DEP Division of Water Supply. The radius of an IWPA varies according to the approved pumping rate. Updated in parallel with the Public Water Supplies data.

PUBLIC WATER SUPPLIES: DEP-DWS, 1:25,000. Community and non-community surface and withdrawal points were field collected using Global Positioning System receivers. The attributes were added from the DEP Division of Water Supply database. Continuously updated.

HYDROGRAPHY: USGS/MassGIS. 1:25,000 USGS Digital Line Graph (DLG) data modified by MassGIS. Approximately 40% of the data was provided by USGS and MassGIS created the remainder to USGS specifications. Source dates 1977-1997.

DRAINAGE BASINS: USGS-WRD/MassGIS, 1:24,000. Automated by MassGIS from USGS Water Resources Division manuscripts with approximately 2400 sub-basins as interpreted from 1:24,000 USGS quadrangle contour lines. 1987-1993.

WETLANDS: Umass Amherst RMP/MassGIS, 1:25,000. Includes nonforested wetlands extracted from the 1971-1991 Land Use datalayer, which was photointerpreted from summer CIR photography. Interpretation was not done in stereo. Also includes, in most areas, forested wetlands from USGS Digital Line Graph (DLG) data.

PROTECTED OPEN SPACE: EOEA (Executive Office of Environmental Affairs) MassGIS, 1:25,000. Includes federal, state, county, municipal, non-profit and protected private conservation and outdoor recreation lands. Ongoing updates.

ACECs: DEM, 1:25,000. Areas of Critical Environmental Concern are areas designated by the Secretary of EOEA as having a number of valuable environmental features coexisting. Projects in ACECs are subject to the highest standards of review and performance. Last updated October 1996.

ROADS: USGS/MassGIS/MHD, 1:100,000. MassGIS extracted roads from the USGS Transportation DLG files. MA Highway Dept. updated roads through 1999. MassGIS and MA DEP GIS group further edited this layer. Numbered routes are part of the state, U.S. or Interstate highway systems.

POLITICAL BOUNDARIES: MassGIS/USGS, 1:25,000. This datalayer was digitized by MassGIS from mylar USGS quads. Source date is approximately 1985.

DEP PERMITTED SOLID WASTE FACILITIES: DEP-DSW (Division of Solid Waste), 1:25,000. Includes only facilities regulated since 1971. Data includes sanitary landfills, transfer stations and recycling or composting facilities. Facility boundaries were compiled or approximate facility point locations drafted onto USGS quadrangles and automated by the DEP Division of Solid Waste. Last updated 1997.

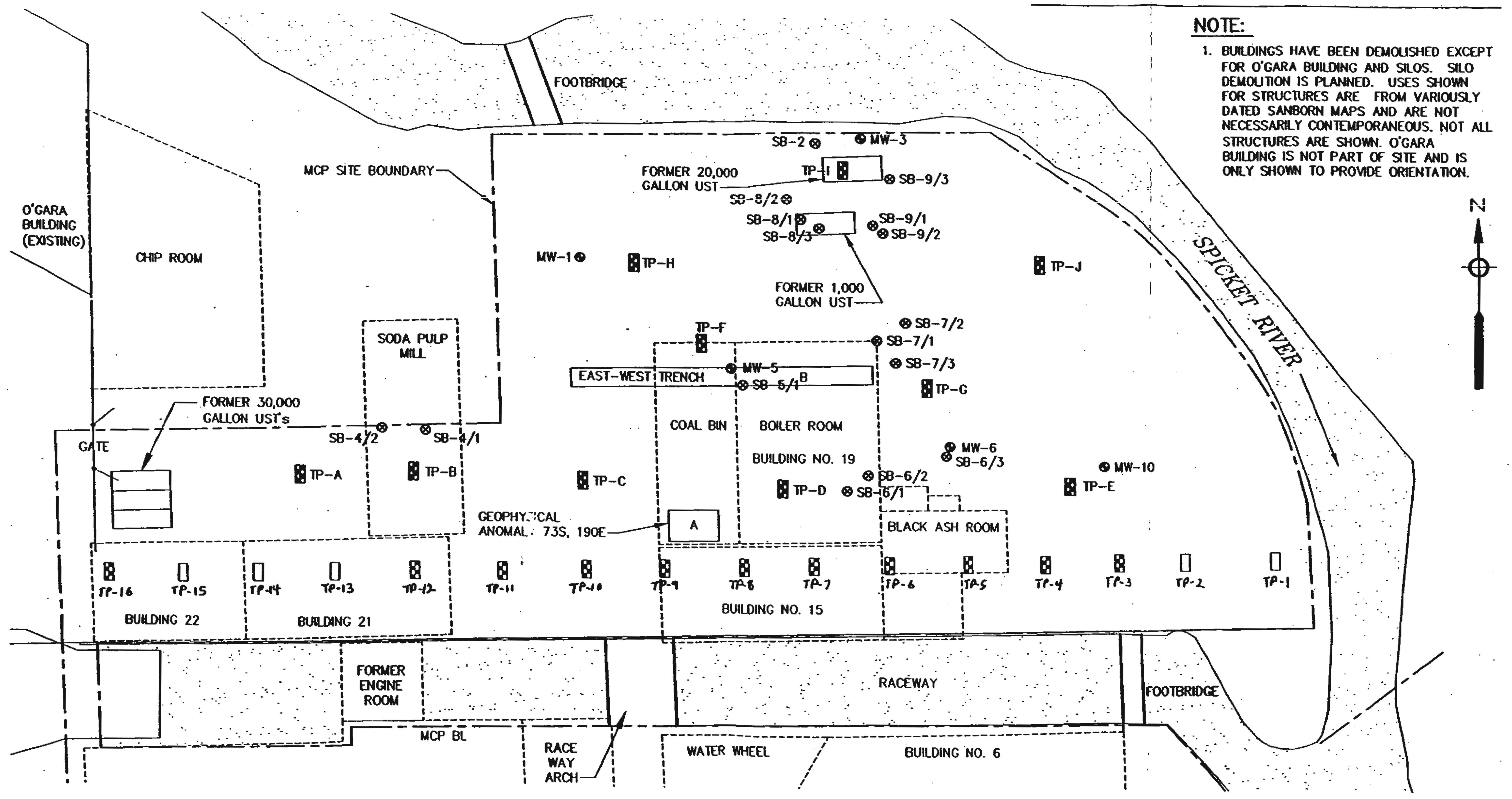
NHESP ESTIMATED HABITATS OF RARE WETLANDS WILDLIFE: Polygons show estimated habitats for all processed occurrences of rare wetlands wildlife. Data collected by Natural Heritage & Endangered Species Program and compiled at 1:24,000 or 1:25,000 scale. For use with Wetlands Protection Act Only. Effective 1999 - 2001.

NHESP CERTIFIED VERNAL POOLS: Points show all vernal pools certified by NHESP/MADFW (Fisheries and Wildlife) as of June 30, 1999. Data compiled at 1:24,000 or 1:25,000 scale. Effective 1999 - 2001.

Last revised: 2000

NOTE:

1. BUILDINGS HAVE BEEN DEMOLISHED EXCEPT FOR O'GARA BUILDING AND SILOS. SILO DEMOLITION IS PLANNED. USES SHOWN FOR STRUCTURES ARE FROM VARIOUSLY DATED SANBORN MAPS AND ARE NOT NECESSARILY CONTEMPORANEOUS. NOT ALL STRUCTURES ARE SHOWN. O'GARA BUILDING IS NOT PART OF SITE AND IS ONLY SHOWN TO PROVIDE ORIENTATION.



LEGEND

— — —	MCP SITE BOUNDARY
- - - - -	HISTORICAL STRUCTURES, DEMOLISHED
———	EXISTING BUILDING
⊗ MW-1	MONITORING WELL LOCATION
⊗ SB-7/1	SOIL BORING LOCATION (/1 FIRST ATTEMPT, /2 SECOND ATTEMPT, /3 THIRD ATTEMPT
▯	WEDGE AREA TEST PITS NOT COMPLETED DUE TO ACM OR SLOPE
▩	WEDGE AREA TEST PITS COMPLETED
▩	NORTH OF WEDGE AREA TEST PITS

0 30 60
1" = 30'
SCALE FEET

M&E Metcalf & Eddy

SHAW ENVIRONMENTAL OXFORD PAPER MILL SITE
SUBSURFACE INVESTIGATION – LAWRENCE, MASSACHUSETTS

FIGURE 1

SITE INVESTIGATION LOCATIONS

SCALE: AS NOTED | 8/27/02 | S.N.

AME 8 – 11-20-01 PLOT DATE: April 21, 2003 @ 12:37:27 pm PATH/FILENAME: P:\00299LAW\C\C2law001.dwg

APPENDIX A TO ATTACHMENT I:

RISK CHARACTERIZATION CALCULATION TABLES

Table A-1. Summary of OEME Fixed Laboratory Analytical Data for Soil
Former Oxford Paper Mill - May 2002

LOCATION NAME	4A	4C	4C	5A	6A	6A	6B	7A	7B	8F
APPROXIMATE SAMPLE DEPTH (ft bgs)	0 - 1	3 - 5	3 - 5	0 - 1	0 - 1	0 - 1	1 - 3	0 - 1	1 - 3	9 - 11
M&E SAMPLE ID	4A	4C	K4C	K5A	6A	K6A	6B	7A	7B	8F
COMMENTS			FD			FD				
PARAMETER/ANALYTE										
PCBs (mg/kg)	NA				NA	NA		NA		
Aroclor-1242		400 U	400 U	1,000 U			900 U		1,100 U	1,000 U
Aroclor-1248		400 U	400 U	1,000 U			900 U		1,100 U	1,000 U
Aroclor-1254		1,500	1,700	1,300			1,200		1,100	2,700
Aroclor-1260		400 U	400 U	1,000 U			900 U		1,100 U	1,000 U
Metals (mg/Kg)		NA	NA				NA		NA	NA
Arsenic	86			94	140	130		93		
Chromium	44			50	66	60		63		
Lead	260			300	330	290		170		

Notes:

FD - Indicates Field Duplicate

ft bgs - feet below ground surface

NA - Not analyzed.

U - Analyte was not detected. Value reported is the sample-specific detection limit.

[redacted]e A-[redacted]mary [redacted]OEME [redacted] Laboratory Analytical Data for Soil
Former Oxford Paper Mill - May 2002

LOCATION NAME	10A	10B	10H	11B	12D	12H	14A	14C	14G	16B
APPROXIMATE SAMPLE DEPTH (ft bgs)	0 - 1	1 - 3		1 - 3	6 - 7	13 - 15	0 - 1	3 - 5	11 - 13	1 - 3
M&E SAMPLE ID	10A	10B		11B	12D	12H	14A	14C	14G	16B
COMMENTS										
PARAMETER/ANALYTE										
PCBs (ug/kg)	NA						NA			
Aroclor-1242		400 U	100 U	900 U	100 U	2,300 U		500 U	200 U	200 U
Aroclor-1248		400 U	100 U	900 U	120	2,300 U		6,000	440	1,200
Aroclor-1254		400	100 U	720	130	16,000		500 U	370	580
Aroclor-1260		400 U	100 U	900 U	100 U	2,300 U		500 U	200 U	200 U
Metals (mg/Kg)		NA	NA	NA	NA	NA		NA	NA	NA
Arsenic	41 U						42 U			
Chromium	15						25			
Lead	16						79			

Notes:
FD - Indicates Field Duplicate
ft bgs - feet below ground surface
NA - Not analyzed.
U - Analyte was not detected. Value reported is the sample-specific detection limit.

Table A-2. Summary of Analytical Data for Soil
Former Oxford Paper Mill - May 2002 and March 2003

LOCATION NAME	4S	4D	6S	6D	8S	8D	10S	10D	K10D	12S	12D	14S
APPROXIMATE SAMPLE DEPTH (ft bgs)	0 - 3	3 - 5	0 - 3	3 - 9	0 - 3	3 - 13	0 - 3	3 - 15		0 - 3	3 - 15	0 - 3
M&E SAMPLE ID	4S	4D	4S	6D	8S	8D	10S	10D	K10D	12S	12D	14S
DATE RECEIVED BY LAB:	5/13/02	5/13/02	5/13/02	5/13/02	5/13/02	5/13/02	5/14/02	5/14/02	5/14/02	5/14/02	5/14/02	5/14/02
COMMENTS									FD			
PARAMETER/ANALYTE												
PCBs (ug/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1016												
Aroclor-1221												
Aroclor-1232												
Aroclor-1242												
Aroclor-1248												
Aroclor-1254												
Aroclor-1260												
EXTRACTABLE PETROLEUM HYDROCARBONS (ug/kg)												
C_9-C_{18} Aliphatics	3,700 U	3,800 U	3,700 U	4,000 U	4,200 U	15,000	3,500 U	3,600 U	3,600 U	3,300 U	3,400 U	3,600 U
C_{19}-C_{36} Aliphatics	5,200	34,000	57,000	82,000	9,000	65,000	43,000	14,000 J	4,800 UJ	4,300 U	11,000	12,000
C_{11}-C_{22} Aromatics	240,000	360,000	460,000	320,000	51,000	250,000	74,000	35,000 J	60,000 J	16,000	90,000	260,000
Acenaphthene	1,600	6,200	6400	5100	700 U	1000	700	590 U	780 J	540 U	1200	4200
Acenaphthylene	620 U	1,300 U	1,200 U	660 U	700 U	660 U	580 U	590 U	600 U	540 U	560 U	590 U
Anthracene	4,100	11,000	14,000	9,200	1,000	4,300	1,300	930 J	1,900 J	540 U	2,400	7,800
Benzo(a)anthracene	16,000	29,000	35,000	21,000	2,900	17,000	2,700	1,900 J	4,300 J	540 U	5,400	16,000
Benzo(a)pyrene	14,000	21,000	24,000	16,000	2,400	13,000	2,600	1,800 J	3,500 J	540 U	4,700	13,000
Benzo(b)fluoranthene	17,000	27,000	35,000	23,000	2,300	22,000	2,700	2,000 J	4,500 J	540 U	5,700	17,000
Benzo(g,h,i)perylene	8,500	14,000	13,000	10,000	1,400	7,400	1,500	1,000 J	2,200	540 U	3,000	7,200
Benzo(k)fluoranthene	9,000	16,000	12,000	8,800	2,300	5,500	2,100	1,300 J	1,500	540 U	2,800	6,500
Chrysene	18,000	28,000	38,000	24,000	3,100	18,000	3,100	2,500 J	4,400 J	660	5,700	16,000
Dibenzo(a,h)anthracene	13,000	21,000	22,000	16,000	2,300	12,000	2,500	1,900 J	3,300 J	690	4,400	11,000
Fluoranthene	30,000	56,000	74,000	44,000	5,600	28,000	6,300	3,700 J	7,900 J	1,000	12,000	33,000
Fluorene	1,600	5,100	6,300	4,500	700 U	840	650	590 U	800 J	540 U	1,200	4,600
Indeno(1,2,3-cd)pyrene	13,000	21,000	22,000	16,000	2,300	12,000	2,500	1,900 J	3,300 J	690	4,400	11,000
Naphthalene	620 UJ	2,400 J	2,000 J	1,300 J	700 UJ	1,300 J	580 UJ	590 UJ	600 UJ	540 UJ	690 J	2,000 J
Phenanthrene	17,000	41,000	58,000	38,000	3,400	20,000	4,400	2,700 J	5,800 J	660	8,000	32,000
Pyrene	30,000	56,000	73,000	44,000	5,500	29,000	6,200	3,600 J	7,500 J	1,000	12,000	33,000
2-Methylnaphthalene	620 U	1,500	1400	980	700 U	790	580 U	590 U	600 U	540 U	560 U	1100
Priority Pollutant Metals Plus Barium and Vanadium (mg/Kg)												
Antimony	0.77 J	1.0 J	1.6 J	3.8 J	0.34 J	0.58 J	0.39 J	0.33 J	0.62 J	0.22 J	0.56 J	0.89 J
Arsenic	43 J	97 J	120 J	84 J	8.4 J	4.4 J	10 J	15 J	7.7 J	9.3 J	13 J	6.6 J
Barium	130	180	150	170	16	300	45	29	39	36	79	140
Beryllium	0.48	0.55	0.62	1.0	0.14	0.52	0.34	0.44	0.59	0.34	0.33	0.28
Cadmium	32	43	46	50	6.8	13	15	18	19	26	21	27
Chromium	2.5	2.3	1.9	1.6	0.16	0.79	0.24	0.13	0.14	0.24	0.52	0.81
Copper	54	85	91	72	12	140	36	32	33	14	30	36
Lead	180	250	230	210	28	140	49	44	52	26	65	53
Mercury	2.0	3.2	5.3	17	0.85	1.6	0.14	0.11	0.11	0.073	0.25	0.23
Nickel	79	86	130	83	26	18	14	16	19	19	25	28
Selenium	0.41 U	0.82	0.76	0.54 U	0.47 U	0.11 UJ	0.22 UJ	0.40 U	0.37 U	0.22 U	0.20 UJ	0.26 U
Silver	0.25	0.18	0.33	0.89	0.11	0.13	0.090	0.071	0.095	0.040	0.079	0.065
Thallium	0.46	0.71	1.3	1.0	0.063	0.11	0.11	0.11	0.13	0.16	0.14	0.097
Vanadium	350	330	520	360	80	27	36	51	83	21	80	20
Zinc	390	560	300	450	35	300	75	65	75	38	100	130

Notes:
FD - Indicates Field Duplicate
ft bgs - feet below ground surface
J - Quantitation is approximate due to limitations identified in the quality control review.
NA - Not analyzed.
R - Value is rejected.
U - Analyte was not detected. Value reported is the sample-specific detection limit.
UJ - Sample-specific detection limit is approximate due to limitations identified in the quality control review.

Table A-2. Summary of Analytical Data for Soil
Former Oxford Paper Mill - May 2002 and March 2003

LOCATION NAME	14D	SB-1/0-1	SB-1/5-7	SB-1/17-19	SB-2/0-1	SB-2/7-9	SB-2/11-13	SB-3/0-1	SB-3/7-9	SB-3/13-15	SB-4/0-1	SB-4/5-7	SB-4/13-15	SB-5/0-1	SB-5/9-11	SB-5/14-16
APPROXIMATE SAMPLE DEPTH (ft bgs)	3 - 13	0-1	5-7	17-19	0-1	7-9	11-13	0-1	7-9	13-15	0-1	5-7	13-15	0-1	9-11	14-16
M&E SAMPLE ID	14D	SB-1/0-1	SB-1/5-7	SB-1/17-19	SB-2/0-1	SB-2/7-9	SB-2/11-13	SB-3/0-1	SB-3/7-9	SB-3/13-15	SB-4/0-1	SB-4/5-7	SB-4/13-15	SB-5/0-1	SB-5/9-11	SB-5/14-16
DATE RECEIVED BY LAB:	5/14/02	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/17/03	3/17/03	3/17/03	3/14/03	3/14/03	3/14/03
COMMENTS																
PARAMETER/ANALYTE																
PCBs (ug/kg)	NA															
Aroclor-1016		38 U	42 U	41 U	44 U	39 U	36 U	41 U	39 U	40 U	44 U	36 U	44 U	42 U	39 U	42 U
Aroclor-1221		38 U	42 U	41 U	44 U	39 U	36 U	41 U	39 U	40 U	44 U	36 U	44 U	42 U	39 U	42 U
Aroclor-1232		38 U	42 U	41 U	44 U	39 U	36 U	41 U	39 U	40 U	44 U	36 U	44 U	42 U	39 U	42 U
Aroclor-1242		38 U	42 U	41 U	44 U	39 U	36 U	41 U	39 U	40 U	44 U	36 U	44 U	42 U	39 U	42 U
Aroclor-1248		38 U	42 U	41 U	44 U	39 U	36 U	41 U	39 U	40 U	44 U	36 U	44 U	42 U	39 U	42 U
Aroclor-1254		1800 J	42 U	41 U	44 UJ	39 UJ	36 U	95	44	40 UJ	71	140	44 U	88	39 U	42 U
Aroclor-1260		38 UJ	42 UJ	41 UJ	44 UJ	39 UJ	36 UJ	41 UJ	39 UJ	40 UJ	44 U	36 U	44 U	42 U	39 U	42 U
EXTRACTABLE PETROLEUM HYDROCARBONS (ug/kg)																
C_9-C_{18} Aliphatics	3,500 U	15000	3500 U	5800	4700	3400 U	18000	4300	3400 U	3400 U	11,000	8,500	13,000 J	9,100	7,800	11,000
C_{19}-C_{36} Aliphatics	35,000	150000	5500	9400	38000	13000	23000	270000	4500 U	14000	66,000	49,000	14,000	10,000	4,700 U	5,000 U
C_{11}-C_{22} Aromatics	97,000	120000	51000	25000	49000	34000	52000	110000	15000	9800 U	110,000	160,000	11,000 U	65,000	32,000	19,000
Acenaphthene	1500	1400 U	590 U	600 U	650 U	570 U	520 U	580 U	560 U	580 U	670 U	1,400	650 U	640 U	590 U	630 U
Acenaphthylene	580 U	1400 U	590 U	600 U	650 U	570 U	520 U	580 U	560 U	580 U	670 U	550 U	650 U	640 U	590 U	630 U
Anthracene	2,900	1400 U	590 U	600 U	650 U	570 U	520 U	580	560 U	580 U	880	3,500	650 U	1,200	590 U	630 U
Benzo(a)anthracene	5,700	2200	820	600 U	1300	1200	710	1300	560 U	580 U	2,000	6,500	650 U	2,400	890	630 U
Benzo(a)pyrene	4,700	1700	590	600 U	1100	940	520 U	950	560 U	580 U	1,500	4,700	650 U	1,800	620	630 U
Benzo(b)fluoranthene	5,300	2700	920	600 U	1800	1500	800	1700	560 U	580 U	2,500	7,700	650 U	3,000	1,000	630 U
Benzo(g,h,i)perylene	2,700	1400 U	590 U	600 U	650 U	570 U	520 U	580 U	560 U	580 U	670 U	2,200	650 U	640 U	590 U	630 U
Benzo(k)fluoranthene	2,900	1400 U	590 U	600 U	820	610	520 U	640	560 U	580 U	960	2,700	650 U	1,200	590 U	630 U
Chrysene	5,700	2300	880	600 U	1400	1300	760	1400	560 U	580 U	1,900	6,300	650 U	2,400	900	630 U
Dibenzo(a,h)anthracene	4,100	1400 U	590 U	600 U	650 U	570 U	520 U	580 U	560 U	580 U	670 U	900	650 U	640 U	590 U	630 U
Fluoranthene	13,000	4900	1800	600 U	2700	2700	1800	2800	740	580 U	4,500	14,000	650 U	6,000	2,000	630 U
Fluorene	1,500	1400 U	590 U	600 U	650 U	570 U	520 U	580 U	560 U	580 U	670 U	1,600	650 U	640 U	590 U	630 U
Indeno(1,2,3-cd)pyrene	4,100	1400 U	590 U	600 U	650 U	570 U	520 U	580 U	560 U	580 U	1,100	3,100	650 U	1,300	590 U	630 U
Naphthalene	800 J	1400 U	590 U	600 U	650 U	570 U	520 U	740	560 U	580 U	670 U	620	650 U	640 U	590 U	630 U
Phenanthrene	9,900	3700	1400	600 U	1500	1600	1000	1800	560 U	580 U	2,800	12,000	650 U	4,800	1,700	630 U
Pyrene	12,000	4500	1700	600 U	2600	2500	1500	2600	630	580 U	4,300	13,000	650 U	5,400	1,900	630 U
2-Methylnaphthalene	580 U	1400 U	590 U	600 U	650 U	570 U	520 U	580 U	560 U	580 U	670 U	550 U	650 U	640 U	590 U	630 U
Priority Pollutant Metals Plus Barium and Vanadium (mg/Kg)																
Antimony	3.0 J	8.8 J	2.1 UJ	0.25 UJ	0.81 UJ	0.72 UJ	0.41 UJ	1.4 UJ	0.36 UJ	0.17 UJ	1.1 UJ	2.3 J	0.21 UJ	R	1.7 J	R
Arsenic	7.5 J	9.3 J	9.5 J	2.3 J	19.6 J	18.9 J	7.0 J	14.8 J	13.2 J	2.5 J	11.1 J	31.8 J	4.4 J	7.0 J	47.4 J	5.7 J
Barium	71	68.4 J	47.8 J	9.8 J	67.2 J	42.8 J	25.8 J	52.1 J	42.7 J	12.9 J	53.3 J	101 J	20.0 J	20.8 J	55.8 J	24.1 J
Beryllium	0.32	0.98	0.83	0.44	0.73	0.75	0.44	0.75	0.58	0.54	1.0	0.84	1.1	0.33 J	0.57	0.66
Cadmium	20	1.2	0.46 U	0.080 UJ	0.40 U	0.31 U	0.16 UJ	0.39 U	0.23 UJ	0.085 UJ	1.0	1.7	0.22	0.15	0.75	0.038 U
Chromium	0.82	25.2	20.4	13.5	16.4	15.2	10.9	15.4	11.2	13.3	40.4 J	27.0 J	20.8 J	8.1 J	25.3 J	18.0 J
Copper	37	37.3 J	49.8 J	4.8 J	30.1 J	32.5 J	21.4 J	45.9 J	12.4 J	2.8 UJ	19.3	40.2	3.9 U	9.0 U	27.1	58.8
Lead	70	1970 J	208 J	3.5 J	87.2 J	163 J	30.0 J	142 J	28.5 J	2.4 J	35.5 J	90.6 J	4.6 J	18.2 J	23.5 J	3.5 J
Mercury	0.59	0.53	0.21	0.018 U	1.1	0.31	0.29	0.92	0.18	0.016 U	R	R	R	0.46	1.1	0.039
Nickel	19	22.7 J	11.8 J	9.4 J	41.1 J	23.9 J	15.2 J	36.2 J	27.3 J	10.3 J	27.4 J	19.8 J	11.8 J	11.9 J	13.1 J	12.4 J
Selenium	0.23 U	0.45 U	0.53 U	0.48 U	0.54 U	0.54 J	0.48 U	0.47 U	0.53 J	0.46 U	0.53 UJ	0.42 UJ	0.48 UJ	1.3	0.50 J	0.49 U
Silver	0.11	0.87 J	0.33 UJ	0.28 UJ	0.12 U	0.10 U	0.11 U	0.11 U	0.12 U	0.16 UJ	0.12 UJ	0.10 UJ	0.14 UJ	0.12 U	0.10 U	0.11 U
Thallium	0.14	1.0 UJ	1.2 UJ	1.1 UJ	1.2 U	1.0 UJ	1.1 U	1.08 UJ	1.2 U	1.0 UJ	0.96	0.78	0.61	0.19 U	0.82	0.16 U
Vanadium	27	30.7 J	14.4 J	7.7 J	148 J	95.2 J	45.0 J	128 J	90.1 J	26.1 J	45.7 J	26.6 J	15.7 J	52.8 J	19.1 J	11.6 J
Zinc	91	79.2 J	115 J	25.2 J	66.7 J	37.1 J	25.4 J	65.5 J	23.8 J	14.5 J	57.9 J	125 J	23.2 J	29.4 J	33.5 J	22.5 J

Notes:

FD - Indicates Field Duplicate

ft bgs - feet below ground surface

J - Quantitation is approximate due to limitations identified in the quality control review.

NA - Not analyzed.

R - Value is rejected.

U - Analyte was not detected. Value reported is the sample-specific detection limit.

UJ - Sample-specific detection limit is approximate due to limitations identified in the quality control review.

Table A-2. Summary of Analytical Data for Soil
Former Oxford Paper Mill - May 2002 and March 2003

LOCATION NAME	SB-6/0-1	SB-6/5-7	SB-6/14-16	KSB-6/14-16	SB-7/0-1	SB-7/7-9	SB-8/0-1	SB-8/7-9	SB-9/0-1	SB-9/5-7	SB-9-13-15	SB-10/0-1	SB-10/9-11	KSB-10/9-11	SB-10-13-15
APPROXIMATE SAMPLE DEPTH (ft bgs)	0-1	5-7	14-16	14-16	0-1	7-9	0-1	7-9	0-1	5-7	13-15	0-1	9-11	9-11	13-15
M&E SAMPLE ID	SB-6/0-1	SB-6/5-7	SB-6/14-16	KSB-6/14-16	SB-7/0-1	SB-7/7-9	SB-8/0-1	SB-8/7-9	SB-9/0-1	SB-9/5-7	SB-9-13-15	SB-10/0-1	SB-10/9-11	KSB-10/9-11	SB-10-13-15
DATE RECEIVED BY LAB:	3/14/03	3/14/03	3/14/03	3/14/03	3/14/03	3/14/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03	3/12/03
COMMENTS														FD	
PARAMETER/ANALYTE															
PCBs (ug/kg)															
Aroclor-1016	42 U	40 U	43 U	44 U	47 U	39 U	40 U	39 U	47 U	38 U	38 U	38 U	36 U	36 U	39 U
Aroclor-1221	42 U	40 U	43 U	44 U	47 U	39 U	40 U	39 U	47 U	38 U	38 U	38 U	36 U	36 U	39 U
Aroclor-1232	42 U	40 U	43 U	44 U	47 U	39 U	40 U	39 U	47 U	38 U	38 U	38 U	36 U	36 U	39 U
Aroclor-1242	42 U	40 U	43 U	44 U	47 U	39 U	40 U	39 U	47 U	38 U	38 U	38 U	36 U	36 U	39 U
Aroclor-1248	42 U	40 U	43 U	44 U	47 U	39 U	40 U	39 U	47 U	38 U	38 U	38 U	36 U	36 U	39 U
Aroclor-1254	210	680	43 U	44 U	47 U	100	40 U	180	170	71	38 U	600	36 U	36 U	39 U
Aroclor-1260	42 U	40 U	43 U	44 U	47 U	39 U	40 UJ	39 UJ	47 UJ	38 UJ	38 UJ	38 UJ	36 UJ	36 UJ	39 UJ
EXTRACTABLE PETROLEUM HYDROCARBONS (ug/kg)															
C_9-C_{18} Aliphatics	9,500 J	7,900 J	11,000 J	12,000 J	16,000	13,000	4500	3300 UJ	26000	5000	6000	20000	460000	380000	150000
C_{19}-C_{36} Aliphatics	180,000 J	46,000 J	7,500 J	6,400 J	12,000	32,000	13000	9700 J	30000	17000	4500 U	54000	76000	60000	32000
C_{11}-C_{22} Aromatics	400,000 J	220,000 J	14,000 J	11,000 UJ	35,000	120,000	45000	96000	66000	58000	9600 U	190000	280000	280000	140000
Acenaphthene	2,900 J	4,100 J	660 UJ	640 UJ	710 U	1,000	580 U	1900	660 U	640	570 U	1400 U	530 UJ	1200 J	560 U
Acenaphthylene	640 UJ	590 UJ	660 UJ	640 UJ	710 U	600 U	580 U	560 U	950	560 U	570 U	1400 U	530 UJ	1900 J	970
Anthracene	6,900 J	8,100 J	660 UJ	640 UJ	710 U	2,400	580 U	2900	1800	1200	570 U	2200	530 U	540 U	560 U
Benzo(a)anthracene	21,000 J	14,000 J	660 UJ	640 UJ	710 U	5,900	1400	5000	1200	2600	570 U	7700	910	540 U	560 U
Benzo(a)pyrene	16,000 J	9,200 J	660 UJ	640 UJ	710 U	4,200	1100	3300	660 U	1900	570 U	6100	800	540 U	560 U
Benzo(b)fluoranthene	27,000 J	16,000 J	660 UJ	640 UJ	900	6,800	1900	5400	1900	3000	570 U	10000	1200 J	540 UJ	560 U
Benzo(g,h,i)perylene	8,000 J	4,400 J	660 UJ	640 UJ	710 U	2,200	580 U	1600	660 U	560 U	570 U	1400 U	530 U	540 U	560 U
Benzo(k)fluoranthene	8,900 J	5,400 J	660 UJ	640 UJ	710 U	2,500	690	2000	790	1200	570 U	3700	530 U	540 U	560 U
Chrysene	20,000 J	15,000 J	660 UJ	640 UJ	720	5,700	1600	4900	1800	2600	570 U	7800	1000	540 U	560 U
Dibenzo(a,h)anthracene	3,300 J	1,800 J	660 UJ	640 UJ	710 U	880	580 U	610	660 U	560 U	570 U	1400 U	530 U	540 U	560 U
Fluoranthene	44,000 J	39,000 J	660 UJ	640 UJ	1,500	13,000	3100	13000	4200	6000	570 U	15000	2200 J	540 UJ	560 U
Fluorene	2,400 J	3,900 J	660 UJ	640 UJ	710 U	990	580 U	1700	660 U	570	570 U	1400 U	2100	2100	1000
Indeno(1,2,3-cd)pyrene	11,000 J	6,600 J	660 UJ	640 UJ	710 U	3,000	580 U	2100	660 U	1200	570 U	5000	530 U	540 U	560 U
Naphthalene	800 J	920 J	660 UJ	640 UJ	710 U	600 U	580 U	1100	660 U	560 U	570 U	1400 U	620	850	560 U
Phenanthrene	23,000 J	38,000 J	660 UJ	640 UJ	960	8,300	2000	12000	3800	4400	570 U	8100	2500	1500	750
Pyrene	42,000 J	35,000 J	660 UJ	640 UJ	1,300	12,000	2900	12000	3900	5600	570 U	15000	1900 J	540 UJ	560 U
2-Methylnaphthalene	640 UJ	720 J	660 UJ	640 UJ	710 U	600 U	580 U	560 U	660 U	560 U	570 U	1400 U	960	1100	2000
Priority Pollutant Metals Plus Barium and Vanadium (mg/Kg)															
Antimony	7.0 J	1.1 UJ	0.39 UJ	R	R	1.0 UJ	0.73 UJ	R	0.64 UJ	0.59 UJ	0.31 UJ	1.7 UJ	R	R	0.73 UJ
Arsenic	49.1 J	30.9 J	4.1 J	3.7 J	21.0 J	24.1 J	16.6 J	12.1 J	9.4 J	21.0 J	8.2 J	19.4 J	3.8 J	4.4 J	4.1 J
Barium	143 J	113 J	14.4 J	12.8 J	57.5 J	103 J	63.4 J	64.5 J	26.8 J	93.6 J	24.2 J	111 J	34.4 J	44.0 J	34.8 J
Beryllium	0.91	0.77	0.55	0.55	0.93	0.72	0.74	1.0	0.41	0.61	0.71	1.0	0.77	1.0	0.64
Cadmium	2.0	2.4	0.060 J	0.051 J	0.31	0.96	0.51 U	0.62 U	0.21 UJ	0.56 U	0.15 UJ	4.2	0.20 UJ	0.25 U	0.12 UJ
Chromium	62.9 J	36.0 J	16.1 J	16.4 J	12.5 J	31.2 J	13.4	31.5	5.8	17.3	17.8	38.6	26.2	31.3	17.6
Copper	70.3	33.8	4.1 U	4.0 U	16.2 U	64.1	34.8 J	36.7 J	8.7 J	27.5 J	6.5 J	43.3 J	16.1 J	19.7 J	7.5 J
Lead	140 J	84.4 J	4.6 J	3.8 J	24.4 J	103 J	93.1 J	91.9 J	13.2 J	91.6 J	10.1 J	120 J	15.0 J	20.4 J	4.8 J
Mercury	1.3	0.51	0.019 U	0.018 U	0.23	0.70	0.83	0.95	0.28	1.4	0.10 U	3.3	0.048 U	0.048 U	0.030 UJ
Nickel	100 J	51.1 J	11.4 J	10.6 J	32.5 J	90.3 J	36.2 J	65.1 J	11.8 J	65.0 J	13.4 J	41.1 J	17.7 J	21.8 J	11.0 J
Selenium	0.55 U	0.49 U	0.51 U	0.55 U	1.8	0.47 U	0.96 J	0.50 U	1.6 J	0.44 U	0.43 U	0.44 U	0.41 U	0.42 U	0.46 U
Silver	0.12 U	0.11 U	0.11 U	0.12 U	0.13 U	0.10 U	0.10 U	0.11 U	0.13 U	0.098 U	0.096 U	0.097 U	0.092 U	0.094 U	0.10 U
Thallium	0.18 U	0.29 J	0.17 U	0.18 U	0.71	0.16 U	1.0 U	1.1 UJ	1.3 U	1.0 U	0.98 U	1.0 UJ	0.94 UJ	0.96 UJ	1.1 U
Vanadium	376 J	264 J	174 J	157 J	166 J	598 J	159 J	247 J	54.4 J	505 J	52.2 J	54.0 J	19.8 J	23.9 J	12.3 J
Zinc	274 J	134 J	21.1 J	17.9 J	32.6 J	252 J	72.3 J	429 J	24.1 J	59.9 J	17.8 J	161 J	24.2 J	30.5 J	15.6 J

Notes:
FD - Indicates Field Duplicate
ft bgs - feet below ground surface
J - Quantitation is approximate due to limitations identified in the quality control review.
NA - Not analyzed.
R - Value is rejected.
U - Analyte was not detected. Value reported is the sample-specific detection limit.
UJ - Sample-specific detection limit is approximate due to limitations identified in the quality control review.

Table A-3. Summary Of Analytical Data For Groundwater
Former Oxford Paper Mill – March 2003

LOCATION NAME	MW-1	MW-3	MW-5	KMW-5	MW-6	MW-10
M&E SAMPLE ID	MW-1	MW-3	MW-5	KMW-5	MW-6	MW-10
DATE RECEIVED BY LAB:	3/27/03	3/27/03	3/27/03	3/27/03	3/27/03	3/27/03
DEPTH TO WATER FROM GROUND SURFACE:	16.5'	14.3'	14.8'	14.8'	15'	6.5'
COMMENTS				FD		
PARAMETER/ANALYTE						
PCBs - EPA SW-846 Method 8082 (ug/L)						
Aroclor-1016	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Aroclor-1221	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Aroclor-1232	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Aroclor-1242	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Aroclor-1248	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Aroclor-1254	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Aroclor-1260	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
VOLATILE PETROLEUM HYDROCARBONS - MADEP-VPH-98-1 (ug/L)						
C_5-C_8 Aliphatics	100 U	100 U	100 U	100 U	100 U	100 U
C_9-C_{12} Aliphatics	20 U	20 U	20 U	20 U	20 U	20 U
C_9-C_{10} Aromatics	40 U	45 U	30 U	34 U	46 U	46 U
MTBE	15 U	15 U	15 U	15 U	15 U	15 U
Benzene	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	15 U	15 U	15 U	15 U	15 U	15 U
Ethylbenzene	5 U	5 U	5 U	5 U	5 U	5 U
m- and p-Xylenes	20 U	20 U	20 U	20 U	20 U	20 U
o-Xylene	10 U	10 U	10 U	10 U	10 U	10 U
Naphthalene	10 U	10 U	10 U	10 U	10 U	10 U
EXTRACTABLE PETROLEUM HYDROCARBONS - MADEP-EPH-98-1 (ug/L)						
C_9-C_{18} Aliphatics	30 UJ	35	30 U	30 U	40 J	44
C_{19}-C_{36} Aliphatics	45	44	40 U	40 U	49 J	45
C_{11}-C_{22} Aromatics	85 U	85 U	85 U	85 U	85 U	85 U
Acenaphthene	5 U	5 U	5 U	5 U	5 U	5 U
Acenaphthylene	5 U	5 U	5 U	5 U	5 U	5 U
Anthracene	5 U	5 U	5 U	5 U	5 U	5 U
Benzo(a)anthracene	5 U	5 U	5 U	5 U	5 U	5 U
Benzo(a)pyrene	5 U	5 U	5 U	5 U	5 U	5 U
Benzo(b)fluoranthene	5 U	5 U	5 U	5 U	5 U	5 U
Benzo(g,h,i)perylene	5 U	5 U	5 U	5 U	5 U	5 U
Benzo(k)fluoranthene	5 U	5 U	5 U	5 U	5 U	5 U
Chrysene	5 U	5 U	5 U	5 U	5 U	5 U
Dibenzo(a,h)anthracene	5 U	5 U	5 U	5 U	5 U	5 U
Fluoranthene	5 U	5 U	5 U	5 U	5 U	5 U
Fluorene	5 U	5 U	5 U	5 U	5 U	5 U
Indeno(1,2,3-cd)pyrene	5 U	5 U	5 U	5 U	5 U	5 U
Naphthalene	5 U	5 U	5 U	5 U	5 U	5 U
Phenanthrene	5 U	5 U	5 U	5 U	5 U	5 U
Pyrene	5 U	5 U	5 U	5 U	5 U	5 U
2-Methylnaphthalene	5 U	5 U	5 U	5 U	5 U	5 U
Priority Pollutant Metals Plus Barium and Vanadium (ug/L)						
Antimony	3.4 UJ	6.7 UJ	6.8 UJ	4.3 UJ	7.1 UJ	4.7 UJ
Arsenic	3.0 U	4.2 J	7.9 J	4.8 J	11.0 J	4.4 J
Barium	76.8 J	83.4 J	34.2 J	81.6	44.0 J	14.7 UJ
Beryllium	0.50 U	0.50 U	0.50 U	0.71 J	0.50 U	0.50 U
Cadmium	0.70 U	0.70 U	0.70 U	0.70 U	0.70 U	0.70 U
Chromium	1.1 J	1.0 J	1.0 J	0.97 J	0.60 U	0.85 J
Copper	4.0 U	4.0 U	11.1 UJ	4.5 UJ	4.0 U	4.0 U
Lead	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U
Mercury	0.12 U	0.14 U	0.13 U	0.13 U	0.12 U	0.14 U
Nickel	1.1 J	4.0 J	2.6 J	20.3 J	5.6 J	0.94 J
Selenium	9.0 U	188	9.0 U	16.0 J	12.1 J	9.0 U
Silver	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Thallium	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
Vanadium	1.2 J	158	0.70 U	11.1 J	3710	15.0 J
Zinc	7.0 U	7.0 U	18.9 J	15.9 J	7.0 U	7.0 U

Notes:
FD - Indicates Field Duplicate
J - Quantitation is approximate due to limitations identified in the quality control review.
U - Analyte was not detected. Value reported is the sample-specific detection limit.
UJ - Sample-specific detection limit is approximate due to limitations identified in the quality control review.

TABLE A-4
SOIL TO OUTDOOR AIR
FUTURE CONSTRUCTION/UTILITY WORKER

	Soil EPC	Soil Temp.	Soil Temp.	Henry's Law Constant at ref. temp.	Henry's Law Reference Temp.	Normal Boiling Point	Enthalpy of vaporization at T_B	Critical Temp.	constant	Enthalpy of vaporization at T_S	Gas Constant	Henry's Law Constant at T_S	Gas Constant	Henry's Law Constant
	C_R	T_S	T_S	H_R	T_R	T_B	$\Delta H_{v,b}$	T_C	n	$\Delta H_{v,TS}$	R_c	H_{TS}	R	H'_{TS}
Units:	µg/kg	°C	K	atm-m^3/mol	K	K	cal/mol	K	unitless	cal/mol	cal/mol-K	atm-m^3/mol	m^3-atm/mol-K	unitless
Formula:	Input	(10 for screening)	(T_S + 273.15)	lookup	(lookup+273.15)	lookup	lookup	lookup	(Note 7)	(Note 8)		(Note 9)		H_{TS} / (R * T_S)
Analyte														
C9-C18 Aliphatics	2.24E+04	1.00E+01	2.83E+02	1.65E+00	2.98E+02	NA	NA	NA	NA	NA	1.99E+00	1.65E+00	8.21E-05	7.10E+01
C11-C22 Aromatics	1.22E+05	1.00E+01	2.83E+02	7.17E-04	2.98E+02	NA	NA	NA	NA	NA	1.99E+00	7.17E-04	8.21E-05	3.09E-02
2-Methylnaphthalene	5.04E+02	1.00E+01	2.83E+02	2.90E-04	2.98E+02	NA	NA	NA	NA	NA	1.99E+00	2.90E-04	8.21E-05	1.25E-02
Naphthalene	6.18E+02	1.00E+01	2.83E+02	4.83E-04	2.98E+02	4.91E+02	1.04E+04	7.48E+02	3.70E-01	1.29E+04	1.99E+00	1.52E-04	8.21E-05	6.55E-03

TABLE A-4 (continued)
SOIL TO OUTDOOR AIR
FUTURE CONSTRUCTION/UTILITY WORKER

	Conversion Factor µg/kg to g/g Conv01	SCS soil type in vadose zone ST_v	Vadose zone soil dry bulk density ρ_b	Vadose zone soil water-filled porosity θ_{wv}	Organic carbon partition coefficient K_{oc}	Vadose zone organic carbon fraction $f_{oc,v}$	Soil-water partition coefficient K_d	Vadose zone soil total porosity n_v	Vadose zone soil air-filled porosity θ_{av}	Conversion Factor g/cm³ to µg/m³ Conv03	Source Vapor Conc. C_{source}
Units:	µg/kg / g/g	unitless	g/cm³	cm³/cm³	cm³/g	unitless	cm³/g	cm³/cm³	cm³/cm³	g/cm³ / µg/m³	µg/m³
Formula:		(Note 11)	(1.5 for screening)	(0.3 for screening)	lookup	(0.002 for screening)	$K_{oc} * f_{oc}$	(0.43 for screening)	$n_v - \theta_{wv}$		(Note 21)
					not used	not used	not used				
Analyte											
C9-C18 Aliphatics	1.00E-09	SCL	1.50E+00	3.00E-01	6.80E+05	2.00E-03	1.36E+03	4.30E-01	1.30E-01	1.00E+12	1.17E+06
C11-C22 Aromatics	1.00E-09	SCL	1.50E+00	3.00E-01	5.00E+03	2.00E-03	1.00E+01	4.30E-01	1.30E-01	1.00E+12	3.69E+05
2-Methylnaphthalene	1.00E-09	SCL	1.50E+00	3.00E-01	7.20E+02	2.00E-03	1.44E+00	4.30E-01	1.30E-01	1.00E+12	3.83E+03
Naphthalene	1.00E-09	SCL	1.50E+00	3.00E-01	2.00E+03	2.00E-03	4.00E+00	4.30E-01	1.30E-01	1.00E+12	9.63E+02

TABLE A-4 (continued)
SOIL TO OUTDOOR AIR
FUTURE CONSTRUCTION/UTILITY WORKER

	Depth below grade to bottom of trench	Depth below grade to contamination	Source Trench Separation	Diffusivity in air	Diffusivity in water	Vadose zone Effective Diffusion Coeff.	Total Overall Effective Diffusion Coeff.	Area of Trench Below Grade	Trench Ventilation Rate	Pressure Diff. between soil & enclosed space	Vadose zone soil saturated hydraulic conductivity	Conversion Factor hr to s
	L_F	L_t	L_T	D_a	D_w	D_v^{eff}	D_T^{eff}	A_B	Q_{trench}	ΔP	$K_{s,v}$	Conv02
Units:	cm	cm	cm	cm^2/s	cm^2/s	cm^2/s	cm^2/s	cm^2	cm^3/s	$g/cm\text{-}s^2$	cm/hr	s/hr
Formula:	(120 (4') for screening)	(400 for screening)	$L_t - L_F$	lookup	lookup	(Note 13)	(Note 4)	(Note 2)	(Note 22)	(40 for screening)	lookup	
Analyte												
C9-C18 Aliphatics	1.20E+02	4.00E+02	2.80E+02	7.00E-02	5.00E-06	4.24E-04	4.24E-04	3.29E+05	1.70E+05	4.00E+01	5.50E-01	3.60E+03
C11-C22 Aromatics	1.20E+02	4.00E+02	2.80E+02	6.00E-02	1.00E-05	3.95E-04	3.95E-04	3.29E+05	1.70E+05	4.00E+01	5.50E-01	3.60E+03
2-Methylnaphthalene	1.20E+02	4.00E+02	2.80E+02	4.80E-02	7.80E-06	3.52E-04	3.52E-04	3.29E+05	1.70E+05	4.00E+01	5.50E-01	3.60E+03
Naphthalene	1.20E+02	4.00E+02	2.80E+02	5.90E-02	7.50E-06	4.70E-04	4.70E-04	3.29E+05	1.70E+05	4.00E+01	5.50E-01	3.60E+03

TABLE A-4 (continued)
SOIL TO OUTDOOR AIR
FUTURE CONSTRUCTION/UTILITY WORKER

	Viscosity of water at 10°C	Viscosity of water at system temp.	Density of water	Acceleration due to gravity	Vadose zone soil intrinsic permeability	Vadose zone residual soil water content	Vadose zone effective total fluid saturation	Vadose zone van Genuchten shape parameter	Vadose zone soil relative air permeability	Vadose zone soil effective vapor permeability	Thickness of soil between soilgas & trench
	$\mu_{w\text{-}10}$	μ_w	ρ_w	g	$k_{i,v}$	$\theta_{r,v}$	S_{te}	M_v	k_{rg}	k_v	L_{soil}
Units:	g/cm-s	g/cm-s	g/cm^3	cm/s^2	cm^2	cm^3/cm^3	unitless	unitless	unitless	cm^2	cm
Formula:		(Note 16)	(0.999 for screening)		(Note 17)	lookup	(Note 18)	lookup	(Note 19)	(Note 20)	(1 for screening)
Analyte											
C9-C18 Aliphatics	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	6.46E-01	2.48E-01	5.42E-01	1.10E-09	1.00E+00
C11-C22 Aromatics	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	6.46E-01	2.48E-01	5.42E-01	1.10E-09	1.00E+00
2-Methylnaphthalene	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	6.46E-01	2.48E-01	5.42E-01	1.10E-09	1.00E+00
Naphthalene	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	6.46E-01	2.48E-01	5.42E-01	1.10E-09	1.00E+00

TABLE A-4 (continued)
SOIL TO OUTDOOR AIR
FUTURE CONSTRUCTION/UTILITY WORKER

	Vapor viscosity at avg. soil temp.	Avg. Vapor Flow Rate Into trench	Infinite Source Attenuation Coeff.	Infinite Source Trench Conc.
	μ_{Ts}	Q_{soil}	α	C_{trench}
Units:	g/cm-s	cm^3/s	unitless	$\mu g/m^3$
Formula:	0.00018*(T_s/298.15)^0.5	(Note 5)	(Note 6)	C_{source} * α
Analyte				
C9-C18 Aliphatics	1.75E-04	2.52E-04	1.48E-09	1.73E-03
C11-C22 Aromatics	1.75E-04	2.52E-04	1.48E-09	5.[illegible]7E-04
2-Methylnaphthalene	1.75E-04	2.52E-04	1.48E-09	5.68E-06
Naphthalene	1.75E-04	2.52E-04	1.48E-09	1.43E-06

TABLE A-4 (continued)
SOIL TO OUTDOOR AIR
FUTURE CONSTRUCTION/UTILITY WORKER

Notes:

Reference: *User's Guide for the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion Into Buildings*, USEPA, September 1997.

(1) Assumed equivalent to D_i^{eff} of soil layer i in contact with the floor

(2) For screening, assume a trench 4 ft deep, 3 ft wide, and 30 ft long.

(3) Depth to water table minus depth to bottom of floor must be > thickness of capillary fringe, which is based on the soil type (typ. around 30 cm). Use 400 cm for screening purposes.

(4) $D_T^{eff} = L_T / (L_T / D_v^{eff})$

(5) $Q_{soil} = (2*\pi*\Delta P*k_v*X_{crack}) / (\mu_{TS}*\ln(2*Z_{crack}/r_{crack}))$

(6) $\alpha = [(D_T^{eff}*A_B/(Q_{building}*L_T))*EXP(Q_{soil}*L_{crack}/(D^{crack}*A_{crack}))]/[EXP(Q_{soil}*L_{crack}/(D^{crack}*A_{crack}))+(D_T^{eff}*A_B/(Q_{building}*L_T))+(D_T^{eff}*A_B/(Q_{soil}*L_T))*(EXP(Q_{soil}*L_{crack}/(D^{crack}*A_{crack}))-1)]$

(7) A function of the ratio T_B/T_C:

T_B/T_C	n
<0.57	0.30
0.57-0.71	$0.74(T_B/T_C)$-0.116
>0.71	0.41

(8) $\Delta H_{v,TS} = \Delta H_{v,b}*[(1-T_S/T_C)/(1-T_B/T_C)]^n$

(9) $H_{TS} = EXP[-\Delta H_{v,TS}/R_c*(1/T_S-1/T_R)]*H_R$

(10) Refer to 12 SCS soil types - use SC for screening.

(11) Refer to 12 SCS soil types - use SCL for screening.

(12) $L_{cz} = 0.15 / (0.2 * D_{cz})$

(13) $D_v^{eff} = D_a*(\theta_{a,v}^{3.33}/n_v^2)+(D_w/H'_{TS})(\theta_{w,v}^{3.33}/n_v^2)$

(14) $D_{cz}^{eff} = D_a*(\theta_{a,cz}^{3.33}/n_{cz}^2)+(D_w/H'_{TS})(\theta_{w,cz}^{3.33}/n_{cz}^2)$

(15) $\theta_{w,cz} = \theta_{r,cz}+((\theta_{s,cz}-\theta_{r,cz})/(2^{1/M_{cz}}))$, where the value 2 in the formula is used for screening, but may be refined based on soil parameters (see USEPA, 1999).

(16) $\mu_v = \mu_{v,10} * (T_s / 283.15)^{0.5}$

(17) $k_{i,v} = K_{s,v} * 1/Conv02 * \mu_w / (\rho_w * g)$

(18) $S_{te} = (\theta_{w,v} - \theta_{r,v}) / (n_v - \theta_{r,v})$

(19) $k_{rg} = (1 - S_{te})^{0.5} * (1-S_{te}^{1/M_v})^{2M_v}$

(20) $k_v = k_{i,v} * k_{rg}$; note that the model is very sensitive to this parameter and if site-specific values are available, they should be used.

(21) $C_{source} = H'_{TS} * C_R * Conv01 * \rho_b / (\theta_{w,v} + K_d * \rho_b + H'_{TS} * \theta_{a,v}) * Conv02$

(22) For screening, assume a trench 4 ft deep, 3 ft wide, 30 ft long and an air exchange rate of 60/hr. The air exchange rate is based on the assumption that the wind speed in the trench is a small fraction of the ground wind speed and that it could take up to 1 minute for a contaminant to be cleared from the trench air space.

TABLE A-5
GROUNDWATER TO OUTDOOR AIR
FUTURE CONSTRUCTION/UTILITY WORKER

	GW EPC	GW Temp.	GW Temp.	Henry's Law Constant at ref. temp.	Henry's Law Reference Temp.	Normal Boiling Point	Enthalpy of vaporization at T_B	Critical Temp.	constant	Enthalpy of vaporization at T_S	Gas Constant	Henry's Law Constant at T_S	Gas Constant	Henry's Law Constant
	C_w	T_S	T_S	H_R	T_R	T_B	$\Delta H_{v,b}$	T_C	n	$\Delta H_{v,TS}$	R_c	H_{TS}	R	H'_{TS}
Units:	µg/L	°C	K	atm-m³/mol	K	K	cal/mol	K	unitless	cal/mol	cal/mol-K	atm-m³/mol	m³-atm/mol-K	unitless
Formula:	Input	(10 for screening)	$(T_S + 273.15)$	lookup	(lookup+273.15)	lookup	lookup	lookup	(Note 7)	(Note 8)		(Note 9)		$H_{TS} / (R * T_S)$
Analyte														
C9-C18 Aliphatics	4.4E+01	1.00E+01	2.83E+02	1.65E+00	2.98E+02	NA	NA	NA	NA	NA	1.99E+00	1.65E+00	8.21E-05	7.10E+01

Notes:

Reference: *User's Guide for the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings*, USEPA, September 1997.

(1) Assumed equivalent to D_i^{eff} of soil layer i in contact with the floor

(2) For screening, assume a trench 4 ft deep, 3 ft wide, and 30 ft long.

(3) Depth to water table minus depth to bottom of floor must be > thickness of capillary fringe, which is based on the soil type (typ. around 30 cm). Use 400 cm for screening purposes.

(4) $D_T^{eff} = L_T / (((L_{WT} - L_{cz} - L_T) / D_v^{eff}) + (L_{cz} / D_{cz}^{eff}))$

(5) $Q_{soil} = \Delta P * k_v * L_{crack}) / \mu_{TS}$; not from above reference

(6) $\alpha = \{D_T^{eff} * A_B / (Q_{trench} * L_T)\} / [(D_T^{eff} * A_B / (Q_{soil} * L_T)) + 1]$; assumes no resistance (Peclet number is infinite)

(7) A function of the ratio T_B/T_C:

T_B/T_C	n
<0.57	0.30
0.57-0.71	$0.74(T_B/T_C)-0.116$
>0.71	0.41

(8) $\Delta H_{v,TS} = \Delta H_{v,b} * [(1 - T_S/T_C)/(1 - T_B/T_C)]^n$

(9) $H_{TS} = EXP[-\Delta H_{v,TS}/R_c * (1/T_S - 1/T_R)] * H_R$

(10) Refer to 12 SCS soil types - use SC for screening.

(11) Refer to 12 SCS soil types - use SCL for screening.

(12) $L_{cz} = 0.15 / (0.2 * D_{cz})$

(13) $D_v^{eff} = D_a * (\theta_{a,v}^{3.33}/n_v^2) + (D_w/H'_{TS})(\theta_{w,v}^{3.33}/n_v^2)$

(14) $D_{cz}^{eff} = D_a * (\theta_{a,cz}^{3.33}/n_{cz}^2) + (D_w/H'_{TS})(\theta_{w,cz}^{3.33}/n_{cz}^2)$

(15) $\theta_{w,cz} = \theta_{r,cz} + ((\theta_{s,cz} - \theta_{r,cz})/(2^{1/M_{cz}}))$, where the value 2 in the formula is used for screening, but may be refined based on soil parameters (see USEPA, 1999).

(16) $\mu_w = \mu_{w,10} * (T_S / 283.15)^{0.5}$

(17) $k_{i,v} = K_{s,v} * 1/Conv02 * \mu_w / (\rho_w * g)$

(18) $S_{te} = (\theta_{w,v} - \theta_{r,v}) / (n_v - \theta_{r,v})$

(19) $k_{rg} = (1 - S_{te})^{0.5} * (1 - S_{te}^{1/M_v})^{2M_v}$

(20) $k_v = k_{i,v} * k_{rg}$; note that the model is very sensitive to this parameter and if site-specific values are available, they should be used.

(21) For screening, assume a trench 4 ft deep, 3 ft wide, 30 ft long and an air exchange rate of 60/hr. The air exchange rate is based on the assumption that the wind speed in the trench is a small fraction of the ground wind speed and that it could take up to 1 minute for a contaminant to be cleared from the trench air space.

TABLE A-5 (continued)
GROUNDWATER TO OUTDOOR AIR
FUTURE CONSTRUCTION/UTILITY WORKER

	Conversion Factor m^3 to L	Source Vapor Conc.	Depth below grade to bottom of trench	Depth below grade to water table	Source Trench Separation	SCS soil type directly above water table	SCS soil type in vadose zone	Capillary zone mean particle diameter	Thickness of capillary zone	Diffusivity in air	Diffusivity in water	Vadose zone soil total porosity
	Conv01	C_{source}	L_F	L_{WT}	L_T	ST_{WT}	ST_v	D_{cz}	L_{cz}	D_a	D_w	n_v
Units:	L/m^3	$\mu g/m^3$	cm	cm	cm	unitless	unitless	cm	cm	cm^2/s	cm^2/s	cm^3/cm^3
Formula:		C_w*H'_{TS}*Conv01	(120 (4') for screening)	(Note 3)	$L_{WT} - L_F$	(Note 10)	(Note 11)	lookup	(Note 12)	lookup	lookup	(0.43 for screening)
Analyte C9-C18 Aliphatics	1.00E+03	3.12E+06	1.20E+02	4.00E+02	2.80E+02	SC	SCL	2.50E-02	3.00E+01	7.00E-02	5.00E-06	4.30E-01

TABLE A-5 (continued)
GROUNDWATER TO OUTDOOR AIR
FUTURE CONSTRUCTION/UTILITY WORKER

	Vadose zone soil water-filled porosity	Vadose zone soil air-filled porosity	Vadose zone Effective Diffusion Coeff.	Capillary zone soil total porosity	Capillary zone residual soil water content	Capillary zone saturated soil water content	Capillary zone van Genuchten shape parameter	Capillary zone soil water-filled porosity	Capillary zone soil air-filled porosity	Capillary zone Effective Diffusion Coeff.	Total Overall Effective Diffusion Coeff.
	θ_{wv}	θ_{av}	D_v^{eff}	n_{cz}	$\theta_{r,cz}$	$\theta_{s,cz}$	M_{cz}	$\theta_{w,cz}$	$\theta_{a,cz}$	D_{cz}^{eff}	D_T^{eff}
Units:	cm^3/cm^3	cm^3/cm^3	cm^2/s	cm^3/cm^3	cm^3/cm^3	cm^3/cm^3	unitless	cm^3/cm^3	cm^3/cm^3	cm^2/s	cm^2/s
Formula:	(0.3 for screening)	$n_v - \theta_{wv}$	(Note 13)	(0.43 for screening)	lookup	lookup	lookup	(Note 15)	$n_{cz} - \theta_{w,cz}$	(Note 14)	(Note 4)
Analyte											
C9-C18 Aliphatics	3.00E-01	1.30E-01	4.24E-04	4.30E-01	1.00E-01	3.80E-01	1.87E-01	3.46E-01	8.40E-02	9.93E-05	3.14E-04

TABLE A-5 (continued)
GROUNDWATER TO OUTDOOR AIR
FUTURE CONSTRUCTION/UTILITY WORKER

	Area of Trench Below Grade	Trench Ventilation Rate	Pressure Diff. between soil & enclosed space	Vadose zone soil saturated hydraulic conductivity	Conversion Factor hr to s	Viscosity of water at 10°C	Viscosity of water at system temp.	Density of water	Acceleration due to gravity	Vadose zone soil intrinsic permeability	Vadose zone residual soil water content	Vadose zone effective total fluid saturation
	A_B	Q_{trench}	ΔP	$K_{s,v}$	Conv02	$\mu_{w\text{-}10}$	μ_w	ρ_w	g	$k_{i,v}$	$\theta_{r,v}$	S_{te}
Units:	cm^2	cm^3/s	$g/cm\text{-}s^2$	cm/hr	s/hr	g/cm-s	g/cm-s	g/cm^3	cm/s^2	cm^2	cm^3/cm^3	unitless
Formula:	(Note 2)	(Note 21)	(40 for screening)	lookup			(Note 16)	(0.999 for screening)		(Note 17)	lookup	(Note 18)
Analyte												
C9-C18 Aliphatics	3.29E+05	1.70E+05	4.00E+01	1.31E+00	3.60E+03	1.31E-02	1.31E-02	9.99E-01	9.81E+02	4.85E-09	1.00E-01	6.06E-01

TABLE A-5 (continued)
GROUNDWATER TO OUTDOOR AIR
FUTURE CONSTRUCTION/UTILITY WORKER

	Vadose zone van Genuchten shape parameter	Vadose zone soil relative air permeability	Vadose zone soil effective vapor permeability	Thickness of soil between soilgas & trench	Vapor viscosity at avg. soil temp.	Avg. Vapor Flow Rate Into trench	Infinite Source Attenuation Coeff.	Infinite Source Trench Conc.
	M_v	k_{rg}	k_v	L_{soil}	μ_{Ts}	Q_{soil}	α	C_{trench}
Units:	unitless	unitless	cm^2	cm	g/cm-s	cm^3/s	unitless	$\mu g/m^3$
Formula:	lookup	(Note 19)	(Note 20)	(1 for screening)	$0.00018*(T_s/298.15)^{\wedge}0.5$	(Note 5)	(Note 6)	$C_{source} * \alpha$
Analyte								
C9-C18 Aliphatics	3.24E-01	5.37E-01	2.61E-09	1.00E+00	1.75E-04	5.95E-04	3.50E-09	1.1E-02

TABLE A-6
PHYSICAL AND CHEMICAL PROPERTIES OF GROUNDWATER AND SURFACE WATER CHEMICALS OF POTENTIAL CONCERN

Analytes	Molecular Weight		Henry's Law Constant H'		Log Octanol/Water Partition Coefficient		Log Kp		Kp	
Units:	g/mole		atm-m^3/mole						cm/hr	
C9-C18 Aliphatics	170	b	1.7E+00	b	5.70	d	-1.5	c	0.032	calc
C19-C36 Aliphatics	283	d	NA	b	11.27	d	-1.5	c	0.032	calc
Arsenic	75	a	NA		NA		NA		0.001	c
Barium	137	a	NA		NA		NA		0.001	c
Beryllium	9	a	NA		NA		NA		0.001	c
Chromium	52	a	NA		NA		NA		0.001	c
Nickel	59	a	NA		NA		NA		0.00020	c
Selenium	79	a	NA		NA		NA		0.001	c
Vanadium	51		NA		NA		NA		0.00100	c
Zinc	65	a	NA		NA		NA		0.00060	c

NOTES:
(a) MADEP 1994
(b) MADEP 1997
(c) EPA 2001. RAGS Part E
(d) TPHCWG Vol.3 1996

TABLE A-7
CALCULATION OF NORMALIZED AVERAGE DAILY INTAKE RATES AND NORMALIZED AVERAGE DAILY CONTACT RATES

Ingestion of Soil	mg/kg*day		mg/day		day/yr		yr		kg		day
	$NADSIR_{soil}$	=	IR	x	EF	x	ED	/	BW	x	AP
Construction Worker	4.9E-01	=	100	x	125	x	1	/	70	x	365
Adolescent Trespasser	6.9E-02	=	50	x	26	x	7	/	51.8	x	2555
Child Recreational User	1.4E+00	=	100	x	78	x	7	/	15	x	2555
Adult Recreational User	1.5E-01	=	50	x	78	x	30	/	70	x	10950
Utility Worker	5.9E-02	=	100	x	15	x	1	/	70	x	365

Dermal Contact of Soil	mg/kg*day		cm2		day/yr		yr		mg/cm2		kg		day
	$NADSCR_{soil}$	=	SA	x	EF	x	ED	x	AF	/	BW	x	AP
Construction Worker	4.9E+00	=	3477	x	125	x	1	x	0.29	/	70	x	365
Adolescent Trespasser	5.6E-01	=	2928	x	26	x	7	x	0.14	/	51.8	x	2555
Child Recreational User	1.2E+01	=	2434	x	78	x	7	x	0.35	/	15	x	2555
Adult Recreational User	2.2E+00	=	5657	x	78	x	30	x	0.13	/	70	x	10950
Utility Worker	5.9E-01	=	3477	x	15	x	1	x	0.29	/	70	x	365

Inhalation of Fugitive Dust from Soil	$(day)^{-1}$		m3/hr		hr/day		day/yr		yr		ug/m3		kg/ug		kg		day
	$NADSIR_{dust}$	=	IR	x	ET	x	EF	x	ED	x	PM10	x	CF	/	BW	x	AP
Construction Worker	8.5E-09	=	3.6	x	8	x	125	x	1	x	60	x	1.0E-09	/	70	x	365
Adolescent Trespasser	3.5E-11	=	0.8	x	1	x	26	x	7	x	32	x	1.0E-09	/	51.8	x	2555
Child Recreational User	2.5E-10	=	0.36	x	1.5	x	78	x	7	x	32	x	1.0E-09	/	15	x	2555
Adult Recreational User	1.2E-10	=	1.2	x	1	x	78	x	30	x	32	x	1.0E-09	/	70	x	10950
Utility Worker	1.0E-09	=	3.6	x	8	x	15	x	1	x	60	x	1.0E-09	/	70	x	365

Incidental Ingestion of Groundwater	L/kg*day		L/day		day/yr		yr		kg		day
or Surface Water	$NADSIR_{gw/sw}$	=	IR	x	EF	x	ED	/	BW	x	AP
Construction Worker	2.4E-04	=	0.05	x	125	x	1	/	70	x	365
Utility Worker	2.9E-05	=	0.05	x	15	x	1	/	70	x	365
Adolescent Trespasser	6.9E-05	=	0.05	x	26	x	7	/	51.8	x	2555
Child Recreational User	7.1E-04	=	0.05	x	78	x	7	/	15	x	2555
Adult Recreational User	1.5E-04	=	0.05	x	78	x	30	/	70	x	10950

Dermal Contact with Groundwater	cm^2-hr/kg*day		cm2		hr/day		day/yr		yr		kg		day
or Surface Water	$NADSCR_{gw/sw}$	=	SA	x	ET	x	EF	x	ED	/	BW	x	AP
Construction Worker	1.4E+02	=	3477	x	8	x	125	x	1	/	70	x	365
Utility Worker	1.6E+01	=	3477	x	8	x	15	x	1	/	70	x	365
Adolescent Trespasser	4.0E+00	=	2928	x	1	x	26	x	7	/	51.8	x	2555
Child Recreational User	3.5E+01	=	2434	x	1	x	78	x	7	/	15	x	2555
Adult Recreational User	1.7E+01	=	5657	x	1	x	78	x	30	/	70	x	10950

Inhalation of Outdoor Air			hr/day		day/yr		yr		day		hr/day
	$NADSIR_{air}$	=	ET	x	EF	x	ED	/	AP	x	CF
Construction Worker	1.1E-01	=	8	x	125	x	1	/	365	x	24
Utility Worker	1.4E-02	=	8	x	15	x	1	/	365	x	24

AF = Adherence Factor
AP = Averaging Period
BW = Body Weight
CF = Conversion Factor
EF = Exposure Frequency
ED = Exposure Duration
ET = Exposure Time
IR = Ingestion Rate; Inhalation Rate
NADSCR = Normalized Average Daily Contact Rate
NADSIR = Normalized Average Daily Intake Rate
PM_{10} = Particulate material less than 10 microns in diameter
SA = Surface Area

TABLE A-8
CALCULATION OF NORMALIZED LIFETIME AVERAGE DAILY INTAKE RATES AND NORMALIZED LIFETIME AVERAGE DAILY CONTACT RATES

Ingestion of Soil	mg/kg*day		mg/day		day/yr		yr		kg		day
	$NLADIR_{soil}$	=	IR	x	EF	x	ED	/	BW	x	AP
Construction Worker	6.5E-03	=	100	x	125	x	1	/	70	x	27375
Adolescent Trespasser	6.4E-03	=	50	x	26	x	7	/	51.8	x	27375
Child Recreational User	1.3E-01	=	100	x	78	x	7	/	15	x	27375
Adult Recreational User	6.1E-02	=	50	x	78	x	30	/	70	x	27375
Utility Worker	7.8E-04	=	100	x	15	x	1	/	70	x	27375

Dermal Contact of Soil	mg/kg*day		cm2		day/yr		yr		mg/cm2		kg		day
	$NLADCR_{soil}$	=	SA	x	EF	x	ED	x	AF	/	BW	x	AP
Construction Worker	6.6E-02	=	3477	x	125	x	1	x	0.29	/	70	x	27375
Adolescent Trespasser	5.3E-02	=	2928	x	26	x	7	x	0.14	/	51.8	x	27375
Child Recreational User	1.1E+00	=	2434	x	78	x	7	x	0.35	/	15	x	27375
Adult Recreational User	9.0E-01	=	5657	x	78	x	30	x	0.13	/	70	x	27375
Utility Worker	7.9E-03	=	3477	x	15	x	1	x	0.29	/	70	x	27375

Inhalation of Fugitive Dust from Soil	$(day)^{-1}$		m3/hr		hr/day		day/yr		yr		ug/m3		kg/ug		kg		day
	$NLADIR_{dust}$	=	IR	x	ET	x	EF	x	ED	x	PM10	x	CF	/	BW	x	AP
Construction Worker	1.1E-10	=	3.6	x	8	x	125	x	1	x	60	x	1.0E-09	/	70	x	27375
Adolescent Trespasser	3.3E-12	=	0.8	x	1	x	26	x	7	x	32	x	1.0E-09	/	51.8	x	27375
Child Recreational User	2.3E-11	=	0.36	x	1.5	x	78	x	7	x	32	x	1.0E-09	/	15	x	27375
Adult Recreational User	4.7E-11	=	1.2	x	1	x	78	x	30	x	32	x	1.0E-09	/	70	x	27375
Utility Worker	1.4E-11	=	3.6	x	8	x	15	x	1	x	60	x	1.0E-09	/	70	x	27375

Incidental Ingestion of Groundwater	L/kg*day		L/day		day/yr		yr		kg		day
or Surface Water	$NLADIR_{gw/sw}$	=	IR	x	EF	x	ED	/	BW	x	AP
Construction Worker	3.3E-06	=	0.05	x	125	x	1	/	70	x	27375
Utility Worker	3.9E-07	=	0.05	x	15	x	1	/	70	x	27375
Adolescent Trespasser	6.4E-06	=	0.05	x	26	x	7	/	51.8	x	27375
Child Recreational User	6.6E-05	=	0.05	x	78	x	7	/	15	x	27375
Adult Recreational User	6.1E-05	=	0.05	x	78	x	30	/	70	x	27375

Dermal Contact with Groundwater	cm^2-hr/kg*day		cm2		hr/day		day/yr		yr		kg		day
or Surface Water	$NADSCR_{gw/sw}$	=	SA	x	ET	x	EF	x	ED	/	BW	x	AP
Construction Worker	1.8E+00	=	3477	x	8	x	125	x	1	/	70	x	27375
Utility Worker	2.2E-01	=	3477	x	8	x	15	x	1	/	70	x	27375
Adolescent Trespasser	3.8E-01	=	2928	x	1	x	26	x	7	/	51.8	x	27375
Child Recreational User	3.2E+00	=	2434	x	1	x	78	x	7	/	15	x	27375
Adult Recreational User	6.9E+00	=	5657	x	1	x	78	x	30	/	70	x	27375

Inhalation of Outdoor Air			hr/day		day/yr		yr		day		hr/day
	$NLADSIR_{air}$	=	ET	x	EF	x	ED	/	AP	x	CF
Construction Worker	1.5E-03	=	8	x	125	x	1	/	27375	x	24
Utility Worker	1.8E-04	=	8	x	15	x	1	/	27375	x	24

AF = Adherence Factor
AP = Averaging Period
BW = Body Weight
CF = Conversion Factor
EF = Exposure Frequency
ED = Exposure Duration
ET = Exposure Time
IR = Ingestion Rate; Inhalation Rate
NLADCR = Normalized Lifetime Average Daily Contact Rate
NLADIR = Normalized Lifetime Average Daily Intake Rate
PM_{10} = Particulate material less than 10 microns in diameter
SA = Surface Area

TABLE A-9
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS . FOR CURRENT ADOLESCENT TRESPASSER EXPOSURES TO SURFACE SOIL

		Chronic Soil Ingestion Exposure		Chronic Soil Dermal Contact Exposure			Chemical-Specific Hazard Quotient		Chemical-Specific Hazard Index (e)
Contaminant of Concern	EPC(a) (mg/kg)	RAF (b)	ADD (c) (mg/kg-day)	RAF (b)	ADD (d) (mg/kg-day)	Chronic RfD (b) (mg/kg-day)	Ingestion (e)	Dermal (e)	
C9-C18 Aliphatics	8.2	1	5.6E-07	0.5	2.3E-06	1.0E-01	5.6E-06	2.3E-05	2.9E-05
C19-C36 Aliphatics	59	1	4.1E-06	0.1	3.4E-06	2.0E+00	2.0E-06	1.7E-06	3.7E-06
C11-C22 Aromatics	143	0.36	3.5E-06	0.1	8.1E-06	3.0E-02	1.2E-04	2.7E-04	3.9E-04
2-Methylnaphthalene	0.48	1	3.3E-08	0.1	2.7E-08	4.0E-02	8.3E-07	6.8E-07	1.5E-06
Acenaphthene	1.3	1	8.6E-08	0.2	1.4E-07	6.0E-02	1.4E-06	2.4E-06	3.8E-06
Acenaphthylene	0.42	0.91	2.6E-08	0.18	4.2E-08	4.0E-02	6.6E-07	1.1E-06	1.7E-06
Anthracene	2.7	1	1.9E-07	0.29	4.5E-07	3.0E-01	6.3E-07	1.5E-06	2.1E-06
Benzo(a)anthracene	7.1	0.91	4.4E-07	0.18	7.2E-07	4.0E-02	1.1E-05	1.8E-05	2.9E-05
Benzo(a)pyrene	5.5	0.91	3.4E-07	0.18	5.5E-07	4.0E-02	8.5E-06	1.4E-05	2.2E-05
Benzo(b)fluoranthene	8.0	0.91	5.0E-07	0.18	8.1E-07	4.0E-02	1.2E-05	2.0E-05	3.3E-05
Benzo(g,h,i)perylene	2.7	0.91	1.7E-07	0.18	2.8E-07	4.0E-02	4.3E-06	6.9E-06	1.1E-05
Benzo(k)fluoranthene	3.2	0.91	2.0E-07	0.18	3.2E-07	4.0E-02	5.0E-06	8.1E-06	1.3E-05
Chrysene	7.5	0.91	4.7E-07	0.18	7.6E-07	4.0E-02	1.2E-05	1.9E-05	3.1E-05
Dibenz(a,h)anthracene	3.7	0.91	2.3E-07	0.08	1.6E-07	4.0E-02	5.7E-06	4.1E-06	9.8E-06
Fluoranthene	15	1	1.0E-06	0.2	1.7E-06	4.0E-02	2.6E-05	4.2E-05	6.8E-05
Fluorene	1.2	1	8.5E-08	0.2	1.4E-07	4.0E-01	2.1E-07	3.5E-07	5.6E-07
Indeno(1,2,3-cd)pyrene	4.5	0.91	2.8E-07	0.18	4.6E-07	4.0E-02	7.1E-06	1.1E-05	1.9E-05
Naphthalene	0.63	1	4.3E-08	0.1	3.6E-08	2.0E-02	2.2E-06	1.8E-06	4.0E-06
Phenanthrene	10	0.91	6.6E-07	0.18	1.1E-06	4.0E-02	1.6E-05	2.7E-05	4.3E-05
Pyrene	15	1	1.0E-06	0.2	1.6E-06	3.0E-02	3.3E-05	5.5E-05	8.8E-05
Aroclor-1248	0.22	0.85	1.3E-08	0.067	8.4E-09	2.0E-05	6.5E-04	4.2E-04	1.1E-03
Aroclor-1254	0.52	0.85	3.1E-08	0.067	2.0E-08	2.0E-05	1.5E-03	9.9E-04	2.5E-03
Antimony	1.7	1	1.1E-07	0.1	9.3E-08	4.0E-04	2.8E-04	2.3E-04	5.2E-04
Arsenic	37	1	2.6E-06	0.03	6.3E-07	3.0E-04	8.6E-03	2.1E-03	1.1E-02
Barium	74	0.39	2.0E-06	0.3	1.2E-05	7.0E-02	2.8E-05	1.8E-04	2.1E-04
Beryllium	0.62	1	4.3E-08	0.03	1.1E-08	2.0E-03	2.1E-05	5.3E-06	2.7E-05
Cadmium	10	1	7.0E-07	0.14	8.0E-07	1.0E-03	7.0E-04	8.0E-04	1.5E-03
Chromium	23	1	1.6E-06	0.09	1.2E-06	3.0E-03	5.3E-04	3.9E-04	9.1E-04
Copper	34	1	2.3E-06	0.3	5.8E-06	4.0E-02	5.9E-05	1.4E-04	2.0E-04
Lead	197	0.5	6.8E-06	0.006	6.7E-07	7.5E-04	9.1E-03	8.9E-04	9.9E-03
Mercury	1.2	1	8.0E-08	0.05	3.3E-08	3.0E-04	2.7E-04	1.1E-04	3.8E-04
Nickel	41	1	2.8E-06	0.35	8.1E-06	2.0E-03	1.4E-03	4.1E-03	5.5E-03
Selenium	0.54	1	3.7E-08	0.002	6.1E-10	5.0E-03	7.5E-06	1.2E-07	7.6E-06
Silver	0.14	1	9.8E-09	0.25	2.0E-08	5.0E-03	2.0E-06	4.0E-06	6.0E-06
Thallium	0.46	1	3.2E-08	0.01	2.6E-09	8.0E-05	3.9E-04	3.2E-05	4.3E-04
Vanadium	140	1.86	1.8E-05	0.14	1.1E-05	9.0E-03	2.0E-03	1.2E-03	3.2E-03
Zinc	114	1	7.9E-06	0.02	1.3E-06	3.0E-01	2.6E-05	4.3E-06	3.1E-05

TOTAL HAZARD INDEX = 2.6E-02 + 1.2E-02 = 4E-02

NOTES:

(a) EPCs presented in Table 1.

(b) RfD and RAF values taken from Tables 5 and 7, respectively.

(c) The soil ingestion average daily dose ADD is calculated by the following equation:

Soil Ingestion ADD = [OHM]soil * 10^{-6} kg/mg * RAFing * NADSIRsoil where, NADSIRsoil = 6.9E-02 mg soil/kg-day

(d) The soil dermal contact ADD is calculated by the following equation:

Soil Contact ADD = [OHM]soil * 10^{-6} kg/mg * RAFderm * NADSCRsoil where, NADSCRsoil = 5.6E-01 mg soil/kg-day

(e) Hazard Quotient = ADD/RfD and Hazard Index = Sum (Hazard Quotients)

TABLE A-10
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR CURRENT ADOLESCENT TRESPASSER EXPOSURES TO SURFACE SOIL

Contaminant of Concern	EPC(a) (mg/kg)	Soil Ingestion Exposure RAF (b)	Soil Ingestion Exposure LADD (c) (mg/kg-day)	Soil Dermal Contact Exposure RAF (b)	Soil Dermal Contact Exposure LADD (d) (mg/kg-day)	SF (b) $(mg/kg\text{-}day)^{-1}$	Chemical-Specific ELCR Ingestion (e)	Chemical-Specific ELCR Dermal (e)	Chemical-Specific ELCR (e)
C9-C18 Aliphatics	8.2	NC	NC	NC	NC	NA	NC	NC	NC
C19-C36 Aliphatics	59	NC	NC	NC	NC	NA	NC	NC	NC
C11-C22 Aromatics	143	NC	NC	NC	NC	NA	NC	NC	NC
2-Methylnaphthalene	0.48	NC	NC	NC	NC	NA	NC	NC	NC
Acenaphthene	1.3	NC	NC	NC	NC	NA	NC	NC	NC
Acenaphthylene	0.42	NC	NC	NC	NC	NA	NC	NC	NC
Anthracene	2.7	NC	NC	NC	NC	NA	NC	NC	NC
Benzo(a)anthracene	7.1	1	4.6E-08	0.2	7.5E-08	7.3E-01	3.3E-08	5.5E-08	8.8E-08
Benzo(a)pyrene	5.5	1	3.5E-08	0.2	5.7E-08	7.3E+00	2.6E-07	4.2E-07	6.7E-07
Benzo(b)fluoranthene	8.0	1	5.1E-08	0.2	8.4E-08	7.3E-01	3.7E-08	6.1E-08	9.9E-08
Benzo(g,h,i)perylene	2.7	NC	NC	NC	NC	NA	NC	NC	NC
Benzo(k)fluoranthene	3.2	1	2.0E-08	0.2	3.3E-08	7.3E-02	1.5E-09	2.4E-09	3.9E-09
Chrysene	7.5	1	4.8E-08	0.2	7.9E-08	7.3E-02	3.5E-09	5.8E-09	9.3E-09
Dibenz(a,h)anthracene	3.7	1	2.3E-08	0.09	1.7E-08	7.3E+00	1.7E-07	1.3E-07	3.0E-07
Fluoranthene	15	NC	NC	NC	NC	NA	NC	NC	NC
Fluorene	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Indeno(1,2,3-cd)pyrene	4.5	1	2.9E-08	0.2	4.7E-08	7.3E-01	2.1E-08	3.5E-08	5.6E-08
Naphthalene	0.63	NC	NC	NC	NC	NA	NC	NC	NC
Phenanthrene	10	NC	NC	NC	NC	NA	NC	NC	NC
Pyrene	15	NC	NC	NC	NC	NA	NC	NC	NC
Aroclor-1248	0.22	0.85	1.2E-09	0.07	7.8E-10	2.0E+00	2.4E-09	1.6E-09	4.0E-09
Aroclor-1254	0.52	0.85	2.9E-09	0.07	1.9E-09	2.0E+00	5.7E-09	3.7E-09	9.4E-09
Antimony	1.7	NC	NC	NC	NC	NA	NC	NC	NC
Arsenic	37	1	2.4E-07	0.03	5.9E-08	1.5E+00	3.6E-07	8.9E-08	4.5E-07
Barium	74	NC	NC	NC	NC	NA	NC	NC	NC
Beryllium	0.62	NC	NC	NC	NC	NA	NC	NC	NC
Cadmium	10	NC	NC	NC	NC	NA	NC	NC	NC
Chromium	23	NC	NC	NC	NC	NA	NC	NC	NC
Copper	34	NC	NC	NC	NC	NA	NC	NC	NC
Lead	197	NC	NC	NC	NC	NA	NC	NC	NC
Mercury	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Nickel	41	NC	NC	NC	NC	NA	NC	NC	NC
Selenium	0.54	NC	NC	NC	NC	NA	NC	NC	NC
Silver	0.14	NC	NC	NC	NC	NA	NC	NC	NC
Thallium	0.46	NC	NC	NC	NC	NA	NC	NC	NC
Vanadium	140	NC	NC	NC	NC	NA	NC	NC	NC
Zinc	114	NC	NC	NC	NC	NA	NC	NC	NC

ELCR = 8.9E-07 + 8.0E-07 = 2E-06

NOTES:

(a) EPCs presented in Table 1.

(b) SF and RAF values taken from Tables 5 and 7, respectively.

(c) The soil ingestion lifetime average daily dose LADD is calculated by the following equation:

Soil Ingestion LADD = [OHM]soil * 10^{-6} kg/mg * RAFing * NLADSIRsoil where, NLADSIRsoil = 6.4E-03 mg soil/kg-day

(d) The soil dermal contact ADD is calculated by the following equation:

Soil Contact LADD = [OHM]soil * 10^{-6} kg/mg * RAFderm * NLADSCRsoil where, NLADSCRsoil = 5.3E-02 mg soil/kg-day

(e) Excess Lifetime Cancer Risk = LADD * SF

TABLE A-11
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS
FOR CURRENT ADOLESCENT TRESPASSER EXPOSURES TO FUGITIVE DUST FROM SURFACE SOIL

Contaminant of Concern	EPC(a) (mg/kg)	Chronic Soil GI Inhalation Exposure RAF (b)	Chronic Soil GI Inhalation Exposure ADD (c) (mg/kg-day)	Chronic Soil Respiratory Exposure RAF (b)	Chronic Soil Respiratory Exposure ADD (d) (mg/kg-day)	Chronic RfD (b) (mg/kg-day)	Chronic RfC (b) (mg/m³)	Chemical-Specific Hazard Quotient Ingestion (e)	Chemical-Specific Hazard Quotient Respiratory (e)	Chemical-Specific Hazard Index (e)
C9-C18 Aliphatics	8.2	1	5.8E-10	1	1.4E-10	1.0E-01	2.0E-01	5.8E-9	2.5E-9	8.3E-9
C19-C36 Aliphatics	59	1	4.2E-9	1	1.0E-9	2.0E+00	NA	2.1E-9	NC	2.1E-9
C11-C22 Aromatics	143	0.36	3.6E-9	1	2.5E-9	3.0E-02	5.0E-02	1.2E-7	1.8E-7	3.0E-7
2-Methylnaphthalene	0.48	1	3.4E-11	1	8.5E-12	4.0E-02	7.1E-02	8.5E-10	4.2E-10	1.3E-9
Acenaphthene	1.3	1	8.8E-11	1	2.2E-11	6.0E-02	7.1E-02	1.5E-9	1.1E-9	2.6E-9
Acenaphthylene	0.42	0.91	2.7E-11	1	7.4E-12	4.0E-02	7.1E-02	6.7E-10	3.6E-10	1.0E-9
Anthracene	2.7	1	1.9E-10	1	4.8E-11	3.0E-01	7.1E-02	6.4E-10	2.4E-9	3.0E-9
Benzo(a)anthracene	7.1	0.91	4.6E-10	1	1.3E-10	4.0E-02	7.1E-02	1.1E-8	6.2E-9	1.8E-8
Benzo(a)pyrene	5.5	0.91	3.5E-10	1	9.6E-11	4.0E-02	7.1E-02	8.7E-9	4.7E-9	1.3E-8
Benzo(b)fluoranthene	8.0	0.91	5.1E-10	1	1.4E-10	4.0E-02	7.1E-02	1.3E-8	6.9E-9	2.0E-8
Benzo(g,h,i)perylene	2.7	0.91	1.7E-10	1	4.8E-11	4.0E-02	7.1E-02	4.4E-9	2.4E-9	6.7E-9
Benzo(k)fluoranthene	3.2	0.91	2.0E-10	1	5.6E-11	4.0E-02	7.1E-02	5.1E-9	2.8E-9	7.9E-9
Chrysene	7.5	0.91	4.8E-10	1	1.3E-10	4.0E-02	7.1E-02	1.2E-8	6.5E-9	1.9E-8
Dibenz(a,h)anthracene	3.7	0.91	2.3E-10	1	6.4E-11	4.0E-02	7.1E-02	5.8E-9	3.2E-9	9.0E-9
Fluoranthene	15	1	1.0E-9	1	2.6E-10	4.0E-02	7.1E-02	2.6E-8	1.3E-8	3.9E-8
Fluorene	1.2	1	8.7E-11	1	2.2E-11	4.0E-01	7.1E-02	2.2E-10	1.1E-9	1.3E-9
Indeno(1,2,3-cd)pyrene	4.5	0.91	2.9E-10	1	7.9E-11	4.0E-02	7.1E-02	7.2E-9	3.9E-9	1.1E-8
Naphthalene	0.63	1	4.5E-11	1	1.1E-11	2.0E-02	7.1E-02	2.2E-9	5.5E-10	2.8E-9
Phenanthrene	10	0.91	6.7E-10	1	1.8E-10	4.0E-02	7.1E-02	1.7E-8	9.1E-9	2.6E-8
Pyrene	15	1	1.0E-9	1	2.6E-10	3.0E-02	7.1E-02	3.4E-8	1.3E-8	4.7E-8
Aroclor-1248	0.22	0.85	1.3E-11	1	3.9E-12	2.0E-05	2.0E-05	6.7E-7	6.9E-7	1.4E-6
Aroclor-1254	0.52	0.85	3.1E-11	1	9.2E-12	2.0E-05	2.0E-05	1.6E-6	1.6E-6	3.2E-6
Antimony	1.7	1	1.2E-10	1	2.9E-11	4.0E-04	NA	2.9E-7	NC	2.9E-7
Arsenic	37	1	2.6E-9	1	6.6E-10	3.0E-04	NA	8.8E-6	NC	8.8E-6
Barium	74	0.39	2.0E-9	1	1.3E-9	7.0E-02	NA	2.9E-8	NC	2.9E-8
Beryllium	0.62	1	4.4E-11	1	1.1E-11	2.0E-03	2.0E-05	2.2E-8	1.9E-6	1.9E-6
Cadmium	10	1	7.1E-10	1	1.8E-10	1.0E-03	NA	7.1E-7	NC	7.1E-7
Chromium	23	1	1.6E-9	1	4.0E-10	3.0E-03	1.0E-04	5.4E-7	1.4E-5	1.5E-5
Copper	34	1	2.4E-9	1	6.0E-10	4.0E-02	NA	6.0E-8	NC	6.0E-8
Lead	197	0.5	7.0E-9	1	3.5E-9	7.5E-04	NA	9.3E-6	NC	9.3E-6
Mercury	1.2	1	8.2E-11	1	2.1E-11	3.0E-04	NA	2.7E-7	NC	2.7E-7
Nickel	41	1	2.9E-9	1	7.2E-10	2.0E-03	NA	1.4E-6	NC	1.4E-6
Selenium	0.54	1	3.8E-11	1	9.6E-12	5.0E-03	NA	7.7E-9	NC	7.7E-9
Silver	0.14	1	1.0E-11	1	2.5E-12	5.0E-03	NA	2.0E-9	NC	2.0E-9
Thallium	0.46	1	3.2E-11	1	8.1E-12	8.0E-05	NA	4.0E-7	NC	4.0E-7
Vanadium	140	1.86	1.8E-8	1	2.5E-9	9.0E-03	NA	2.0E-6	NC	2.0E-6
Zinc	114	1	8.1E-9	1	2.0E-9	3.0E-01	NA	2.7E-8	NC	2.7E-8

TOTAL HAZARD INDEX = 2.6E-05 + 1.9E-05 = 5E-05

NOTES:

(a) EPCs presented in Table 1.

(b) RfD, RfC, and RAF values taken from Tables 5, 6, and 7, respectively.

(c) The fugitive dust gastrointestinal ingestion ADD is calculated by the following equation:

$ADD_{inhalation-GI} = [OHM]_{particulate} * 2 * RAF_{ing} * NADSIR_{fugd}$ where, $NADSIR_{fugd}$ = 3.5E-11 mg soil/kg-day

(d) The fugitive dust respiratory system ADD is calculated by the following equation:

$ADD_{inhalation} = [OHM]_{particulate} * 0.5 * RAF_{inh} * NADSIR_{fugd}$

(e) Ingestion Hazard Quotient = $ADD_{inhalation-GI}$ / RfD

Respiratory Hazard Quotient = ($ADD_{inhalation}$ * Body Weight (70 Kg) / Daily Inhalation Rate (20 m^3/day)) / RfC

and Hazard Index = Sum (Hazard Quotients)

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-12
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR CURRENT ADOLESCENT TRESPASSER EXPOSURES TO FUGITIVE DUST FROM SURFACE SOIL

		Chronic Soil GI Inhalation Exposure		Chronic Soil Respiratory Exposure				Chemical-Specific ELCR		Chemical-Specific ELCR
Contaminant of Concern	EPC(a) (mg/kg)	RAF (b)	LADD (c) (mg/kg-day)	RAF (b)	LADD (d) (mg/kg-day)	SF (b) $(mg/kg\text{-}day)^{-1}$	Unit Risk (b) $(mg/m^3)^{-1}$	Ingestion (e)	Respiratory (e)	(e)
C9-C18 Aliphatics	8.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
C19-C36 Aliphatics	59	NC	NC	NC	NC	NA	NA	NC	NC	NC
C11-C22 Aromatics	143	NC	NC	NC	NC	NA	NA	NC	NC	NC
2-Methylnaphthalene	0.48	NC	NC	NC	NC	NA	NA	NC	NC	NC
Acenaphthene	1.3	NC	NC	NC	NC	NA	NA	NC	NC	NC
Acenaphthylene	0.42	NC	NC	NC	NC	NA	NA	NC	NC	NC
Anthracene	2.7	NC	NC	NC	NC	NA	NA	NC	NC	NC
Benzo(a)anthracene	7.1	1	4.7E-11	1	1.2E-11	7.3E-01	1.7E+00	6.4E-11	2.4E-11	8.8E-11
Benzo(a)pyrene	5.5	1	3.6E-11	1	9.0E-12	7.3E+00	1.7E+00	4.9E-12	1.8E-11	2.3E-11
Benzo(b)fluoranthene	8.0	1	5.2E-11	1	1.3E-11	7.3E-01	1.7E+00	7.2E-11	2.7E-11	9.9E-11
Benzo(g,h,i)perylene	2.7	NC	NC	NC	NC	NA	NA	NC	NC	NC
Benzo(k)fluoranthene	3.2	1	2.1E-11	1	5.2E-12	7.3E-02	1.7E+00	2.9E-10	1.1E-11	3.0E-10
Chrysene	7.5	1	4.9E-11	1	1.2E-11	7.3E-02	1.7E+00	6.8E-10	2.5E-11	7.0E-10
Dibenz(a,h)anthracene	3.7	1	2.4E-11	1	6.0E-12	7.3E+00	1.7E+00	3.3E-12	1.2E-11	1.6E-11
Fluoranthene	15	NC	NC	NC	NC	NA	NA	NC	NC	NC
Fluorene	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Indeno(1,2,3-cd)pyrene	4.5	1	3.0E-11	1	7.4E-12	7.3E-01	1.7E+00	4.1E-11	1.5E-11	5.6E-11
Naphthalene	0.63	NC	NC	NC	NC	NA	NA	NC	NC	NC
Phenanthrene	10	NC	NC	NC	NC	NA	NA	NC	NC	NC
Pyrene	15	NC	NC	NC	NC	NA	NA	NC	NC	NC
Aroclor-1248	0.22	0.85	1.2E-12	1	3.7E-13	2.0E+00	5.0E-01	6.2E-13	2.6E-12	3.2E-12
Aroclor-1254	0.52	0.85	2.9E-12	1	8.6E-13	2.0E+00	5.0E-01	1.5E-12	6.0E-12	7.5E-12
Antimony	1.7	NC	NC	NC	NC	NA	NA	NC	NC	NC
Arsenic	37	1	2.5E-10	1	6.2E-11	1.5E+00	4.3E+00	1.6E-10	5.0E-11	2.1E-10
Barium	74	NC	NC	NC	NC	NA	NA	NC	NC	NC
Beryllium	0.62	NC	NC	1	1.0E-12	NA	2.4E+00	NC	1.5E-12	1.5E-12
Cadmium	10	NC	NC	1	1.7E-11	NA	1.8E+00	NC	3.2E-11	3.2E-11
Chromium	23	NC	NC	1	3.8E-11	NA	1.2E+01	NC	1.1E-11	1.1E-11
Copper	34	NC	NC	NC	NC	NA	NA	NC	NC	NC
Lead	197	NC	NC	NC	NC	NA	NA	NC	NC	NC
Mercury	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Nickel	41	NC	NC	NC	NC	NA	NA	NC	NC	NC
Selenium	0.54	NC	NC	NC	NC	NA	NA	NC	NC	NC
Silver	0.14	NC	NC	NC	NC	NA	NA	NC	NC	NC
Thallium	0.46	NC	NC	NC	NC	NA	NA	NC	NC	NC
Vanadium	140	NC	NC	NC	NC	NA	NA	NC	NC	NC
Zinc	114	NC	NC	NC	NC	NA	NA	NC	NC	NC

ELCR = 1.3E-09 + 2.4E-10 = 2E-09

NOTES:

(a) EPCs presented in Table 1.

(b) SF, Unit Risk, and RAF values taken from Tables 5, 6, and 7, respectively.

(c) The fugitive dust gastrointestinal ingestion ADD is calculated by the following equation:

$LADD_{inhalation\text{-}GI} = [OHM]_{particulate} * 2 * RAF_{ing} * NLADSIR_{fugd}$ where, $NLADSIR_{fugd} =$ 3.3E-12 mg soil/kg-day

(d) The fugitive dust respiratory system ADD is calculated by the following equation:

$LADD_{inhalation} = [OHM]_{particulate} * 0.5 * RAF_{inh} * NLADSIR_{fugd}$

(e) Ingestion ELCR = $LADD_{inhalation\text{-}GI} * SF$

Respiratory ELCR = ($LADD_{inhalation}$ * Body Weight (70 Kg) / Daily Inhalation Rate (20 m^3/day)) * Unit Risk

and Hazard Index = Sum (Hazard Quotients)

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-13
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS
FOR CURRENT ADOLESCENT TRESPASSER EXPOSURES TO SURFACE WATER

Contaminant of Concern	EPC(a) (ug/L)	Chronic Ingestion Exposure RAF (b)	Chronic Ingestion Exposure ADD (c) (mg/kg-day)	Chronic Dermal Contact Exposure RAF (b)	Chronic Dermal Contact Exposure Kp (cm/hr)	Chronic Dermal Contact Exposure ADD (d) (mg/kg-day)	Chronic RfD (b) (mg/kg-day)	Chemical-Specific Hazard Quotient Ingestion (e)	Chemical-Specific Hazard Quotient Dermal (e)	Chemical-Specific Hazard Index (e)
C9-C18 Aliphatics	3.0E+00	1	2.0E-07	1	0.032	3.8E-07	1.0E-01	2.0E-06	3.8E-06	5.8E-06
C19-C36 Aliphatics	4.1E+00	1	2.8E-07	1	0.032	5.2E-07	2.0E+00	1.4E-07	2.6E-07	4.0E-07
Arsenic	5.5E-01	1	3.8E-08	1	0.001	2.2E-09	3.0E-04	1.3E-04	7.4E-06	1.3E-04
Barium	5.4E+00	1	3.7E-07	1	0.001	2.2E-08	7.0E-02	5.3E-06	3.1E-07	5.6E-06
Beryllium	3.0E-02	1	2.0E-09	1	0.001	1.2E-10	2.0E-03	1.0E-06	6.0E-08	1.1E-06
Chromium	8.5E-02	1	5.8E-09	1	0.001	3.4E-10	3.0E-03	1.9E-06	1.1E-07	2.1E-06
Nickel	4.6E-01	1	3.2E-08	1	0.000	3.7E-10	2.0E-03	1.6E-05	1.9E-07	1.6E-05
Selenium	4.4E+00	1	3.0E-07	1	0.001	1.8E-08	5.0E-03	6.0E-05	3.5E-06	6.4E-05
Vanadium	7.8E+01	1.9	1.0E-05	1	0.001	3.1E-07	9.0E-03	1.1E-03	3.5E-05	1.2E-03
Zinc	6.3E-01	1	4.3E-08	1	0.001	1.5E-09	3.0E-01	1.4E-07	5.1E-09	1.5E-07

TOTAL HAZARD INDEX = 1.3E-03 + 5.0E-05 = 1E-03

NOTES:

(a) EPCs presented in Table 3.

(b) RfD and RAF values taken from Tables 5 and 7, respectively.

(c) The surface water ingestion average daily dose ADD is calculated by the following equation:

SW Ingestion ADD = [OHM]sw * 10^{-3} mg/ug * RAFing * NADSIRsw where, NADSIRsw = 6.9E-05 L_{sw}/kg-day

(d) The SW dermal contact ADD is calculated by the following equation:

SW Contact ADD = [OHM]sw* 10^{-3} L/cm^3 *10^{-3}mg/ug *RAFderm *Kp* NADSCRsw where, NADSCRsw = 4.0E+00 cm$^2{}_{sw}$-hr/kg-day

TABLE A-14

LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR CURRENT ADOLESCENT TRESPASSER EXPOSURES TO SURFACE WATER

		Ingestion Exposure		Dermal Contact Exposure				Chemical-Specific ELCR		
Contaminant of Concern	EPC(a) (mg/L)	RAF (b)	LADD (c) (mg/kg-day)	RAF (b)	Kp (cm/hr)	LADD (d) (mg/kg-day)	SF (b) (mg/kg-day)$^{-1}$	Ingestion (e)	Dermal (e)	Chemical-Specific ELCR (e)
C9-C18 Aliphatics	3.0E+00	NC	NA	NC	0.032	NA	NA	NA	NA	NA
C19-C36 Aliphatics	4.1E+00	NC	NA	NC	0.032	NA	NA	NA	NA	NA
Arsenic	5.5E-01	1	3.5E-09	1	0.001	2.1E-10	1.5E+00	5.3E-09	3.1E-10	5.6E-09
Barium	5.4E+00	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Beryllium	3.0E-02	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Chromium	8.5E-02	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Nickel	4.6E-01	NC	NA	NC	0.000	NA	NA	NA	NA	NA
Selenium	4.4E+00	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Vanadium	7.8E+01	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Zinc	6.3E-01	NC	NA	NC	0.001	NA	NA	NA	NA	NA

ELCR = 5.3E-09 + 3.1E-10 = 5.6E-09

NOTES:

(a) EPCs presented in Table 3.

(b) SF and RAF values taken from Tables 5 and 7, respectively.

(c) The surface water ingestion lifetime average daily dose LADD is calculated by the following equation:

SW Ingestion LADD = [OHM]sw * 10^{-3} mg/ug * RAFing * NLADSIRsw where, NLADSIRsw = 6.4E-06 L_{sw}/kg-day

(d) The SW dermal contact LADD is calculated by the following equation:

SW Contact LADD = [OHM]sw* 10^{-3} L/cm^3 *10^{-3} mg/ug *RAFderm *Kp* NLADSCRsw where, NLADSCRsw = 3.8E-01 cm^2$_{sw}$-hr/kg-day

TABLE A-15
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS FOR FUTURE ADOLESCENT TRESPASSER EXPOSURES TO SOIL

Contaminant of Concern	EPC(a) (mg/kg)	Chronic Soil Ingestion Exposure RAF (b)	Chronic Soil Ingestion Exposure ADD (c) (mg/kg-day)	Chronic Soil Dermal Contact Exposure RAF (b)	Chronic Soil Dermal Contact Exposure ADD (d) (mg/kg-day)	Chronic RfD (b) (mg/kg-day)	Chemical-Specific Hazard Quotient Ingestion (e)	Chemical-Specific Hazard Quotient Dermal (e)	Chemical-Specific Hazard Index (e)
C9-C18 Aliphatics	22	1	1.5E-06	0.5	6.3E-06	1.0E-01	1.5E-05	6.3E-05	7.9E-05
C19-C36 Aliphatics	39	1	2.7E-06	0.1	2.2E-06	2.0E+00	1.4E-06	1.1E-06	2.5E-06
C11-C22 Aromatics	122	0.36	3.0E-06	0.1	6.9E-06	3.0E-02	1.0E-04	2.3E-04	3.3E-04
2-Methylnaphthalene	0.50	1	3.5E-08	0.1	2.8E-08	4.0E-02	8.7E-07	7.1E-07	1.6E-06
Acenaphthene	1.2	1	8.6E-08	0.2	1.4E-07	6.0E-02	1.4E-06	2.3E-06	3.8E-06
Acenaphthylene	0.39	0.91	2.5E-08	0.18	4.0E-08	4.0E-02	6.1E-07	1.0E-06	1.6E-06
Anthracene	2.5	1	1.7E-07	0.29	4.0E-07	3.0E-01	5.7E-07	1.3E-06	1.9E-06
Benzo(a)anthracene	6.0	0.91	3.8E-07	0.18	6.1E-07	4.0E-02	9.4E-06	1.5E-05	2.5E-05
Benzo(a)pyrene	4.6	0.91	2.8E-07	0.18	4.6E-07	4.0E-02	7.1E-06	1.2E-05	1.9E-05
Benzo(b)fluoranthene	6.7	0.91	4.2E-07	0.18	6.8E-07	4.0E-02	1.0E-05	1.7E-05	2.7E-05
Benzo(g,h,i)perylene	2.5	0.91	1.5E-07	0.18	2.5E-07	4.0E-02	3.9E-06	6.3E-06	1.0E-05
Benzo(k)fluoranthene	2.7	0.91	1.7E-07	0.18	2.8E-07	4.0E-02	4.2E-06	6.9E-06	1.1E-05
Chrysene	6.3	0.91	4.0E-07	0.18	6.4E-07	4.0E-02	9.9E-06	1.6E-05	2.6E-05
Dibenz(a,h)anthracene	3.2	0.91	2.0E-07	0.08	1.5E-07	4.0E-02	5.1E-06	3.7E-06	8.7E-06
Fluoranthene	13	1	8.7E-07	0.2	1.4E-06	4.0E-02	2.2E-05	3.6E-05	5.8E-05
Fluorene	1.2	1	8.5E-08	0.2	1.4E-07	4.0E-01	2.1E-07	3.5E-07	5.6E-07
Indeno(1,2,3-cd)pyrene	3.9	0.91	2.4E-07	0.18	3.9E-07	4.0E-02	6.1E-06	9.9E-06	1.6E-05
Naphthalene	0.62	1	4.2E-08	0.1	3.5E-08	2.0E-02	2.1E-06	1.7E-06	3.9E-06
Phenanthrene	9.6	0.91	6.0E-07	0.18	9.7E-07	4.0E-02	1.5E-05	2.4E-05	3.9E-05
Pyrene	12	1	8.5E-07	0.2	1.4E-06	3.0E-02	2.8E-05	4.6E-05	7.5E-05
Aroclor-1248	0.32	0.85	1.8E-08	0.067	1.2E-08	2.0E-05	9.2E-04	6.0E-04	1.5E-03
Aroclor-1254	0.79	0.85	4.6E-08	0.067	3.0E-08	2.0E-05	2.3E-03	1.5E-03	3.8E-03
Antimony	1.2	1	8.2E-08	0.1	6.7E-08	4.0E-04	2.1E-04	1.7E-04	3.7E-04
Arsenic	29	1	2.0E-06	0.03	4.8E-07	3.0E-04	6.6E-03	1.6E-03	8.2E-03
Barium	74	0.39	2.0E-06	0.3	1.2E-05	7.0E-02	2.8E-05	1.8E-04	2.1E-04
Beryllium	0.65	1	4.5E-08	0.03	1.1E-08	2.0E-03	2.2E-05	5.5E-06	2.8E-05
Cadmium	8.6	1	5.9E-07	0.14	6.8E-07	1.0E-03	5.9E-04	6.8E-04	1.3E-03
Chromium	19	1	1.3E-06	0.09	9.8E-07	3.0E-03	4.4E-04	3.3E-04	7.7E-04
Copper	35	1	2.4E-06	0.3	6.0E-06	4.0E-02	6.1E-05	1.5E-04	2.1E-04
Lead	135	0.5	4.7E-06	0.006	4.6E-07	7.5E-04	6.2E-03	6.1E-04	6.8E-03
Mercury	1.2	1	8.6E-08	0.05	3.5E-08	3.0E-04	2.9E-04	1.2E-04	4.0E-04
Nickel	35	1	2.4E-06	0.35	7.0E-06	2.0E-03	1.2E-03	3.5E-03	4.7E-03
Selenium	0.39	1	2.7E-08	0.002	4.4E-10	5.0E-03	5.3E-06	8.7E-08	5.4E-06
Silver	0.12	1	8.5E-09	0.25	1.7E-08	5.0E-03	1.7E-06	3.5E-06	5.2E-06
Thallium	0.45	1	3.1E-08	0.01	2.5E-09	8.0E-05	3.9E-04	3.2E-05	4.2E-04
Vanadium	137	1.86	1.8E-05	0.14	1.1E-05	9.0E-03	1.9E-03	1.2E-03	3.1E-03
Zinc	122	1	8.4E-06	0.02	1.4E-06	3.0E-01	2.8E-05	4.6E-06	3.3E-05

TOTAL HAZARD INDEX = 2.1E-02 + 1.1E-02 = 3E-02

NOTES:

(a) EPCs presented in Table 2.

(b) RfD and RAF values taken from Tables 5 and 7, respectively.

(c) The soil ingestion average daily dose ADD is calculated by the following equation:

Soil Ingestion ADD = [OHM]soil * 10^{-6} kg/mg * RAFing * NADSIRsoil where, NADSIRsoil = 6.9E-02 mg soil/kg-day

(d) The soil dermal contact ADD is calculated by the following equation:

Soil Contact ADD = [OHM]soil * 10^{-6} kg/mg * RAFderm * NADSCRsoil where, NADSCRsoil = 5.6E-01 mg soil/kg-day

(e) Hazard Quotient = ADD/RfD and Hazard Index = Sum (Hazard Quotients)

TABLE A-16
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE ADOLESCENT TRESPASSER EXPOSURES TO SOIL

		Soil Ingestion Exposure		Soil Dermal Contact Exposure			Chemical-Specific ELCR		Chemical-Specific
Contaminant of Concern	EPC(a) (mg/kg)	RAF (b)	LADD (c) (mg/kg-day)	RAF (b)	LADD (d) (mg/kg-day)	SF (b) $(mg/kg\text{-}day)^{-1}$	Ingestion (e)	Dermal (e)	ELCR (e)
C9-C18 Aliphatics	22	NC	NC	NC	NC	NA	NC	NC	NC
C19-C36 Aliphatics	39	NC	NC	NC	NC	NA	NC	NC	NC
C11-C22 Aromatics	122	NC	NC	NC	NC	NA	NC	NC	NC
2-Methylnaphthalene	0.50	NC	NC	NC	NC	NA	NC	NC	NC
Acenaphthene	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Acenaphthylene	0.39	NC	NC	NC	NC	NA	NC	NC	NC
Anthracene	2.5	NC	NC	NC	NC	NA	NC	NC	NC
Benzo(a)anthracene	6.0	1	3.9E-08	0.2	6.3E-08	7.3E-01	2.8E-08	4.6E-08	7.5E-08
Benzo(a)pyrene	4.6	1	2.9E-08	0.2	4.8E-08	7.3E+00	2.1E-07	3.5E-07	5.6E-07
Benzo(b)fluoranthene	6.7	1	4.3E-08	0.2	7.0E-08	7.3E-01	3.1E-08	5.1E-08	8.2E-08
Benzo(g,h,i)perylene	2.5	NC	NC	NC	NC	NA	NC	NC	NC
Benzo(k)fluoranthene	2.7	1	1.7E-08	0.2	2.9E-08	7.3E-02	1.3E-09	2.1E-09	3.4E-09
Chrysene	6.3	1	4.1E-08	0.2	6.7E-08	7.3E-02	3.0E-09	4.9E-09	7.8E-09
Dibenz(a,h)anthracene	3.2	1	2.1E-08	0.09	1.5E-08	7.3E+00	1.5E-07	1.1E-07	2.6E-07
Fluoranthene	13	NC	NC	NC	NC	NA	NC	NC	NC
Fluorene	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Indeno(1,2,3-cd)pyrene	3.9	1	2.5E-08	0.2	4.1E-08	7.3E-01	1.8E-08	3.0E-08	4.8E-08
Naphthalene	0.62	NC	NC	NC	NC	NA	NC	NC	NC
Phenanthrene	9.6	NC	NC	NC	NC	NA	NC	NC	NC
Pyrene	12	NC	NC	NC	NC	NA	NC	NC	NC
Aroclor-1248	0.32	0.85	1.7E-09	0.07	1.1E-09	2.0E+00	3.4E-09	2.2E-09	5.7E-09
Aroclor-1254	0.79	0.85	4.3E-09	0.07	2.8E-09	2.0E+00	8.6E-09	5.6E-09	1.4E-08
Antimony	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Arsenic	29	1	1.8E-07	0.03	4.5E-08	1.5E+00	2.8E-07	6.8E-08	3.4E-07
Barium	74	NC	NC	NC	NC	NA	NC	NC	NC
Beryllium	0.65	NC	NC	NC	NC	NA	NC	NC	NC
Cadmium	8.6	NC	NC	NC	NC	NA	NC	NC	NC
Chromium	19	NC	NC	NC	NC	NA	NC	NC	NC
Copper	35	NC	NC	NC	NC	NA	NC	NC	NC
Lead	135	NC	NC	NC	NC	NA	NC	NC	NC
Mercury	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Nickel	35	NC	NC	NC	NC	NA	NC	NC	NC
Selenium	0.39	NC	NC	NC	NC	NA	NC	NC	NC
Silver	0.12	NC	NC	NC	NC	NA	NC	NC	NC
Thallium	0.45	NC	NC	NC	NC	NA	NC	NC	NC
Vanadium	137	NC	NC	NC	NC	NA	NC	NC	NC
Zinc	122	NC	NC	NC	NC	NA	NC	NC	NC

ELCR = 7.4E-07 + 6.7E-07 = 1E-06

NOTES:

(a) EPCs presented in Table 2.

(b) SF and RAF values taken from Tables 5 and 7, respectively.

(c) The soil ingestion lifetime average daily dose LADD is calculated by the following equation:

Soil Ingestion LADD = [OHM]soil * 10^{-6} kg/mg * RAFing * NLADSIRsoil where, NLADSIRsoil = 6.4E-03 mg soil/kg-day

(d) The soil dermal contact ADD is calculated by the following equation:

Soil Contact LADD = [OHM]soil * 10^{-6} kg/mg * RAFderm * NLADSCRsoil where, NLADSCRsoil = 5.3E-02 mg soil/kg-day

(e) Excess Lifetime Cancer Risk = LADD * SF

TABLE A-17
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS FOR FUTURE ADOLESCENT TRESPASSER EXPOSURES TO FUGITIVE DUST FROM SOIL

Contaminant of Concern	EPC(a) (mg/kg)	Chronic Soil GI Inhalation Exposure RAF (b)	ADD (c) (mg/kg-day)	Chronic Soil Respiratory Exposure RAF (b)	ADD (d) (mg/kg-day)	Chronic RfD (b) (mg/kg-day)	Chronic RfC (b) (mg/m^3)	Chemical-Specific Hazard Quotient Ingestion (e)	Respiratory (e)	Chemical-Specific Hazard Index (e)
C9-C18 Aliphatics	22	1	1.6E-9	1	4.0E-10	1.0E-01	2.0E-01	1.6E-8	6.9E-9	2.3E-8
C19-C36 Aliphatics	39	1	2.8E-9	1	6.9E-10	2.0E+00	NA	1.4E-9	NC	1.4E-9
C11-C22 Aromatics	122	0.36	3.1E-9	1	2.1E-9	3.0E-02	5.0E-02	1.0E-7	1.5E-7	2.5E-7
2-Methylnaphthalene	0.50	1	3.5E-11	1	8.9E-12	4.0E-02	7.1E-02	8.9E-10	4.4E-10	1.3E-9
Acenaphthene	1.2	1	8.8E-11	1	2.2E-11	6.0E-02	7.1E-02	1.5E-9	1.1E-9	2.5E-9
Acenaphthylene	0.39	0.91	2.5E-11	1	6.9E-12	4.0E-02	7.1E-02	6.3E-10	3.4E-10	9.7E-10
Anthracene	2.5	1	1.7E-10	1	4.4E-11	3.0E-01	7.1E-02	5.8E-10	2.1E-9	2.7E-9
Benzo(a)anthracene	6.0	0.91	3.9E-10	1	1.1E-10	4.0E-02	7.1E-02	9.7E-9	5.2E-9	1.5E-8
Benzo(a)pyrene	4.6	0.91	2.9E-10	1	8.0E-11	4.0E-02	7.1E-02	7.3E-9	4.0E-9	1.1E-8
Benzo(b)fluoranthene	6.7	0.91	4.3E-10	1	1.2E-10	4.0E-02	7.1E-02	1.1E-8	5.8E-9	1.6E-8
Benzo(g,h,i)perylene	2.5	0.91	1.6E-10	1	4.4E-11	4.0E-02	7.1E-02	4.0E-9	2.1E-9	6.1E-9
Benzo(k)fluoranthene	2.7	0.91	1.7E-10	1	4.8E-11	4.0E-02	7.1E-02	4.4E-9	2.4E-9	6.7E-9
Chrysene	6.3	0.91	4.1E-10	1	1.1E-10	4.0E-02	7.1E-02	1.0E-8	5.5E-9	1.6E-8
Dibenz(a,h)anthracene	3.2	0.91	2.1E-10	1	5.7E-11	4.0E-02	7.1E-02	5.2E-9	2.8E-9	8.0E-9
Fluoranthene	13	1	8.9E-10	1	2.2E-10	4.0E-02	7.1E-02	2.2E-8	1.1E-8	3.3E-8
Fluorene	1.2	1	8.7E-11	1	2.2E-11	4.0E-01	7.1E-02	2.2E-10	1.1E-9	1.3E-9
Indeno(1,2,3-cd)pyrene	3.9	0.91	2.5E-10	1	6.9E-11	4.0E-02	7.1E-02	6.2E-9	3.4E-9	9.6E-9
Naphthalene	0.62	1	4.3E-11	1	1.1E-11	2.0E-02	7.1E-02	2.2E-9	5.4E-10	2.7E-9
Phenanthrene	9.6	0.91	6.1E-10	1	1.7E-10	4.0E-02	7.1E-02	1.5E-8	8.3E-9	2.4E-8
Pyrene	12	1	8.7E-10	1	2.2E-10	3.0E-02	7.1E-02	2.9E-8	1.1E-8	4.0E-8
Aroclor-1248	0.32	0.85	1.9E-11	1	5.6E-12	2.0E-05	2.0E-05	9.4E-7	9.7E-7	1.9E-6
Aroclor-1254	0.79	0.85	4.7E-11	1	1.4E-11	2.0E-05	2.0E-05	2.4E-6	2.4E-6	4.8E-6
Antimony	1.2	1	8.4E-11	1	2.1E-11	4.0E-04	NA	2.1E-7	NC	2.1E-7
Arsenic	29	1	2.0E-9	1	5.0E-10	3.0E-04	NA	6.7E-6	NC	6.7E-6
Barium	74	0.39	2.0E-9	1	1.3E-9	7.0E-02	NA	2.9E-8	NC	2.9E-8
Beryllium	0.65	1	4.6E-11	1	1.1E-11	2.0E-03	2.0E-05	2.3E-8	2.0E-6	2.0E-6
Cadmium	8.6	1	6.1E-10	1	1.5E-10	1.0E-03	NA	6.1E-7	NC	6.1E-7
Chromium	19	1	1.4E-9	1	3.4E-10	3.0E-03	1.0E-04	4.5E-7	1.2E-5	1.2E-5
Copper	35	1	2.5E-9	1	6.2E-10	4.0E-02	NA	6.2E-8	NC	6.2E-8
Lead	135	0.5	4.8E-9	1	2.4E-9	7.5E-04	NA	6.4E-6	NC	6.4E-6
Mercury	1.2	1	8.8E-11	1	2.2E-11	3.0E-04	NA	2.9E-7	NC	2.9E-7
Nickel	35	1	2.5E-9	1	6.2E-10	2.0E-03	NA	1.2E-6	NC	1.2E-6
Selenium	0.39	1	2.7E-11	1	6.8E-12	5.0E-03	NA	5.5E-9	NC	5.5E-9
Silver	0.12	1	8.7E-12	1	2.2E-12	5.0E-03	NA	1.7E-9	NC	1.7E-9
Thallium	0.45	1	3.2E-11	1	7.9E-12	8.0E-05	NA	4.0E-7	NC	4.0E-7
Vanadium	137	1.86	1.8E-8	1	2.4E-9	9.0E-03	NA	2.0E-6	NC	2.0E-6
Zinc	122	1	8.6E-9	1	2.2E-9	3.0E-01	NA	2.9E-8	NC	2.9E-8

TOTAL HAZARD INDEX = 2.2E-05 + 1.8E-05 = 4E-05

NOTES:

(a) EPCs presented in Table 2.

(b) RfD, RfC, and RAF values taken from Tables 5, 6, and 7, respectively.

(c) The fugitive dust gastrointestinal ingestion ADD is calculated by the following equation:

$ADD_{inhalation-GI} = [OHM]_{particulates} * 2 * RAF_{ing} * NADSIR_{dust}$ where, $NADSIR_{dust}$ = 3.5E-11 mg soil/kg-day

(d) The fugitive dust respiratory system ADD is calculated by the following equation:

$ADD_{inhalation} = [OHM]_{particulates} * 0.5 * RAF_{inh} * NADSIR_{dust}$

(e) Ingestion Hazard Quotient = $ADD_{inhalation-GI}$ / RfD

Respiratory Hazard Quotient = ($ADD_{inhalation}$ * Body Weight (70 Kg) / Daily Inhalation Rate (20 m^3/day)) / RfC

and Hazard Index = Sum (Hazard Quotients)

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-18
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE ADOLESCENT TRESPASSER EXPOSURES TO FUGITIVE DUST FROM SOIL

		Chronic Soil GI Inhalation Exposure		Chronic Soil Respiratory Exposure				Chemical-Specific ELCR		Chemical-Specific
Contaminant of Concern	EPC(a) (mg/kg)	RAF (b)	LADD (c) (mg/kg-day)	RAF (b)	LADD (d) (mg/kg-day)	SF (b) $(mg/kg\text{-}day)^{-1}$	Unit Risk (b) $(mg/m^3)^{-1}$	Ingestion (e)	Respiratory (e)	ELCR (e)
C9-C18 Aliphatics	22	NC	NC	NC	NC	NA	NA	NC	NC	NC
C19-C36 Aliphatics	39	NC	NC	NC	NC	NA	NA	NC	NC	NC
C11-C22 Aromatics	122	NC	NC	NC	NC	NA	NA	NC	NC	NC
2-Methylnaphthalene	0.50	NC	NC	NC	NC	NA	NA	NC	NC	NC
Acenaphthene	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Acenaphthylene	0.39	NC	NC	NC	NC	NA	NA	NC	NC	NC
Anthracene	2.5	NC	NC	NC	NC	NA	NA	NC	NC	NC
Benzo(a)anthracene	6.0	1	4.0E-11	1	9.9E-12	7.3E-01	1.7E+00	5.4E-11	2.0E-11	7.5E-11
Benzo(a)pyrene	4.6	1	3.0E-11	1	7.5E-12	7.3E+00	1.7E+00	4.1E-12	1.5E-11	2.0E-11
Benzo(b)fluoranthene	6.7	1	4.4E-11	1	1.1E-11	7.3E-01	1.7E+00	6.0E-11	2.3E-11	8.3E-11
Benzo(g,h,i)perylene	2.5	NC	NC	NC	NC	NA	NA	NC	NC	NC
Benzo(k)fluoranthene	2.7	1	1.8E-11	1	4.5E-12	7.3E-02	1.7E+00	2.4E-10	9.2E-12	2.5E-10
Chrysene	6.3	1	4.2E-11	1	1.0E-11	7.3E-02	1.7E+00	5.7E-10	2.1E-11	5.9E-10
Dibenz(a,h)anthracene	3.2	1	2.1E-11	1	5.3E-12	7.3E+00	1.7E+00	2.9E-12	1.1E-11	1.4E-11
Fluoranthene	13	NC	NC	NC	NC	NA	NA	NC	NC	NC
Fluorene	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Indeno(1,2,3-cd)pyrene	3.9	1	2.6E-11	1	6.4E-12	7.3E-01	1.7E+00	3.5E-11	1.3E-11	4.8E-11
Naphthalene	0.62	NC	NC	NC	NC	NA	NA	NC	NC	NC
Phenanthrene	9.6	NC	NC	NC	NC	NA	NA	NC	NC	NC
Pyrene	12	NC	NC	NC	NC	NA	NA	NC	NC	NC
Aroclor-1248	0.32	0.85	1.8E-12	1	5.2E-13	2.0E+00	5.0E-01	8.8E-13	3.6E-12	4.5E-12
Aroclor-1254	0.79	0.85	4.4E-12	1	1.3E-12	2.0E+00	5.0E-01	2.2E-12	9.1E-12	1.1E-11
Antimony	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Arsenic	29	1	1.9E-10	1	4.7E-11	1.5E+00	4.3E+00	1.3E-10	3.8E-11	1.6E-10
Barium	74	NC	NC	NC	NC	NA	NA	NC	NC	NC
Beryllium	0.65	NC	NC	1	1.1E-12	NA	2.4E+00	NC	1.6E-12	1.6E-12
Cadmium	8.6	NC	NC	1	1.4E-11	NA	1.8E+00	NC	2.7E-11	2.7E-11
Chromium	19	NC	NC	1	3.2E-11	NA	1.2E+01	NC	9.3E-12	9.3E-12
Copper	35	NC	NC	NC	NC	NA	NA	NC	NC	NC
Lead	135	NC	NC	NC	NC	NA	NA	NC	NC	NC
Mercury	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Nickel	35	NC	NC	NC	NC	NA	NA	NC	NC	NC
Selenium	0.39	NC	NC	NC	NC	NA	NA	NC	NC	NC
Silver	0.12	NC	NC	NC	NC	NA	NA	NC	NC	NC
Thallium	0.45	NC	NC	NC	NC	NA	NA	NC	NC	NC
Vanadium	137	NC	NC	NC	NC	NA	NA	NC	NC	NC
Zinc	122	NC	NC	NC	NC	NA	NA	NC	NC	NC

ELCR = 1.1E-09 + 2.0E-10 = 1E-09

NOTES:

(a) EPCs presented in Table 2.

(b) SF, Unit Risk, and RAF values taken from Tables 5, 6, and 7, respectively.

(c) The fugitive dust gastrointestinal ingestion ADD is calculated by the following equation:

$LADD_{inhalation\text{-}GI} = [OHM]_{particulates} * 2 * RAF_{ing} * NLADSIR_{dept}$ where, $NLADSIR_{dept}$ = 3.3E-12 mg soil/kg-day

(d) The fugitive dust respiratory system ADD is calculated by the following equation:

$LADD_{inhalation} = [OHM]_{particulates} * 0.5 * RAF_{inh} * NLADSIR_{dept}$

(e) Ingestion ELCR = $LADD_{inhalation\text{-}GI}$ * SF

Respiratory ELCR = ($LADD_{inhalation}$ * Body Weight (70 Kg) / Daily Inhalation Rate (20 m^3/day)) * Unit Risk

and Hazard Index = Sum (Hazard Quotients)

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-19
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS FOR FUTURE ADOLESCENT TRESPASSER EXPOSURES TO SURFACE WATER

		Chronic Ingestion Exposure		Chronic Dermal Contact Exposure				Chemical-Specific Hazard Quotient		Chemical-Specific Hazard Index
Contaminant of Concern	EPC(a) (ug/L)	RAF (b)	ADD (c) (mg/kg-day)	RAF (b)	Kp (cm/hr)	ADD (d) (mg/kg-day)	Chronic RfD (b) (mg/kg-day)	Ingestion (e)	Dermal (e)	(e)
C9-C18 Aliphatics	3.0E+00	1	2.0E-07	1	0.032	3.8E-07	1.0E-01	2.0E-06	3.8E-06	5.8E-06
C19-C36 Aliphatics	4.1E+00	1	2.8E-07	1	0.032	5.2E-07	2.0E+00	1.4E-07	2.6E-07	4.0E-07
Arsenic	5.5E-01	1	3.8E-08	1	0.001	2.2E-09	3.0E-04	1.3E-04	7.4E-06	1.3E-04
Barium	5.4E+00	1	3.7E-07	1	0.001	2.2E-08	7.0E-02	5.3E-06	3.1E-07	5.6E-06
Beryllium	3.0E-02	1	2.0E-09	1	0.001	1.2E-10	2.0E-03	1.0E-06	6.0E-08	1.1E-06
Chromium	8.5E-02	1	5.8E-09	1	0.001	3.4E-10	3.0E-03	1.9E-06	1.1E-07	2.1E-06
Nickel	4.6E-01	1	3.2E-08	1	0.000	3.7E-10	2.0E-03	1.6E-05	1.9E-07	1.6E-05
Selenium	4.4E+00	1	3.0E-07	1	0.001	1.8E-08	5.0E-03	6.[illegible]-05	3.5E-06	6.4E-05
Vanadium	7.8E+01	1.9	1.0E-05	1	0.001	3.1E-07	9.0E-03	1.1E-03	3.5E-05	1.2E-03
Zinc	6.3E-01	1	4.3E-08	1	0.001	1.5E-09	3.0E-01	1.4E-07	5.1E-09	1.5E-07

TOTAL HAZARD INDEX = 1.3E-03 + 5.0E-05 = 1E-03

NOTES:

(a) EPCs presented in Table 3.

(b) RfD and RAF values taken from Tables 5 and 7, respectively.

(c) The surface water ingestion average daily dose ADD is calculated by the following equation:
SW Ingestion ADD = [OHM]sw * 10^{-3} mg/ug * RAFing * NADSIRsw where, NADSIRsw = 6.9E-05 L_{sw}/kg-day

(d) The SW dermal contact ADD is calculated by the following equation:
SW Contact ADD = [OHM]sw* 10^{-3} L/cm^3 *10^{-3}mg/ug *RAFderm *Kp* NADSCRsw where, NADSCRsw = 4.0E+00 cm^2_{sw}-hr,kg-day

TABLE A-20
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE ADOLESCENT TRESPASSER EXPOSURES TO SURFACE WATER

Contaminant of Concern	EPC(a) (ug/L)	Ingestion Exposure		Dermal Contact Exposure			SF (b) (mg/kg-day)$^{-1}$	Chemical-Specific ELCR		Chemical-Specific ELCR (e)
		RAF (b)	LADD (c) (mg/kg-day)	RAF (b)	Kp (cm/hr)	LADD (d) (mg/kg-day)		Ingestion (e)	Dermal (e)	
C9-C18 Aliphatics	3.0E+00	NC	NA	NC	0.032	NA	NA	NA	NA	NA
C19-C36 Aliphatics	4.1E+00	NC	NA	NC	0.032	NA	NA	NA	NA	NA
Arsenic	5.5E-01	1	3.5E-09	1	0.001	2.1E-10	1.5E+00	5.3E-09	3.1E-10	5.6E-09
Barium	5.4E+00	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Beryllium	3.0E-02	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Chromium	8.5E-02	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Nickel	4.6E-01	NC	NA	NC	0.000	NA	NA	NA	NA	NA
Selenium	4.4E+00	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Vanadium	7.8E+01	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Zinc	6.3E-01	NC	NA	NC	0.001	NA	NA	NA	NA	NA

ELCR = 5.3E-09 + 3.1E-10 = 5.6E-09

NOTES:

(a) EPCs presented in Table 3.

(b) SF and RAF values taken from Tables 5 and 7, respectively.

(c) The surface water ingestion lifetime average daily dose LADD is calculated by the following equation:

SW Ingestion LADD = [OHM]sw * 10^{-3} mg/ug * RAFing * NLADSIRsw where, NLADSIRsw = 6.4E-06 L_{sw}/kg-day

(d) The SW dermal contact LADD is calculated by the following equation:

SW Contact LADD = [OHM]sw* 10^{-3} L/cm^3 *10^{-3}mg/ug *RAFderm *Kp* NLADSCRsw where, NLADSCRsw = 3.8E-01 cm^2$_{sw}$-hr/kg-day

TABLE A-21
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS FOR FUTURE CONSTRUCTION WORKER EXPOSURES TO SOIL

Contaminant of Concern	EPC(a) (mg/kg)	Subchronic Soil Ingestion Exposure		Subchronic Soil Dermal Contact Exposure		Subchronic RfD (b) (mg/kg-day)	Chemical-Specific Hazard Quotient		Chemical-Specific Hazard Index (e)
		RAF (b)	ADD (c) (mg/kg-day)	RAF (b)	ADD (d) (mg/kg-day)		Ingestion (e)	Dermal (e)	
C9-C18 Aliphatics	22	1	1.1E-5	0.5	5.5E-5	1.0E+00	1.1E-5	5.5E-5	6.6E-5
C19-C36 Aliphatics	39	1	1.9E-5	0.1	1.9E-5	6.0E+00	3.2E-6	3.2E-6	6.4E-6
C11-C22 Aromatics	122	0.36	2.1E-5	0.1	6.0E-5	3.0E-01	7.2E-5	2.0E-4	2.7E-4
2-Methylnaphthalene	0.50	1	2.5E-7	0.1	2.5E-7	4.0E-02	6.2E-6	6.2E-6	1.2E-5
Acenaphthene	1.2	1	6.1E-7	0.2	1.2E-6	6.0E-01	1.0E-6	2.0E-6	3.1E-6
Acenaphthylene	0.39	0.91	1.7E-7	0.18	3.5E-7	4.0E-02	4.4E-6	8.7E-6	1.3E-5
Anthracene	2.5	1	1.2E-6	0.29	3.5E-6	3.0E+00	4.0E-7	1.2E-6	1.6E-6
Benzo(a)anthracene	6.0	0.91	2.7E-6	0.18	5.4E-6	4.0E-02	6.7E-5	1.3E-4	2.0E-4
Benzo(a)pyrene	4.6	0.91	2.0E-6	0.18	4.0E-6	4.0E-02	5.1E-5	1.0E-4	1.5E-4
Benzo(b)fluoranthene	6.7	0.91	3.0E-6	0.18	5.9E-6	4.0E-02	7.4E-5	1.5E-4	2.2E-4
Benzo(g,h,i)perylene	2.5	0.91	1.1E-6	0.18	2.2E-6	4.0E-02	2.8E-5	5.5E-5	8.2E-5
Benzo(k)fluoranthene	2.7	0.91	1.2E-6	0.18	2.4E-6	4.0E-02	3.0E-5	6.0E-5	9.1E-5
Chrysene	6.3	0.91	2.8E-6	0.18	5.6E-6	4.0E-02	7.0E-5	1.4E-4	2.1E-4
Dibenz(a,h)anthracene	3.2	0.91	1.4E-6	0.08	1.3E-6	4.0E-02	3.6E-5	3.2E-5	6.8E-5
Fluoranthene	13	1	6.2E-6	0.2	1.3E-5	4.0E-01	1.6E-5	3.1E-5	4.7E-5
Fluorene	1.2	1	6.1E-7	0.2	1.2E-6	4.0E-01	1.5E-6	3.1E-6	4.6E-6
Indeno(1,2,3-cd)pyrene	3.9	0.91	1.7E-6	0.18	3.5E-6	4.0E-02	4.3E-5	8.6E-5	1.3E-4
Naphthalene	0.62	1	3.0E-7	0.1	3.0E-7	2.0E-02	1.5E-5	1.5E-5	3.0E-5
Phenanthrene	10	0.91	4.3E-6	0.18	8.5E-6	4.0E-02	1.1E-4	2.1E-4	3.2E-4
Pyrene	12	1	6.0E-6	0.2	1.2E-5	3.0E-01	2.0E-5	4.1E-5	6.1E-5
Aroclor-1248	0.32	0.85	1.3E-7	0.07	1.0E-7	2.0E-05	6.6E-3	5.2E-3	1.2E-2
Aroclor-1254	0.79	0.85	3.3E-7	0.07	2.6E-7	2.0E-05	1.6E-2	1.3E-2	3.0E-2
Antimony	1.2	1	5.9E-7	0.1	5.9E-7	4.0E-04	1.5E-3	1.5E-3	2.9E-3
Arsenic	29	1	1.4E-5	0.03	4.2E-6	3.0E-04	4.7E-2	1.4E-2	6.1E-2
Barium	74	0.39	1.4E-5	0.3	1.1E-4	7.0E-02	2.0E-4	1.6E-3	1.8E-3
Beryllium	0.65	1	3.2E-7	0.03	9.6E-8	2.0E-03	1.6E-4	4.8E-5	2.1E-4
Cadmium	8.6	1	4.2E-6	0.14	5.9E-6	1.0E-03	4.2E-3	5.9E-3	1.0E-2
Chromium	19	1	9.5E-6	0.09	8.6E-6	3.0E-03	3.2E-3	2.9E-3	6.0E-3
Copper	35	1	1.7E-5	0.3	5.2E-5	4.0E-02	4.3E-4	1.3E-3	1.7E-3
Lead	135	0.5	3.3E-5	0.01	4.0E-6	7.5E-04	4.4E-2	5.3E-3	4.9E-2
Mercury	1.2	1	6.1E-7	0.05	3.1E-7	3.0E-04	2.0E-3	1.0E-3	3.1E-3
Nickel	35	1	1.7E-5	0.35	6.1E-5	2.0E-03	8.6E-3	3.0E-2	3.9E-2
Selenium	0.39	1	1.9E-7	0	3.8E-9	5.0E-03	3.8E-5	7.6E-7	3.9E-5
Silver	0.12	1	6.0E-8	0.25	1.5E-7	5.0E-03	1.2E-5	3.0E-5	4.2E-5
Thallium	0.45	1	2.2E-7	0.01	2.2E-8	8.0E-05	2.8E-3	2.8E-4	3.0E-3
Vanadium	137	1.86	1.2E-4	0.14	9.5E-5	9.0E-03	1.4E-2	1.1E-2	2.4E-2
Zinc	122	1	6.0E-5	0.02	1.2E-5	3.0E-01	2.0E-4	4.0E-5	2.4E-4

TOTAL HAZARD INDEX = 1.5E-01 + 9.5E-02 = 2E-01

NOTES:

(a) EPCs presented in Table 2.

(b) RfD and RAF values taken from Tables 5 and 7, respectively.

(c) The soil ingestion ADD is calculated by the following equation:

Soil Ingestion ADD = $[OHM]_{soil}$ * 10^{-6} kg/mg * RAF_{ing} * $NADSIR_{soil}$ where, $NADSIR_{soil}$ = 4.9E-01 mg soil/kg-day

(d) The soil dermal contact ADD is calculated by the following equation:

Soil Contact ADD = $[OHM]_{soil}$ * 10^{-6} kg/mg * RAF_{derm} * $NADSCR_{soil}$ where, $NADSCR_{soil}$ = 4.9E+00 mg soil/kg-day

(e) Hazard Quotient = ADD/RfD and Hazard Index = Sum (Hazard Quotients)

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-22
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE CONSTRUCTION WORKER EXPOSURES TO SOIL

		Subchronic Soil Ingestion Exposure		Subchronic Soil Dermal Contact Exposure			Chemical-Specific ELCR		Chemical-Specific
Contaminant of Concern	EPC(a) (mg/kg)	RAF (b)	LADD (c) (mg/kg-day)	RAF (b)	LADD (d) (mg/kg-day)	SF (b) $(mg/kg\text{-}day)^{-1}$	Ingestion (e)	Dermal (e)	ELCR (e)
C9-C18 Aliphatics	22	NC	NC	NC	NC	NA	NC	NC	NC
C19-C36 Aliphatics	39	NC	NC	NC	NC	NA	NC	NC	NC
C11-C22 Aromatics	122	NC	NC	NC	NC	NA	NC	NC	NC
2-Methylnaphthalene	0.50	NC	NC	NC	NC	NA	NC	NC	NC
Acenaphthene	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Acenaphthylene	0.39	NC	NC	NC	NC	NA	NC	NC	NC
Anthracene	2.5	NC	NC	NC	NC	NA	NC	NC	NC
Benzo(a)anthracene	6.0	1	3.9E-08	0.2	7.9E-08	7.3E-01	2.9E-08	5.8E-08	8.7E-08
Benzo(a)pyrene	4.6	1	3.0E-08	0.2	6.0E-08	7.3E+00	2.2E-07	4.4E-07	6.5E-07
Benzo(b)fluoranthene	6.7	1	4.3E-08	0.2	8.8E-08	7.3E-01	3.2E-08	6.4E-08	9.6E-08
Benzo(g,h,i)perylene	2.5	NC	NC	NC	NC	NA	NC	NC	NC
Benzo(k)fluoranthene	2.7	1	1.8E-08	0.2	3.6E-08	7.3E-02	1.3E-09	2.6E-09	3.9E-09
Chrysene	6.3	1	4.1E-08	0.2	8.3E-08	7.3E-02	3.0E-09	6.1E-09	9.1E-09
Dibenz(a,h)anthracene	3.2	1	2.1E-08	0.09	1.9E-08	7.3E+00	1.5E-07	1.4E-07	2.9E-07
Fluoranthene	13	NC	NC	NC	NC	NA	NC	NC	NC
Fluorene	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Indeno(1,2,3-cd)pyrene	3.9	1	2.5E-08	0.2	5.1E-08	7.3E-01	1.9E-08	3.7E-08	5.6E-08
Naphthalene	0.62	NC	NC	NC	NC	NA	NC	NC	NC
Phenanthrene	10	NC	NC	NC	NC	NA	NC	NC	NC
Pyrene	12	NC	NC	NC	NC	NA	NC	NC	NC
Aroclor-1248	0.32	0.85	1.7E-09	0.07	1.4E-09	2.0E+00	3.5E-09	2.8E-09	6.3E-09
Aroclor-1254	0.79	0.85	4.4E-09	0.07	3.5E-09	2.0E+00	8.8E-09	7.0E-09	1.6E-08
Antimony	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Arsenic	29	1	1.9E-07	0.03	5.7E-08	1.5E+00	2.8E-07	8.5E-08	3.7E-07
Barium	74	NC	NC	NC	NC	NA	NC	NC	NC
Beryllium	0.65	NC	NC	NC	NC	NA	NC	NC	NC
Cadmium	8.6	NC	NC	NC	NC	NA	NC	NC	NC
Chromium	19	NC	NC	NC	NC	NA	NC	NC	NC
Copper	35	NC	NC	NC	NC	NA	NC	NC	NC
Lead	135	NC	NC	NC	NC	NA	NC	NC	NC
Mercury	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Nickel	35	NC	NC	NC	NC	NA	NC	NC	NC
Selenium	0.39	NC	NC	NC	NC	NA	NC	NC	NC
Silver	0.12	NC	NC	NC	NC	NA	NC	NC	NC
Thallium	0.45	NC	NC	NC	NC	NA	NC	NC	NC
Vanadium	137	NC	NC	NC	NC	NA	NC	NC	NC
Zinc	122	NC	NC	NC	NC	NA	NC	NC	NC

ECLR = 7.5E-07 + 8.4E-07 = 2E-06

NOTES:

(a) EPCs presented in Table 2.

(b) SF and RAF values taken from Tables 5 and 7, respectively.

(c) The soil ingestion LADD is calculated by the following equation:

Soil Ingestion LADD = $[OHM]_{soil}$ * 10^{-6} kg/mg * RAF_{ing} * $NLADSIR_{soil}$ where, $NLADSIR_{soil}$ = 6.5E-03 mg soil/kg-day

(d) The soil dermal contact LADD is calculated by the following equation:

Soil Contact LADD = $[OHM]_{soil}$ * 10^{-6} kg/mg * RAF_{derm} * $NLADSCR_{soil}$ where, $NLADSCR_{soil}$ = 6.6E-02 mg soil/kg-day

(e) Excess Lifetime Cancer Risk = LADD * SF

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-23
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS FOR FUTURE CONSTRUCTION WORKER EXPOSURES TO FUGITIVE DUST FROM SOIL

Contaminant of Concern	EPC(a) (mg/kg)	Subchronic Soil GI Inhalation Exposure RAF (b)	Subchronic Soil GI Inhalation Exposure ADD (c) (mg/kg-day)	Subchronic Soil Respiratory Exposure RAF (b)	Subchronic Soil Respiratory Exposure ADD (d) (mg/kg-day)	Subchronic RfD (b) (mg/kg-day)	Subchronic RfC (b) (mg/m^3)	Chemical-Specific Hazard Quotient Ingestion (e)	Chemical-Specific Hazard Quotient Respiratory (e)	Chemical-Specific Hazard Index (e)
C9-C18 Aliphatics	22	1	3.8E-7	1	9.5E-8	1.0E+00	2.0E+00	3.8E-7	1.7E-7	5.5E-7
C19-C36 Aliphatics	39	1	6.7E-7	1	1.7E-7	6.0E+00	NA	1.1E-7	NC	1.1E-7
C11-C22 Aromatics	122	0.36	7.4E-7	1	5.2E-7	3.0E-01	5.0E-01	2.5E-6	3.6E-6	6.1E-6
2-Methylnaphthalene	0.50	1	8.5E-9	1	2.1E-9	4.0E-02	7.1E-01	2.1E-7	1.1E-8	2.2E-7
Acenaphthene	1.2	1	2.1E-8	1	5.3E-9	6.0E-01	7.1E-01	3.5E-8	2.6E-8	6.1E-8
Acenaphthylene	0.39	0.91	6.0E-9	1	1.7E-9	4.0E-02	7.1E-01	1.5E-7	8.2E-9	1.6E-7
Anthracene	2.5	1	4.2E-8	1	1.0E-8	3.0E+00	·7.1E-01	1.4E-8	5.2E-8	6.6E-8
Benzo(a)anthracene	6.0	0.91	9.3E-8	1	2.5E-8	4.0E-02	7.1E-01	2.3E-6	1.3E-7	2.4E-6
Benzo(a)pyrene	4.6	0.91	7.0E-8	1	1.9E-8	4.0E-02	7.1E-01	1.8E-6	9.5E-8	1.8E-6
Benzo(b)fluoranthene	6.7	0.91	1.0E-7	1	2.8E-8	4.0E-02	7.1E-01	2.6E-6	1.4E-7	2.7E-6
Benzo(g,h,i)perylene	2.5	0.91	3.8E-8	1	1.0E-8	4.0E-02	7.1E-01	9.5E-7	5.2E-8	1.0E-6
Benzo(k)fluoranthene	2.7	0.91	4.2E-8	1	1.1E-8	4.0E-02	7.1E-01	1.0E-6	5.7E-8	1.1E-6
Chrysene	6.3	0.91	9.7E-8	1	2.7E-8	4.0E-02	7.1E-01	2.4E-6	1.3E-7	2.6E-6
Dibenz(a,h)anthracene	3.2	0.91	5.0E-8	1	1.4E-8	4.0E-02	7.1E-01	1.2E-6	6.8E-8	1.3E-6
Fluoranthene	13	1	2.1E-7	1	5.4E-8	4.0E-01	7.1E-01	5.4E-7	2.6E-7	8.0E-7
Fluorene	1.2	1	2.1E-8	1	5.2E-9	4.0E-01	7.1E-01	5.2E-8	2.6E-8	7.8E-8
Indeno(1,2,3-cd)pyrene	3.9	0.91	6.0E-8	1	1.6E-8	4.0E-02	7.1E-01	1.5E-6	8.1E-8	1.6E-6
Naphthalene	0.62	1	1.0E-8	1	2.6E-9	2.0E-02	7.1E-01	5.2E-7	1.3E-8	5.3E-7
Phenanthrene	10	0.91	1.5E-7	1	4.1E-8	4.0E-02	7.1E-01	3.7E-6	2.0E-7	3.9E-6
Pyrene	12	1	2.1E-7	1	5.2E-8	3.0E-01	7.1E-01	6.9E-7	2.6E-7	9.5E-7
Aroclor-1248	0.32	0.85	4.5E-9	1	1.3E-9	2.0E-05	2.0E-04	2.3E-4	2.3E-5	2.5E-4
Aroclor-1254	0.79	0.85	1.1E-8	1	3.3E-9	2.0E-05	2.0E-04	5.7E-4	5.9E-5	6.3E-4
Antimony	1.2	1	2.0E-8	1	5.1E-9	4.0E-04	NA	5.1E-5	NC	5.1E-5
Arsenic	29	1	4.8E-7	1	1.2E-7	3.0E-04	NA	1.6E-3	NC	1.6E-3
Barium	74	0.39	4.9E-7	1	3.1E-7	7.0E-02	NA	6.9E-6	NC	6.9E-6
Beryllium	0.65	1	1.1E-8	1	2.8E-9	2.0E-03	2.0E-04	5.5E-6	4.8E-5	5.4E-5
Cadmium	8.6	1	1.5E-7	1	3.6E-8	1.0E-03	NA	1.5E-4	NC	1.5E-4
Chromium	19	1	3.3E-7	1	8.2E-8	3.0E-03	1.0E-03	1.1E-4	2.9E-4	3.9E-4
Copper	35	1	6.0E-7	1	1.5E-7	4.0E-02	NA	1.5E-5	NC	1.5E-5
Lead	135	0.5	1.1E-6	1	5.7E-7	7.5E-04	NA	1.5E-3	NC	1.5E-3
Mercury	1.2	1	2.1E-8	1	5.3E-9	3.0E-04	NA	7.0E-5	NC	7.0E-5
Nickel	35	1	6.0E-7	1	1.5E-7	2.0E-03	NA	3.0E-4	NC	3.0E-4
Selenium	0.39	1	6.5E-9	1	1.6E-9	5.0E-03	NA	1.3E-6	NC	1.3E-6
Silver	0.12	1	2.1E-9	1	5.2E-10	5.0E-03	NA	4.2E-7	NC	4.2E-7
Thallium	0.45	1	7.6E-9	1	1.9E-9	8.0E-05	NA	9.5E-5	NC	9.5E-5
Vanadium	137	1.86	4.3E-6	1	5.8E-7	9.0E-03	NA	4.8E-4	NC	4.8E-4
Zinc	122	1	2.1E-6	1	5.2E-7	3.0E-01	NA	6.9E-6	NC	6.9E-6

TOTAL HAZARD INDEX = 5.2E-03 + 4.2E-04 = 6E-03

NOTES:

(a) EPCs presented in Table 2.

(b) RfD, RfC, and RAF values taken from Tables 5, 6, and 7, respectively.

(c) The fugitive dust gastrointestinal ingestion ADD is calculated by the following equation:

$ADD_{inhalation-GI} = [OHM]_{particulate} * 2 * RAF_{ing} * NADSIR_{fugit}$ where, $NADSIR_{fugit}$ = 8.5E-09 mg soil/kg-day

(d) The fugitive dust respiratory system ADD is calculated by the following equation:

$ADD_{inhalation} = [OHM]_{particulate} * 0.5 * RAF_{inh} * NADSIR_{fugit}$

(e) Ingestion Hazard Quotient = $ADD_{inhalation-GI}$ / RfD

Respiratory Hazard Quotient = ($ADD_{inhalation}$ * Body Weight (70 Kg) / Daily Inhalation Rate (20 m^3/day)) / RfC

and Hazard Index = Sum (Hazard Quotients)

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-24
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE CONSTRUCTION WORKER EXPOSURES TO FUGITIVE DUST FROM SOIL

		Subchronic Soil GI Inhalation Exposure		Subchronic Soil Respiratory Exposure				Chemical-Specific ELCR		Chemical-Specific
Contaminant of Concern	EPC(a) (mg/kg)	RAF (b)	LADD (c) (mg/kg-day)	RAF (b)	LADD (d) (mg/kg-day)	SF (b) $(mg/kg\text{-}day)^{-1}$	Unit Risk (b) $(mg/m^3)^{-1}$	Ingestion (e)	Respiratory (e)	ELCR (e)
C9-C18 Aliphatics	22	NC	NC	NC	NC	NA	NA	NC	NC	NC
C19-C36 Aliphatics	39	NC	NC	NC	NC	NA	NA	NC	NC	NC
C11-C22 Aromatics	122	NC	NC	NC	NC	NA	NA	NC	NC	NC
2-Methylnaphthalene	0.50	NC	NC	NC	NC	NA	NA	NC	NC	NC
Acenaphthene	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Acenaphthylene	0.39	NC	NC	NC	NC	NA	NA	NC	NC	NC
Anthracene	2.5	NC	NC	NC	NC	NA	NA	NC	NC	NC
Benzo(a)anthracene	6.0	1	1.4E-9	1	3.4E-10	7.3E-01	1.7E+00	1.9E-9	7.0E-10	2.6E-9
Benzo(a)pyrene	4.6	1	1.0E-9	1	2.6E-10	7.3E+00	1.7E+00	1.4E-10	5.3E-10	6.7E-10
Benzo(b)fluoranthene	6.7	1	1.5E-9	1	3.8E-10	7.3E-01	1.7E+00	2.1E-9	7.7E-10	2.8E-9
Benzo(g,h,i)perylene	2.5	NC	NC	NC	NC	NA	NA	NC	NC	NC
Benzo(k)fluoranthene	2.7	1	6.1E-10	1	1.5E-10	7.3E-02	1.7E+00	8.4E-9	3.2E-10	8.7E-9
Chrysene	6.3	1	1.4E-9	1	3.6E-10	7.3E-02	1.7E+00	2.0E-8	7.3E-10	2.0E-8
Dibenz(a,h)anthracene	3.2	1	7.3E-10	1	1.8E-10	7.3E+00	1.7E+00	1.0E-10	3.8E-10	4.8E-10
Fluoranthene	13	NC	NC	NC	NC	NA	NA	NC	NC	NC
Fluorene	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Indeno(1,2,3-cd)pyrene	3.9	1	8.8E-10	1	2.2E-10	7.3E-01	1.7E+00	1.2E-9	4.5E-10	1.7E-9
Naphthalene	0.62	NC	NC	NC	NC	NA	NA	NC	NC	NC
Phenanthrene	10	NC	NC	NC	NC	NA	NA	NC	NC	NC
Pyrene	12	NC	NC	NC	NC	NA	NA	NC	NC	NC
Aroclor-1248	0.32	0.85	6.0E-11	1	1.8E-11	2.0E+00	5.0E-01	3.0E-11	1.2E-10	1.5E-10
Aroclor-1254	0.79	0.85	1.5E-10	1	4.5E-11	2.0E+00	5.0E-01	7.6E-11	3.1E-10	3.9E-10
Antimony	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Arsenic	29	1	6.5E-9	1	1.6E-9	1.5E+00	4.3E+00	4.3E-9	1.3E-9	5.6E-9
Barium	74	NC	NC	NC	NC	NA	NA	NC	NC	NC
Beryllium	0.65	NC	NC	1	3.7E-11	NA	2.4E+00	NC	5.4E-11	5.4E-11
Cadmium	8.6	NC	NC	1	4.8E-10	NA	1.8E+00	NC	9.4E-10	9.4E-10
Chromium	19	NC	NC	1	1.1E-9	NA	1.2E+01	NC	3.2E-10	3.2E-10
Copper	35	NC	NC	NC	NC	NA	NA	NC	NC	NC
Lead	135	NC	NC	NC	NC	NA	NA	NC	NC	NC
Mercury	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Nickel	35	NC	NC	NC	NC	NA	NA	NC	NC	NC
Selenium	0.39	NC	NC	NC	NC	NA	NA	NC	NC	NC
Silver	0.12	NC	NC	NC	NC	NA	NA	NC	NC	NC
Thallium	0.45	NC	NC	NC	NC	NA	NA	NC	NC	NC
Vanadium	137	NC	NC	NC	NC	NA	NA	NC	NC	NC
Zinc	122	NC	NC	NC	NC	NA	NA	NC	NC	NC

ELCR = 3.8E-08 + 6.9E-09 = 4E-08

NOTES:

(a) EPCs presented in Table 2.

(b) SF, Unit Risk, and RAF values taken from Tables 5, 6, and 7, respectively.

(c) The fugitive dust gastrointestinal ingestion ADD is calculated by the following equation:

$LADD_{inhalation\text{-}GI} = [OHM]_{particulate} * 2 * RAF_{ing} * NLADSIR_{fugd}$ where, $NLADSIR_{fugd} =$ 1.1E-10 mg soil/kg-day

(d) The fugitive dust respiratory system ADD is calculated by the following equation:

$LADD_{inhalation} = [OHM]_{particulate} * 0.5 * RAF_{inh} * NLADSIR_{fugd}$

(e) Ingestion ELCR = $LADD_{inhalation\text{-}GI} * SF$

Respiratory ELCR = ($LADD_{inhalation}$ * Body Weight (70 Kg) / Daily Inhalation Rate (20 m^3/day)) * Unit Risk

and Hazard Index = Sum (Hazard Quotients)

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-25
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS FOR FUTURE CONSTRUCTION WORKER EXPOSURES TO GROUNDWATER

		Subchronic Ingestion Exposure		Subchronic Dermal Contact Exposure			Subchronic	Chemical-Specific Hazard Quotient		Chemical-Specific Hazard
Contaminant of Concern	EPC(a) (ug/L)	RAF (b)	ADD (c) (mg/kg-day)	RAF (b)	Kp (cm/hr)	ADD (d) (mg/kg-day)	RfD (b) (mg/kg-day)	Ingestion (e)	Dermal (e)	Index (e)
C9-C18 Aliphatics	44	1	1.1E-05	1	0.032	1.9E-04	1.0E+00	1.1E-05	1.9E-04	2.0E-04
C19-C36 Aliphatics	49	1	1.2E-05	1	0.032	2.1E-04	2.0E+01	6.0E-07	1.1E-05	1.1E-05
Arsenic	11	1	2.7E-06	1	0.001	1.5E-06	3.0E-04	9.0E-03	5.0E-03	1.4E-02
Barium	83	1	2.0E-05	1	0.001	1.1E-05	7.0E-02	2.9E-04	1.6E-04	4.5E-04
Beryllium	0.48	1	1.2E-07	1	0.001	6.5E-08	2.0E-03	5.9E-05	3.3E-05	9.1E-05
Chromium	1.1	1	2.7E-07	1	0.001	1.5E-07	3.0E-03	9.0E-05	5.0E-05	1.4E-04
Nickel	12	1	2.8E-06	1	0.000	3.1E-07	2.0E-03	1.4E-03	1.6E-04	1.6E-03
Selenium	188	1	4.6E-05	1	0.001	2.6E-05	5.0E-03	9.2E-03	5.1E-03	1.4E-02
Vanadium	3710	1.9	1.7E-03	1	0.001	5.0E-04	9.0E-03	1.9E-01	5.6E-02	2.5E-01
Zinc	17	1	4.3E-06	1	0.001	1.4E-06	3.0E-01	1.4E-05	4.7E-06	1.9E-05

TOTAL HAZARD INDEX = 2.1E-01 + 6.7E-02 = 3E-01

NOTES:

(a) EPCs presented in Table 3.

(b) RfD and RAF values taken from Tables 5 and 7, respectively.

(c) The groundwater ingestion average daily dose ADD is calculated by the following equation:

GW Ingestion ADD = [OHM]gw * 10^{-3} mg/ug * RAFing * NADSIRgw   where, NADSIRgw = 2.4E-04 L_{gw}/kg-day

(d) The GW dermal contact ADD is calculated by the following equation:

GW Contact ADD = [OHM]gw* 10^{-3} L/cm^{3} *10^{-3}mg/ug *RAFderm *Kp* NADSCRgw   where, NADSCRgw = 1.4E+02 cm$^{2}_{gw}$-hr/kg-day

TABLE A-26

LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE CONSTRUCTION WORKER EXPOSURES TO GROUNDWATER

		Ingestion Exposure		Dermal Contact Exposure				Chemical-Specific ELCR		Chemical-Specific
Contaminant of Concern	EPC(a) (ug/L)	RAF (b)	LADD (c) (mg/kg-day)	RAF (b)	Kp (cm/hr)	LADD (d) (mg/kg-day)	SF (b) $(mg/kg\text{-}day)^{-1}$	Ingestion (e)	Dermal (e)	ELCR (e)
C9-C18 Aliphatics	44	NC	NA	NC	0.032	NA	NA	NA	NA	NA
C19-C36 Aliphatics	49	NC	NA	NC	0.032	NA	NA	NA	NA	NA
Arsenic	11	1	3.6E-08	1	0.001	2.0E-08	1.5E+00	5.4E-08	3.0E-08	8.4E-08
Barium	83	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Beryllium	0.48	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Chromium	1.1	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Nickel	12	NC	NA	NC	0.000	NA	NA	NA	NA	NA
Selenium	188	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Vanadium	3710	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Zinc	17	NC	NA	NC	0.001	NA	NA	NA	NA	NA

ELCR = 5.4E-08 + 3.0E-08 = 8E-08

NOTES:

(a) EPCs presented in Table 3.

(b) SF and RAF values taken from Tables 5 and 7, respectively.

(c) The groundwater ingestion lifetime average daily dose LADD is calculated by the following equation:
GW Ingestion LADD = [OHM]gw * 10^{-3} mg/ug * RAFing * NLADSIRgw where, NLADSIRgw = 3.3E-06 L_{gw}/kg-day

(d) The GW dermal contact LADD is calculated by the following equation:
GW Contact LADD = [OHM]gw* 10^{-3} L/cm^3 *10^{-3}mg/ug *RAFderm *Kp* NLADSCRgw where, NLADSCRgw = 1.8E+00 $cm^2{}_{gw}$-hr/kg-day

TABLE A-27
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS
FOR FUTURE CONSTRUCTION WORKER EXPOSURES TO SOIL GAS (FROM SOIL AND GROUNDWATER) IN OUTDOOR AIR

		Inhalation Exposure		Chemical-Specific Hazard Quotient
Contaminant of Concern	**EPC(a) (mg/m^3)**	**ADD (c) (mg/m^3)**	**Subchronic RfC (b) (mg/m^3)**	**Inhalation (d)**
C9-C18 Aliphatics	1.3E-02	1.4E-03	2.0E+00	7.2E-04
C11-C22 Aromatics	5.5E-04	6.2E-05	5.0E-01	1.2E-04
2-Methylnaphthalene	5.7E-06	6.5E-07	7.1E-01	9.1E-07
Naphthalene	1.4E-06	1.6E-07	7.1E-01	2.3E-07

TOTAL HAZARD INDEX = 8E-04

NOTES:
(a) EPCs presented in Table 4.
(b) RfC values taken from Table 6.
(c) The soil gas inhalation average daily dose ADD is calculated by the following equation:
Soil Gas Inhalation ADD = [OHM]air * NADSIR$_{air}$ where, NADSIRair = 1.1E-01
(d) Hazard Quotient = ADD/RfD and Hazard Index = Sum (Hazard Quotients)

TABLE A-28
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE CONSTRUCTION WORKER EXPOSURES TO SOIL GAS (FROM SOIL AND GROUNDWATER) IN OUTDOOR AIR

		Inhalation Exposure		Chemical-Specific ELCR
Contaminant of Concern	**EPC(a) (mg/m^3)**	**LADD (c) (mg/m^3)**	**Unit Risk (b) (mg/m^3)$^{-1}$**	**Inhalation (d)**
C9-C18 Aliphatics	1.3E-02	1.9E-05	NA	NC
C11-C22 Aromatics	5.5E-04	8.3E-07	NA	NC
2-Methylnaphthalene	5.7E-06	8.6E-09	NA	NC
Naphthalene	1.4E-06	2.2E-09	NA	NC

ELCR = NA

NOTES:

(a) EPCs presented in Table 4.

(b) Unit Risk values taken from Table 6.

(c) The soil gas inhalation lifetime average daily dose LADD is calculated by the following equation:

Soil Gas Inhalation LADD = [OHM]air * NLADSIR$_{air}$ where, NLADSIRair = 1.5E-03

(d) Excess Lifetime Cancer Risk = LADD * SF

TABLE A-29
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS FOR FUTURE UTILITY WORKER EXPOSURES TO SOIL

Contaminant of Concern	EPC(a) (mg/kg)	Subchronic Soil Ingestion Exposure RAF (b)	Subchronic Soil Ingestion Exposure ADD (c) (mg/kg-day)	Subchronic Soil Dermal Contact Exposure RAF (b)	Subchronic Soil Dermal Contact Exposure ADD (d) (mg/kg-day)	Subchronic RfD (b) (mg/kg-day)	Chemical-Specific Hazard Quotient Ingestion (e)	Chemical-Specific Hazard Quotient Dermal (e)	Chemical-Specific Hazard Index (e)
C9-C18 Aliphatics	22	1	1.3E-6	0.5	6.6E-6	1.0E+00	1.3E-6	6.6E-6	8.0E-6
C19-C36 Aliphatics	39	1	2.3E-6	0.1	2.3E-6	6.0E+00	3.8E-7	3.9E-7	7.7E-7
C11-C22 Aromatics	122	0.36	2.6E-6	0.1	7.2E-6	3.0E-01	8.6E-6	2.4E-5	3.3E-5
2-Methylnaphthalene	0.50	1	3.0E-8	0.1	3.0E-8	4.0E-02	7.4E-7	7.5E-7	1.5E-6
Acenaphthene	1.2	1	7.3E-8	0.2	1.5E-7	6.0E-01	1.2E-7	2.5E-7	3.7E-7
Acenaphthylene	0.39	0.91	2.1E-8	0.18	4.2E-8	4.0E-02	5.2E-7	1.0E-6	1.6E-6
Anthracene	2.5	1	1.5E-7	0.29	4.2E-7	3.0E+00	4.8E-8	1.4E-7	1.9E-7
Benzo(a)anthracene	6.0	0.91	3.2E-7	0.18	6.4E-7	4.0E-02	8.1E-6	1.6E-5	2.4E-5
Benzo(a)pyrene	4.6	0.91	2.4E-7	0.18	4.9E-7	4.0E-02	6.1E-6	1.2E-5	1.8E-5
Benzo(b)fluoranthene	6.7	0.91	3.6E-7	0.18	7.1E-7	4.0E-02	8.9E-6	1.8E-5	2.7E-5
Benzo(g,h,i)perylene	2.5	0.91	1.3E-7	0.18	2.6E-7	4.0E-02	3.3E-6	6.6E-6	9.9E-6
Benzo(k)fluoranthene	2.7	0.91	1.5E-7	0.18	2.9E-7	4.0E-02	3.6E-6	7.2E-6	1.1E-5
Chrysene	6.3	0.91	3.4E-7	0.18	6.7E-7	4.0E-02	8.4E-6	1.7E-5	2.5E-5
Dibenz(a,h)anthracene	3.2	0.91	1.7E-7	0.08	1.5E-7	4.0E-02	4.3E-6	3.8E-6	8.2E-6
Fluoranthene	13	1	7.4E-7	0.2	1.5E-6	4.0E-01	1.9E-6	3.8E-6	5.6E-6
Fluorene	1.2	1	7.3E-8	0.2	1.5E-7	4.0E-01	1.8E-7	3.7E-7	5.5E-7
Indeno(1,2,3-cd)pyrene	3.9	0.91	2.1E-7	0.18	4.1E-7	4.0E-02	5.2E-6	1.0E-5	1.6E-5
Naphthalene	0.62	1	3.6E-8	0.1	3.7E-8	2.0E-02	1.8E-6	1.8E-6	3.6E-6
Phenanthrene	10	0.91	5.1E-7	0.18	1.0E-6	4.0E-02	1.3E-5	2.6E-5	3.8E-5
Pyrene	12	1	7.2E-7	0.2	1.5E-6	3.0E-01	2.4E-6	4.9E-6	7.3E-6
Aroclor-1248	0.32	0.85	1.6E-8	0.07	1.3E-8	2.0E-05	7.9E-4	6.3E-4	1.4E-3
Aroclor-1254	0.79	0.85	4.0E-8	0.07	3.1E-8	2.0E-05	2.0E-3	1.6E-3	3.5E-3
Antimony	1.2	1	7.0E-8	0.1	7.1E-8	4.0E-04	1.8E-4	1.8E-4	3.5E-4
Arsenic	29	1	1.7E-6	0.03	5.1E-7	3.0E-04	5.6E-3	1.7E-3	7.3E-3
Barium	74	0.39	1.7E-6	0.3	1.3E-5	7.0E-02	2.4E-5	1.9E-4	2.1E-4
Beryllium	0.65	1	3.8E-8	0.03	1.2E-8	2.0E-03	1.9E-5	5.8E-6	2.5E-5
Cadmium	8.6	1	5.0E-7	0.14	7.1E-7	1.0E-03	5.0E-4	7.1E-4	1.2E-3
Chromium	19	1	1.1E-6	0.09	1.0E-6	3.0E-03	3.8E-4	3.4E-4	7.2E-4
Copper	35	1	2.1E-6	0.3	6.3E-6	4.0E-02	5.2E-5	1.6E-4	2.1E-4
Lead	135	0.5	4.0E-6	0.01	4.8E-7	7.5E-04	5.3E-3	6.4E-4	5.9E-3
Mercury	1.2	1	7.3E-8	0.05	3.7E-8	3.0E-04	2.4E-4	1.2E-4	3.7E-4
Nickel	35	1	2.1E-6	0.35	7.3E-6	2.0E-03	1.0E-3	3.7E-3	4.7E-3
Selenium	0.39	1	2.3E-8	0	4.6E-10	5.0E-03	4.5E-6	9.2E-8	4.6E-6
Silver	0.12	1	7.2E-9	0.25	1.8E-8	5.0E-03	1.4E-6	3.6E-6	5.1E-6
Thallium	0.45	1	2.7E-8	0.01	2.7E-9	8.0E-05	3.3E-4	3.3E-5	3.6E-4
Vanadium	137	1.86	1.5E-5	0.14	1.1E-5	9.0E-03	1.7E-3	1.3E-3	2.9E-3
Zinc	122	1	7.2E-6	0.02	1.5E-6	3.0E-01	2.4E-5	4.8E-6	2.9E-5

TOTAL HAZARD INDEX = 1.8E-02 + 1.1E-02 = 3E-02

NOTES:

(a) EPCs presented in Table 2.

(b) RfD and RAF values taken from Tables 5 and 7, respectively.

(c) The soil ingestion ADD is calculated by the following equation:

Soil Ingestion ADD = $[OHM]_{soil}$ * 10^{-6} kg/mg * RAF_{ing} * $NADSIR_{soil}$ where, $NADSIR_{soil}$ = 5.9E-02 mg soil/kg-day

(d) The soil dermal contact ADD is calculated by the following equation:

Soil Contact ADD = $[OHM]_{soil}$ * 10^{-6} kg/mg * RAF_{derm} * $NADSCR_{soil}$ where, $NADSCR_{soil}$ = 5.9E-01 mg soil/kg-day

(e) Hazard Quotient = ADD/RfD and Hazard Index = Sum (Hazard Quotients)

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-30
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE UTILITY WORKER EXPOSURES TO SOIL

		Subchronic Soil Ingestion Exposure		Subchronic Soil Dermal Contact Exposure			Chemical-Specific ELCR		Chemical-Specific ELCR
Contaminant of Concern	**EPC(a) (mg/kg)**	**RAF (b)**	**LADD (c) (mg/kg-day)**	**RAF (b)**	**LADD (d) (mg/kg-day)**	**SF (b) $(mg/kg\text{-}day)^{-1}$**	**Ingestion (e)**	**Dermal (e)**	**(e)**
C9-C18 Aliphatics	22	NC	NC	NC	NC	NA	NC	NC	NC
C19-C36 Aliphatics	39	NC	NC	NC	NC	NA	NC	NC	NC
C11-C22 Aromatics	122	NC	NC	NC	NC	NA	NC	NC	NC
2-Methylnaphthalene	0.50	NC	NC	NC	NC	NA	NC	NC	NC
Acenaphthene	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Acenaphthylene	0.39	NC	NC	NC	NC	NA	NC	NC	NC
Anthracene	2.5	NC	NC	NC	NC	NA	NC	NC	NC
Benzo(a)anthracene	6.0	1	4.7E-09	0.2	9.5E-09	7.3E-01	3.4E-09	7.0E-09	1.0E-08
Benzo(a)pyrene	4.6	1	3.6E-09	0.2	7.2E-09	7.3E+00	2.6E-08	5.2E-08	7.8E-08
Benzo(b)fluoranthene	6.7	1	5.2E-09	0.2	1.1E-08	7.3E-01	3.8E-09	7.7E-09	1.1E-08
Benzo(g,h,i)perylene	2.5	NC	NC	NC	NC	NA	NC	NC	NC
Benzo(k)fluoranthene	2.7	1	2.1E-09	0.2	4.3E-09	7.3E-02	1.6E-10	3.1E-10	4.7E-10
Chrysene	6.3	1	5.0E-09	0.2	1.0E-08	7.3E-02	3.6E-10	7.3E-10	1.1E-09
Dibenz(a,h)anthracene	3.2	1	2.5E-09	0.09	2.3E-09	7.3E+00	1.9E-08	1.7E-08	3.5E-08
Fluoranthene	13	NC	NC	NC	NC	NA	NC	NC	NC
Fluorene	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Indeno(1,2,3-cd)pyrene	3.9	1	3.0E-09	0.2	6.1E-09	7.3E-01	2.2E-09	4.5E-09	6.7E-09
Naphthalene	0.62	NC	NC	NC	NC	NA	NC	NC	NC
Phenanthrene	10	NC	NC	NC	NC	NA	NC	NC	NC
Pyrene	12	NC	NC	NC	NC	NA	NC	NC	NC
Aroclor-1248	0.32	0.85	2.1E-10	0.07	1.7E-10	2.0E+00	4.2E-10	3.3E-10	7.5E-10
Aroclor-1254	0.79	0.85	5.3E-10	0.07	4.2E-10	2.0E+00	1.1E-09	8.4E-10	1.9E-09
Antimony	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Arsenic	29	1	2.2E-08	0.03	6.8E-09	1.5E+00	3.4E-08	1.0E-08	4.4E-08
Barium	74	NC	NC	NC	NC	NA	NC	NC	NC
Beryllium	0.65	NC	NC	NC	NC	NA	NC	NC	NC
Cadmium	8.6	NC	NC	NC	NC	NA	NC	NC	NC
Chromium	19	NC	NC	NC	NC	NA	NC	NC	NC
Copper	35	NC	NC	NC	NC	NA	NC	NC	NC
Lead	135	NC	NC	NC	NC	NA	NC	NC	NC
Mercury	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Nickel	35	NC	NC	NC	NC	NA	NC	NC	NC
Selenium	0.39	NC	NC	NC	NC	NA	NC	NC	NC
Silver	0.12	NC	NC	NC	NC	NA	NC	NC	NC
Thallium	0.45	NC	NC	NC	NC	NA	NC	NC	NC
Vanadium	137	NC	NC	NC	NC	NA	NC	NC	NC
Zinc	122	NC	NC	NC	NC	NA	NC	NC	NC

ECLR = 9.0E-08 + 1.0E-07 = 2E-07

NOTES:
(a) EPCs presented in Table 2.
(b) SF and RAF values taken from Tables 5 and 7, respectively.
(c) The soil ingestion LADD is calculated by the following equation:
Soil Ingestion LADD = $[OHM]_{soil} * 10^{-6}$ kg/mg * $RAF_{ing} * NLADSIR_{soil}$ where, $NLADSIR_{soil}$ = 7.8E-04 mg soil/kg-day
(d) The soil dermal contact LADD is calculated by the following equation:
Soil Contact LADD = $[OHM]_{soil} * 10^{-6}$ kg/mg * $RAF_{derm} * NLADSCR_{soil}$ where, $NLADSCR_{soil}$ = 7.9E-03 mg soil/kg-day
(e) Excess Lifetime Cancer Risk = LADD * SF
NC = Not calculated
NA = Not Applicable/Available/Analyzed

TABLE A-31
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS FOR FUTURE UTILITY WORKER EXPOSURES TO FUGITIVE DUST FROM SOIL

Contaminant of Concern	EPC(a) (mg/kg)	Subchronic Soil GI Inhalation Exposure RAF (b)	Subchronic Soil GI Inhalation Exposure ADD (c) (mg/kg-day)	Subchronic Soil Respiratory Exposure RAF (b)	Subchronic Soil Respiratory Exposure ADD (d) (mg/kg-day)	Subchronic RfD (b) (mg/kg-day)	Subchronic RfC (b) (mg/m^3)	Chemical-Specific Hazard Quotient Ingestion (e)	Chemical-Specific Hazard Quotient Respiratory (e)	Chemical-Specific Hazard Index (e)
C9-C18 Aliphatics	22	1	4.6E-8	1	1.1E-8	1.0E+00	2.0E+00	4.6E-8	2.0E-8	6.5E-8
C19-C36 Aliphatics	39	1	8.0E-8	1	2.0E-8	6.0E+00	NA	1.3E-8	NC	1.3E-8
C11-C22 Aromatics	122	0.36	8.9E-8	1	6.2E-8	3.0E-01	5.0E-01	3.0E-7	4.3E-7	7.3E-7
2-Methylnaphthalene	0.50	1	1.0E-9	1	2.6E-10	4.0E-02	7.1E-01	2.6E-8	1.3E-9	2.7E-8
Acenaphthene	1.2	1	2.5E-9	1	6.3E-10	6.0E-01	7.1E-01	4.2E-9	3.1E-9	7.3E-9
Acenaphthylene	0.39	0.91	7.2E-10	1	2.0E-10	4.0E-02	7.1E-01	1.8E-8	9.8E-10	1.9E-8
Anthracene	2.5	1	5.0E-9	1	1.3E-9	3.0E+00	7.1E-01	1.7E-9	6.2E-9	7.9E-9
Benzo(a)anthracene	6.0	0.91	1.1E-8	1	3.1E-9	4.0E-02	7.1E-01	2.8E-7	1.5E-8	2.9E-7
Benzo(a)pyrene	4.6	0.91	8.4E-9	1	2.3E-9	4.0E-02	7.1E-01	2.1E-7	1.1E-8	2.2E-7
Benzo(b)fluoranthene	6.7	0.91	1.2E-8	1	3.4E-9	4.0E-02	7.1E-01	3.1E-7	1.7E-8	3.2E-7
Benzo(g,h,i)perylene	2.5	0.91	4.6E-9	1	1.3E-9	4.0E-02	7.1E-01	1.1E-7	6.2E-9	1.2E-7
Benzo(k)fluoranthene	2.7	0.91	5.0E-9	1	1.4E-9	4.0E-02	7.1E-01	1.3E-7	6.8E-9	1.3E-7
Chrysene	6.3	0.91	1.2E-8	1	3.2E-9	4.0E-02	7.1E-01	2.9E-7	1.6E-8	3.1E-7
Dibenz(a,h)anthracene	3.2	0.91	6.0E-9	1	1.6E-9	4.0E-02	7.1E-01	1.5E-7	8.1E-9	1.6E-7
Fluoranthene	13	1	2.6E-8	1	6.4E-9	4.0E-01	7.1E-01	6.4E-8	3.2E-8	9.6E-8
Fluorene	1.2	1	2.5E-9	1	6.3E-10	4.0E-01	7.1E-01	6.3E-9	3.1E-9	9.4E-9
Indeno(1,2,3-cd)pyrene	3.9	0.91	7.2E-9	1	2.0E-9	4.0E-02	7.1E-01	1.8E-7	9.7E-9	1.9E-7
Naphthalene	0.62	1	1.3E-9	1	3.1E-10	2.0E-02	7.1E-01	6.3E-8	1.5E-9	6.4E-8
Phenanthrene	10	0.91	1.8E-8	1	4.9E-9	4.0E-02	7.1E-01	4.4E-7	2.4E-8	4.7E-7
Pyrene	12	1	2.5E-8	1	6.2E-9	3.0E-01	7.1E-01	8.3E-8	3.1E-8	1.1E-7
Aroclor-1248	0.32	0.85	5.4E-10	1	1.6E-10	2.0E-05	2.0E-04	2.7E-5	2.8E-6	3.0E-5
Aroclor-1254	0.79	0.85	1.4E-9	1	4.0E-10	2.0E-05	2.0E-04	6.8E-5	7.0E-6	7.5E-5
Antimony	1.2	1	2.4E-9	1	6.1E-10	4.0E-04	NA	6.1E-6	NC	6.1E-6
Arsenic	29	1	5.8E-8	1	1.5E-8	3.0E-04	NA	1.9E-4	NC	1.9E-4
Barium	74	0.39	5.8E-8	1	3.7E-8	7.0E-02	NA	8.3E-7	NC	8.3E-7
Beryllium	0.65	1	1.3E-9	1	3.3E-10	2.0E-03	2.0E-04	6.6E-7	5.8E-6	6.4E-6
Cadmium	8.6	1	1.7E-8	1	4.4E-9	1.0E-03	NA	1.7E-5	NC	1.7E-5
Chromium	19	1	3.9E-8	1	9.8E-9	3.0E-03	1.0E-03	1.3E-5	3.4E-5	4.7E-5
Copper	35	1	7.2E-8	1	1.8E-8	4.0E-02	NA	1.8E-6	NC	1.8E-6
Lead	135	[illegible]	1.4E-7	1	6.9E-8	7.5E-04	NA	1.8E-4	NC	1.8E-4
Mercury	1.2	1	2.5E-9	1	6.3E-10	3.0E-04	NA	8.4E-6	NC	8.4E-6
Nickel	35	1	7.2E-8	1	1.8E-8	2.0E-03	NA	3.6E-5	NC	3.6E-5
Selenium	0.39	1	7.9E-10	1	2.0E-10	5.0E-03	NA	1.6E-7	NC	1.6E-7
Silver	0.12	1	2.5E-10	1	6.2E-11	5.0E-03	NA	5.0E-8	NC	5.0E-8
Thallium	0.45	1	9.2E-10	1	2.3E-10	8.0E-05	NA	1.1E-5	NC	1.1E-5
Vanadium	137	1.86	5.2E-7	1	6.9E-8	9.0E-03	NA	5.7E-5	NC	5.7E-5
Zinc	122	1	2.5E-7	1	6.2E-8	3.0E-01	NA	8.3E-7	NC	8.3E-7

TOTAL HAZARD INDEX = 6.3E-04 + 5.1E-05 = 7E-04

NOTES:
(a) EPCs presented in Table 2.
(b) RfD, RfC, and RAF values taken from Tables 5, 6, and 7, respectively.
(c) The fugitive dust gastrointestinal ingestion ADD is calculated by the following equation:
$ADD_{inhalation-GI} = [OHM]_{particulates} * 2 * RAF_{ing} * NADSIR_{fugd}$ where, $NADSIR_{fugd}$ = 1.0E-09 mg soil/kg-day
(d) The fugitive dust respiratory system ADD is calculated by the following equation:
$ADD_{inhalation} = [OHM]_{particulates} * 0.5 * RAF_{inh} * NADSIR_{fugd}$
(e) Ingestion Hazard Quotient = $ADD_{inhalation-GI}$ / RfD
Respiratory Hazard Quotient = ($ADD_{inhalation}$ * Body Weight (70 Kg) / Daily Inhalation Rate (20 m^3/day)) / RfC
and Hazard Index = Sum (Hazard Quotients)
NC = Not calculated
NA = Not Applicable/Available/Analyzed

TABLE A-32
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE UTILITY WORKER EXPOSURES TO FUGITIVE DUST FROM SOIL

Contaminant of Concern	EPC(a) (mg/kg)	Subchronic Soil GI Inhalation Exposure RAF (b)	Subchronic Soil GI Inhalation Exposure LADD (c) (mg/kg-day)	Subchronic Soil Respiratory Exposure RAF (b)	Subchronic Soil Respiratory Exposure LADD (d) (mg/kg-day)	SF (b) (mg/kg-day)$^{-1}$	Unit Risk (b) (mg/m^3)$^{-1}$	Chemical-Specific ELCR Ingestion (e)	Chemical-Specific ELCR Respiratory (e)	Chemical-Specific ELCR (e)
C9-C18 Aliphatics	22	NC	NC	NC	NC	NA	NA	NC	NC	NC
C19-C36 Aliphatics	39	NC	NC	NC	NC	NA	NA	NC	NC	NC
C11-C22 Aromatics	122	NC	NC	NC	NC	NA	NA	NC	NC	NC
2-Methylnaphthalene	0.50	NC	NC	NC	NC	NA	NA	NC	NC	NC
Acenaphthene	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Acenaphthylene	0.39	NC	NC	NC	NC	NA	NA	NC	NC	NC
Anthracene	2.5	NC	NC	NC	NC	NA	NA	NC	NC	NC
Benzo(a)anthracene	6.0	1	1.6E-10	1	4.1E-11	7.3E-01	1.7E+00	2.2E-10	8.4E-11	3.1E-10
Benzo(a)pyrene	4.6	1	1.2E-10	1	3.1E-11	7.3E+00	1.7E+00	1.7E-11	6.3E-11	8.0E-11
Benzo(b)fluoranthene	6.7	1	1.8E-10	1	4.5E-11	7.3E-01	1.7E+00	2.5E-10	9.3E-11	3.4E-10
Benzo(g,h,i)perylene	2.5	NC	NC	NC	NC	NA	NA	NC	NC	NC
Benzo(k)fluoranthene	2.7	1	7.3E-11	1	1.8E-11	7.3E-02	1.7E+00	1.0E-9	3.8E-11	1.0E-9
Chrysene	6.3	1	1.7E-10	1	4.3E-11	7.3E-02	1.7E+00	2.3E-9	8.8E-11	2.4E-9
Dibenz(a,h)anthracene	3.2	1	8.8E-11	1	2.2E-11	7.3E+00	1.7E+00	1.2E-11	4.5E-11	5.7E-11
Fluoranthene	13	NC	NC	NC	NC	NA	NA	NC	NC	NC
Fluorene	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Indeno(1,2,3-cd)pyrene	3.9	1	1.1E-10	1	2.6E-11	7.3E-01	1.7E+00	1.4E-10	5.4E-11	2.0E-10
Naphthalene	0.62	NC	NC	NC	NC	NA	NA	NC	NC	NC
Phenanthrene	10	NC	NC	NC	NC	NA	NA	NC	NC	NC
Pyrene	12	NC	NC	NC	NC	NA	NA	NC	NC	NC
Aroclor-1248	0.32	0.85	7.3E-12	1	2.1E-12	2.0E+00	5.0E-01	3.6E-12	1.5E-11	1.9E-11
Aroclor-1254	0.79	0.85	1.8E-11	1	5.4E-12	2.0E+00	5.0E-01	9.1E-12	3.7E-11	4.7E-11
Antimony	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Arsenic	29	1	7.8E-10	1	1.9E-10	1.5E+00	4.3E+00	5.2E-10	1.6E-10	6.7E-10
Barium	74	NC	NC	NC	NC	NA	NA	NC	NC	NC
Beryllium	0.65	NC	NC	1	4.4E-12	NA	2.4E+00	NC	6.4E-12	6.4E-12
Cadmium	8.6	NC	NC	1	5.8E-11	NA	1.8E+00	NC	1.1E-10	1.1E-10
Chromium	19	NC	NC	1	1.3E-10	NA	1.2E+01	NC	3.8E-11	3.8E-11
Copper	35	NC	NC	NC	NC	NA	NA	NC	NC	NC
Lead	135	NC	NC	NC	NC	NA	NA	NC	NC	NC
Mercury	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Nickel	35	NC	NC	NC	NC	NA	NA	NC	NC	NC
Selenium	0.39	NC	NC	NC	NC	NA	NA	NC	NC	NC
Silver	0.12	NC	NC	NC	NC	NA	NA	NC	NC	NC
Thallium	0.45	NC	NC	NC	NC	NA	NA	NC	NC	NC
Vanadium	137	NC	NC	NC	NC	NA	NA	NC	NC	NC
Zinc	122	NC	NC	NC	NC	NA	NA	NC	NC	NC

ELCR = 4.5E-09 + 8.3E-10 = 5E-09

NOTES:

(a) EPCs presented in Table 2.

(b) SF, Unit Risk, and RAF values taken from Tables 5, 6, and 7, respectively.

(c) The fugitive dust gastrointestinal ingestion ADD is calculated by the following equation:

$\text{LADD}_{\text{inhalation-GI}} = [\text{OHM}]_{\text{particulates}} * 2 * \text{RAF}_{\text{ing}} * \text{NLADSIR}_{\text{fugd}}$ where, $\text{NLADSIR}_{\text{fugd}} =$ 1.4E-11 mg soil/kg-day

(d) The fugitive dust respiratory system ADD is calculated by the following equation:

$\text{LADD}_{\text{inhalation}} = [\text{OHM}]_{\text{particulates}} * 0.5 * \text{RAF}_{\text{inh}} * \text{NLADSIR}_{\text{fugd}}$

(e) Ingestion ELCR = $\text{LADD}_{\text{inhalation-GI}}$ * SF

Respiratory ELCR = ($\text{LADD}_{\text{inhalation}}$ * Body Weight (70 Kg) / Daily Inhalation Rate (20 m^3/day)) * Unit Risk

and Hazard Index = Sum (Hazard Quotients)

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-33
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS FOR FUTURE UTILITY WORKER EXPOSURES TO GROUNDWATER

		Subchronic Ingestion Exposure		Subchronic Dermal Contact Exposure			Subchronic	Chemical-Specific Hazard Quotient		Chemical-Specific Hazard
Contaminant of Concern	EPC(a) (ug/L)	RAF (b)	ADD (c) (mg/kg-day)	RAF (b)	Kp (cm/hr)	ADD (d) (mg/kg-day)	RfD (b) (mg/kg-day)	Ingestion (e)	Dermal (e)	Index (e)
C9-C18 Aliphatics	44	1	1.3E-06	1	0.032	2.3E-05	1.0E+00	1.3E-06	2.3E-05	2.4E-05
C19-C36 Aliphatics	49	1	1.4E-06	1	0.032	2.5E-05	2.0E+01	7.2E-08	1.3E-06	1.3E-06
Arsenic	11	1	3.2E-07	1	0.001	1.8E-07	3.0E-04	1.1E-03	6.0E-04	1.7E-03
Barium	83	1	2.4E-06	1	0.001	1.4E-06	7.0E-02	3.5E-05	1.9E-05	5.4E-05
Beryllium	0.48	1	1.4E-08	1	0.001	7.8E-09	2.0E-03	7.0E-06	3.9E-06	1.1E-05
Chromium	1.1	1	3.2E-08	1	0.001	1.8E-08	3.0E-03	1.1E-05	6.0E-06	1.7E-05
Nickel	12	1	3.4E-07	1	0.000	3.8E-08	2.0E-03	1.7E-04	1.9E-05	1.9E-04
Selenium	188	1	5.5E-06	1	0.001	3.1E-06	5.0E-03	1.1E-03	6.1E-04	1.7E-03
Vanadium	3710	1.9	2.1E-04	1	0.001	6.1E-05	9.0E-03	2.3E-02	6.7E-03	3.0E-02
Zinc	17	1	5.1E-07	1	0.001	1.7E-07	3.0E-01	1.7E-06	5.7E-07	2.3E-06
							TOTAL HAZARD INDEX =	2.5E-02 +	8.0E-03	= 3E-02

NOTES:

(a) EPCs presented in Table 3.

(b) RfD and RAF values taken from Tables 5 and 7, respectively.

(c) The groundwater ingestion average daily dose ADD is calculated by the following equation:
GW Ingestion ADD = [OHM]gw * 10^{-3} mg/ug * RAFing * NADSIRgw where, NADSIRgw = 2.9E-05 L_{gw}/kg-day

(d) The GW dermal contact ADD is calculated by the following equation:
GW Contact ADD = [OHM]gw* 10^{-3} L/cm^3 *10^{-3}mg/ug *RAFderm *Kp* NADSCRgw where, NADSCRgw = 1.6E+01 cm$^2_{gw}$-hr/kg-day

TABLE A-34
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE UTILITY WORKER EXPOSURES TO GROUNDWATER

		Ingestion Exposure		Dermal Contact Exposure				Chemical-Specific ELCR		Chemical-Specific
Contaminant of Concern	EPC(a) (ug/L)	RAF (b)	LADD (c) (mg/kg-day)	RAF (b)	Kp (cm/hr)	LADD (d) (mg/kg-day)	SF (b) $(mg/kg\text{-}day)^{-1}$	Ingestion (e)	Dermal (e)	ELCR (e)
C9-C18 Aliphatics	44	NC	NA	NC	0.032	NA	NA	NA	NA	NA
C19-C36 Aliphatics	49	NC	NA	NC	0.032	NA	NA	NA	NA	NA
Arsenic	11	1	4.3E-09	1	0.001	2.4E-09	1.5E+00	6.5E-09	3.6E-09	1.0E-08
Barium	83	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Beryllium	0.48	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Chromium	1.1	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Nickel	12	NC	NA	NC	0.000	NA	NA	NA	NA	NA
Selenium	188	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Vanadium	3710	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Zinc	17	NC	NA	NC	0.001	NA	NA	NA	NA	NA

ELCR = 6.5E-09 + 3.6E-09 = 1E-08

NOTES:

(a) EPCs presented in Table 3.

(b) SF and RAF values taken from Tables 5 and 7, respectively.

(c) The groundwater ingestion lifetime average daily dose LADD is calculated by the following equation:

GW Ingestion LADD = [OHM]gw * 10^{-3} mg/ug * RAFing * NLADSIRgw where, NLADSIRgw = 3.9E-07 L_{gw}/kg-day

(d) The GW dermal contact LADD is calculated by the following equation:

GW Contact LADD = [OHM]gw* 10^{-3} L/cm^3 *10^{-3}mg/ug *RAFderm *Kp* NLADSCRgw where, NLADSCRgw = 2.2E-01 cm^2_{gw}-hr/kg-day

TABLE A-35
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS
FOR FUTURE UTILITY WORKER EXPOSURES TO SOIL GAS (FROM SOIL AND GROUNDWATER) IN OUTDOOR AIR

Contaminant of Concern	EPC(a) (mg/m^3)	Inhalation Exposure ADD (c) (mg/m^3)	Subchronic RfC (b) (mg/m^3)	Chemical-Specific Hazard Quotient Inhalation (d)
C9-C18 Aliphatics	1.3E-02	1.7E-04	2.0E+00	8.7E-05
C11-C22 Aromatics	5.5E-04	7.5E-06	5.0E-01	1.5E-05
2-Methylnaphthalene	5.7E-06	7.8E-08	7.1E-01	1.1E-07
Naphthalene	1.4E-06	2.0E-08	7.1E-01	2.8E-08

TOTAL HAZARD INDEX = 1E-04

NOTES:

(a) EPCs presented in Table 4.

(b) RfC values taken from Table 6.

(c) The soil gas inhalation average daily dose ADD is calculated by the following equation:

Soil Gas Inhalation ADD = [OHM]air * NADSIR$_{air}$ where, NADSIRair = 1.4E-02

(d) Hazard Quotient = ADD/RfD and Hazard Index = Sum (Hazard Quotients)

TABLE A-36
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE UTILITY WORKER EXPOSURES TO SOIL GAS (FROM SOIL AND GROUNDWATER) IN OUTDOOR AIR

Contaminant of Concern	EPC(a) (mg/m^3)	Inhalation Exposure LADD (c) (mg/m^3)	Unit Risk (b) $(mg/m^3)^{-1}$	Chemical-Specific ELCR Inhalation (d)
C9-C18 Aliphatics	1.3E-02	2.3E-06	NA	NC
C11-C22 Aromatics	5.5E-04	1.0E-07	NA	NC
2-Methylnaphthalene	5.7E-06	1.0E-09	NA	NC
Naphthalene	1.4E-06	2.6E-10	NA	NC

ELCR = NA

NOTES:
(a) EPCs presented in Table 4.
(b) Unit Risk values taken from Table 6.
(c) The soil gas inhalation lifetime average daily dose LADD is calculated by the following equation:
Soil Gas Inhalation LADD = [OHM]air * $NLADSIR_{air}$ where, NLADSIRair = 1.8E-04
(d) Excess Lifetime Cancer Risk = LADD * SF

TABLE A-37
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS FOR FUTURE CHILD RECREATIONAL USER EXPOSURES TO SOIL

		Chronic Soil Ingestion Exposure		Chronic Soil Dermal Contact Exposure			Chemical-Specific Hazard Quotient		Chemical-Specific Hazard Index
Contaminant of Concern	EPC(a) (mg/kg)	RAF (b)	ADD (c) (mg/kg-day)	RAF (b)	ADD (d) (mg/kg-day)	Chronic RfD (b) (mg/kg-day)	Ingestion (e)	Dermal (e)	(e)
C9-C18 Aliphatics	22	1	3.2E-05	0.5	1.4E-04	1.0E-01	3.2E-04	1.4E-03	1.7E-03
C19-C36 Aliphatics	39	1	5.6E-05	0.1	4.8E-05	2.0E+00	2.8E-05	2.4E-05	5.2E-05
C11-C22 Aromatics	122	0.36	6.3E-05	0.1	1.5E-04	3.0E-02	2.1E-03	4.9E-03	7.0E-03
2-Methylnaphthalene	0.50	1	7.2E-07	0.1	6.1E-07	4.0E-02	1.8E-05	1.5E-05	3.3E-05
Acenaphthene	1.2	1	1.8E-06	0.2	3.0E-06	6.0E-02	3.0E-05	5.0E-05	8.0E-05
Acenaphthylene	0.39	0.91	5.1E-07	0.18	8.6E-07	4.0E-02	1.3E-05	2.1E-05	3.4E-05
Anthracene	2.5	1	3.5E-06	0.29	8.7E-06	3.0E-01	1.2E-05	2.9E-05	4.1E-05
Benzo(a)anthracene	6.0	0.91	7.8E-06	0.18	1.3E-05	4.0E-02	2.0E-04	3.3E-04	5.2E-04
Benzo(a)pyrene	4.6	0.91	5.9E-06	0.18	9.9E-06	4.0E-02	1.5E-04	2.5E-04	4.0E-04
Benzo(b)fluoranthene	6.7	0.91	8.6E-06	0.18	1.5E-05	4.0E-02	2.2E-04	3.6E-04	5.8E-04
Benzo(g,h,i)perylene	2.5	0.91	3.2E-06	0.18	5.4E-06	4.0E-02	8.0E-05	1.3E-04	2.2E-04
Benzo(k)fluoranthene	2.7	0.91	3.5E-06	0.18	5.9E-06	4.0E-02	8.8E-05	1.5E-04	2.4E-04
Chrysene	6.3	0.91	8.2E-06	0.18	1.4E-05	4.0E-02	2.1E-04	3.5E-04	5.5E-04
Dibenz(a,h)anthracene	3.2	0.91	4.2E-06	0.08	3.1E-06	4.0E-02	1.1E-04	7.9E-05	1.8E-04
Fluoranthene	13	1	1.8E-05	0.2	3.1E-05	4.0E-02	4.5E-04	7.7E-04	1.2E-03
Fluorene	1.2	1	1.8E-06	0.2	3.0E-06	4.0E-01	4.4E-06	7.5E-06	1.2E-05
Indeno(1,2,3-cd)pyrene	3.9	0.91	5.0E-06	0.18	8.5E-06	4.0E-02	1.3E-04	2.1E-04	3.4E-04
Naphthalene	0.62	1	8.8E-07	0.1	7.5E-07	2.0E-02	4.4E-05	3.7E-05	8.1E-05
Phenanthrene	10	0.91	1.2E-05	0.18	2.1E-05	4.0E-02	3.1E-04	5.2E-04	8.3E-04
Pyrene	12	1	1.8E-05	0.2	3.0E-05	3.0E-02	5.9E-04	1.0E-03	1.6E-03
Aroclor-1248	0.32	0.85	3.8E-07	0.067	2.6E-07	2.0E-05	1.9E-02	1.3E-02	3.2E-02
Aroclor-1254	0.79	0.85	9.6E-07	0.067	6.4E-07	2.0E-05	4.8E-02	3.2E-02	8.0E-02
Antimony	1.2	1	1.7E-06	0.1	1.5E-06	4.0E-04	4.3E-03	3.6E-03	7.9E-03
Arsenic	29	1	4.1E-05	0.03	1.0E-05	3.0E-04	1.4E-01	3.5E-02	1.7E-01
Barium	74	0.39	4.1E-05	0.3	2.7E-04	7.0E-02	5.8E-04	3.8E-03	4.4E-03
Beryllium	0.65	1	9.3E-07	0.03	2.4E-07	2.0E-03	4.6E-04	1.2E-04	5.8E-04
Cadmium	8.6	1	1.2E-05	0.14	1.5E-05	1.0E-03	1.2E-02	1.5E-02	2.7E-02
Chromium	19	1	2.8E-05	0.09	2.1E-05	3.0E-03	9.2E-03	7.0E-03	1.6E-02
Copper	35	1	5.1E-05	0.3	1.3E-04	4.0E-02	1.3E-03	3.2E-03	4.5E-03
Lead	135	0.5	9.6E-05	0.006	9.9E-06	7.5E-04	1.3E-01	1.3E-02	1.4E-01
Mercury	1.2	1	1.8E-06	0.05	7.6E-07	3.0E-04	5.9E-03	2.5E-03	8.4E-03
Nickel	35	1	5.0E-05	0.35	1.5E-04	2.0E-03	2.5E-02	7.5E-02	1.0E-01
Selenium	0.39	1	5.5E-07	0.002	9.4E-09	5.0E-03	1.1E-04	1.9E-06	1.1E-04
Silver	0.12	1	1.8E-07	0.25	3.7E-07	5.0E-03	3.5E-05	7.5E-05	1.1E-04
Thallium	0.45	1	6.4E-07	0.01	5.5E-08	8.0E-05	8.0E-03	6.9E-04	8.7E-03
Vanadium	137	1.86	3.6E-04	0.14	2.3E-04	9.0E-03	4.0E-02	2.6E-02	6.6E-02
Zinc	122	1	1.7E-04	0.02	3.0E-05	3.0E-01	5.8E-04	9.9E-05	6.8E-04

TOTAL HAZARD INDEX = 4.4E-01 + 2.4E-01 = 7E-01

NOTES:

(a) EPCs presented in Table 2.

(b) RfD and RAF values taken from Tables 5 and 7, respectively.

(c) The soil ingestion average daily dose ADD is calculated by the following equation:

Soil Ingestion ADD = [OHM]soil * 10^{-6} kg/mg * RAFing * NADSIRsoil where, NADSIRsoil = 1.4E+00 mg soil/kg-day

(d) The soil dermal contact ADD is calculated by the following equation:

Soil Contact ADD = [OHM]soil * 10^{-6} kg/mg * RAFderm * NADSCRsoil where, NADSCRsoil = 1.2E+01 mg soil/kg-day

(e) Hazard Quotient = ADD/RfD and Hazard Index = Sum (Hazard Quotients)

TABLE A-38
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE CHILD RECREATIONAL USER EXPOSURES TO SOIL

Contaminant of Concern	EPC(a) (mg/kg)	Soil Ingestion Exposure RAF (b)	Soil Ingestion Exposure LADD (c) (mg/kg-day)	Soil Dermal Contact Exposure RAF (b)	Soil Dermal Contact Exposure LADD (d) (mg/kg-day)	SF (b) $(mg/kg\text{-}day)^{-1}$	Chemical-Specific ELCR Ingestion (e)	Chemical-Specific ELCR Dermal (e)	Chemical-Specific ELCR (e)
C9-C18 Aliphatics	22	NC	NC	NC	NC	NA	NC	NC	NC
C19-C36 Aliphatics	39	NC	NC	NC	NC	NA	NC	NC	NC
C11-C22 Aromatics	122	NC	NC	NC	NC	NA	NC	NC	NC
2-Methylnaphthalene	0.50	NC	NC	NC	NC	NA	NC	NC	NC
Acenaphthene	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Acenaphthylene	0.39	NC	NC	NC	NC	NA	NC	NC	NC
Anthracene	2.5	NC	NC	NC	NC	NA	NC	NC	NC
Benzo(a)anthracene	6.0	1	8.0E-07	0.2	1.4E-06	7.3E-01	5.9E-07	1.0E-06	1.6E-06
Benzo(a)pyrene	4.6	1	6.1E-07	0.2	1.0E-06	7.3E+00	4.4E-06	7.5E-06	1.2E-05
Benzo(b)fluoranthene	6.7	1	8.9E-07	0.2	1.5E-06	7.3E-01	6.5E-07	1.1E-06	1.7E-06
Benzo(g,h,i)perylene	2.5	NC	NC	NC	NC	NA	NC	NC	NC
Benzo(k)fluoranthene	2.7	1	3.6E-07	0.2	6.2E-07	7.3E-02	2.6E-08	4.5E-08	7.1E-08
Chrysene	6.3	1	8.4E-07	0.2	1.4E-06	7.3E-02	6.1E-08	1.0E-07	1.7E-07
Dibenz(a,h)anthracene	3.2	1	4.3E-07	0.09	3.3E-07	7.3E+00	3.1E-06	2.4E-06	5.6E-06
Fluoranthene	13	NC	NC	NC	NC	NA	NC	NC	NC
Fluorene	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Indeno(1,2,3-cd)pyrene	3.9	1	5.2E-07	0.2	8.8E-07	7.3E-01	3.8E-07	6.4E-07	1.0E-06
Naphthalene	0.62	NC	NC	NC	NC	NA	NC	NC	NC
Phenanthrene	10	NC	NC	NC	NC	NA	NC	NC	NC
Pyrene	12	NC	NC	NC	NC	NA	NC	NC	NC
Aroclor-1248	0.32	0.85	3.6E-08	0.07	2.4E-08	2.0E+00	7.1E-08	4.8E-08	1.2E-07
Aroclor-1254	0.79	0.85	9.0E-08	0.07	6.0E-08	2.0E+00	1.8E-07	1.2E-07	3.0E-07
Antimony	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Arsenic	29	1	3.8E-06	0.03	9.7E-07	1.5E+00	5.7E-06	1.5E-06	7.2E-06
Barium	74	NC	NC	NC	NC	NA	NC	NC	NC
Beryllium	0.65	NC	NC	NC	NC	NA	NC	NC	NC
Cadmium	8.6	NC	NC	NC	NC	NA	NC	NC	NC
Chromium	19	NC	NC	NC	NC	NA	NC	NC	NC
Copper	35	NC	NC	NC	NC	NA	NC	NC	NC
Lead	135	NC	NC	NC	NC	NA	NC	NC	NC
Mercury	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Nickel	35	NC	NC	NC	NC	NA	NC	NC	NC
Selenium	0.39	NC	NC	NC	NC	NA	NC	NC	NC
Silver	0.12	NC	NC	NC	NC	NA	NC	NC	NC
Thallium	0.45	NC	NC	NC	NC	NA	NC	NC	NC
Vanadium	137	NC	NC	NC	NC	NA	NC	NC	NC
Zinc	122	NC	NC	NC	NC	NA	NC	NC	NC

ELCR = 1.5E-05 + 1.4E-05 = 3E-05

NOTES:

(a) EPCs presented in Table 2.

(b) SF and RAF values taken from Tables 5 and 7, respectively.

(c) The soil ingestion lifetime average daily dose LADD is calculated by the following equation:

Soil Ingestion LADD = [OHM]soil * 10^{-6} kg/mg * RAFing * NLADSIRsoil where, NLADSIRsoil = 1.3E-01 mg soil/kg-day

(d) The soil dermal contact ADD is calculated by the following equation:

Soil Contact LADD = [OHM]soil * 10^{-6} kg/mg * RAFderm * NLADSCRsoil where, NLADSCRsoil = 1.1E+00 mg soil/kg-day

(e) Excess Lifetime Cancer Risk = LADD * SF

TABLE A-39
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS FOR FUTURE CHILD RECREATIONAL USER EXPOSURES TO FUGITIVE DUST FROM SOIL

Contaminant of Concern	EPC(a) (mg/kg)	Chronic Soil GI Inhalation Exposure RAF (b)	Chronic Soil GI Inhalation Exposure ADD (c) (mg/kg-day)	Chronic Soil Respiratory Exposure RAF (b)	Chronic Soil Respiratory Exposure ADD (d) (mg/kg-day)	Chronic RfD (b) (mg/kg-day)	Chronic RfC (b) (mg/m³)	Chemical-Specific Hazard Quotient Ingestion (e)	Chemical-Specific Hazard Quotient Respiratory (e)	Chemical-Specific Hazard Index (e)
C9-C18 Aliphatics	22	1	1.1E-8	1	2.8E-9	1.0E-01	2.0E-01	1.1E-7	4.8E-8	1.6E-7
C19-C36 Aliphatics	39	1	1.9E-8	1	4.8E-9	2.0E+00	NA	9.7E-9	NC	9.7E-9
C11-C22 Aromatics	122	0.36	2.2E-8	1	1.5E-8	3.0E-02	5.0E-02	7.2E-7	1.1E-6	1.8E-6
2-Methylnaphthalene	0.50	1	2.5E-10	1	6.2E-11	4.0E-02	7.1E-02	6.2E-9	3.1E-9	9.3E-9
Acenaphthene	1.2	1	6.1E-10	1	1.5E-10	6.0E-02	7.1E-02	1.0E-8	7.6E-9	1.8E-8
Acenaphthylene	0.39	0.91	1.8E-10	1	4.8E-11	4.0E-02	7.1E-02	4.4E-9	2.4E-9	6.8E-9
Anthracene	2.5	1	1.2E-9	1	3.0E-10	3.0E-01	7.1E-02	4.1E-9	1.5E-8	1.9E-8
Benzo(a)anthracene	6.0	0.91	2.7E-9	1	7.4E-10	4.0E-02	7.1E-02	6.8E-8	3.7E-8	1.0E-7
Benzo(a)pyrene	4.6	0.91	2.0E-9	1	5.6E-10	4.0E-02	7.1E-02	5.1E-8	2.8E-8	7.9E-8
Benzo(b)fluoranthene	6.7	0.91	3.0E-9	1	8.2E-10	4.0E-02	7.1E-02	7.5E-8	4.0E-8	1.2E-7
Benzo(g,h,i)perylene	2.5	0.91	1.1E-9	1	3.0E-10	4.0E-02	7.1E-02	2.8E-8	1.5E-8	4.3E-8
Benzo(k)fluoranthene	2.7	0.91	1.2E-9	1	3.3E-10	4.0E-02	7.1E-02	3.0E-8	1.6E-8	4.7E-8
Chrysene	6.3	0.91	2.8E-9	1	7.8E-10	4.0E-02	7.1E-02	7.1E-8	3.8E-8	1.1E-7
Dibenz(a,h)anthracene	3.2	0.91	1.5E-9	1	4.0E-10	4.0E-02	7.1E-02	3.6E-8	2.0E-8	5.6E-8
Fluoranthene	13	1	6.2E-9	1	1.6E-9	4.0E-02	7.1E-02	1.6E-7	7.7E-8	2.3E-7
Fluorene	1.2	1	6.1E-10	1	1.5E-10	4.0E-01	7.1E-02	1.5E-9	7.5E-9	9.0E-9
Indeno(1,2,3-cd)pyrene	3.9	0.91	1.7E-9	1	4.8E-10	4.0E-02	7.1E-02	4.4E-8	2.4E-8	6.7E-8
Naphthalene	0.62	1	3.0E-10	1	7.6E-11	2.0E-02	7.1E-02	1.5E-8	3.7E-9	1.9E-8
Phenanthrene	10	0.91	4.3E-9	1	1.2E-9	4.0E-02	7.1E-02	1.1E-7	5.8E-8	1.7E-7
Pyrene	12	1	6.1E-9	1	1.5E-9	3.0E-02	7.1E-02	2.0E-7	7.5E-8	2.8E-7
Aroclor-1248	0.32	0.85	1.3E-10	1	3.9E-11	2.0E-05	2.0E-05	6.6E-6	6.8E-6	1.3E-5
Aroclor-1254	0.79	0.85	3.3E-10	1	9.7E-11	2.0E-05	2.0E-05	1.7E-5	1.7E-5	3.4E-5
Antimony	1.2	1	5.9E-10	1	1.5E-10	4.0E-04	NA	1.5E-6	NC	1.5E-6
Arsenic	29	1	1.4E-8	1	3.5E-9	3.0E-04	NA	4.7E-5	NC	4.7E-5
Barium	74	0.39	1.4E-8	1	9.1E-9	7.0E-02	NA	2.0E-7	NC	2.0E-7
Beryllium	0.65	1	3.2E-10	1	8.0E-11	2.0E-03	2.0E-05	1.6E-7	1.4E-5	1.4E-5
Cadmium	8.6	1	4.2E-9	1	1.1E-9	1.0E-03	NA	4.2E-6	NC	4.2E-6
Chromium	19	1	9.5E-9	1	2.4E-9	3.0E-03	1.0E-04	3.2E-6	8.3E-5	8.6E-5
Copper	35	1	1.7E-8	1	4.4E-9	4.0E-02	NA	4.4E-7	NC	4.4E-7
Lead	135	0.5	3.3E-8	1	1.7E-8	7.5E-04	NA	4.4E-5	NC	4.4E-5
Mercury	1.2	1	6.1E-10	1	1.5E-10	3.0E-04	NA	2.0E-6	NC	2.0E-6
Nickel	35	1	1.7E-8	1	4.3E-9	2.0E-03	NA	8.7E-6	NC	8.7E-6
Selenium	0.39	1	1.9E-10	1	4.8E-11	5.0E-03	NA	3.8E-8	NC	3.8E-8
Silver	0.12	1	6.1E-11	1	1.5E-11	5.0E-03	NA	1.2E-8	NC	1.2E-8
Thallium	0.45	1	2.2E-10	1	5.6E-11	8.0E-05	NA	2.8E-6	NC	2.8E-6
Vanadium	137	1.86	1.3E-7	1	1.7E-8	9.0E-03	NA	1.4E-5	NC	1.4E-5
Zinc	122	1	6.0E-8	1	1.5E-8	3.0E-01	NA	2.0E-7	NC	2.0E-7

TOTAL HAZARD INDEX = 1.5E-04 + 1.2E-04 = 3E-04

NOTES:

(a) EPCs presented in Table 2.

(b) RfD, RfC, and RAF values taken from Tables 5, 6, and 7, respectively.

(c) The fugitive dust gastrointestinal ingestion ADD is calculated by the following equation:

$ADD_{inhalation-GI} = [OHM]_{particulates} * 2 * RAF_{ing} * NADSIR_{fugd}$ where, $NADSIR_{fugd} =$ 2.5E-10 mg soil/kg-day

(d) The fugitive dust respiratory system ADD is calculated by the following equation:

$ADD_{inhalation} = [OHM]_{particulates} * 0.5 * RAF_{inh} * NADSIR_{fugd}$

(e) Ingestion Hazard Quotient = $ADD_{inhalation-GI}$ / RfD

Respiratory Hazard Quotient = ($ADD_{inhalation}$ * Body Weight (70 Kg) / Daily Inhalation Rate (20 m³/day)) / RfC

and Hazard Index = Sum (Hazard Quotients)

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-40

LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE CHILD RECREATIONAL USER EXPOSURES TO FUGITIVE DUST FROM SOIL

		Chronic Soil GI Inhalation Exposure		**Chronic Soil Respiratory Exposure**				**Chemical-Specific ELCR**		**Chemical-Specific**
Contaminant of Concern	**EPC(a) (mg/kg)**	**RAF (b)**	**LADD (c) (mg/kg-day)**	**RAF (b)**	**LADD (d) (mg/kg-day)**	**SF (b) $(mg/kg\text{-}day)^{-1}$**	**Unit Risk (b) $(mg/m^3)^{-1}$**	**Ingestion (e)**	**Respiratory (e)**	**ELCR (e)**
C9-C18 Aliphatics	22	NC	NC	NC	NC	NA	NA	NC	NC	NC
C19-C36 Aliphatics	39	NC	NC	NC	NC	NA	NA	NC	NC	NC
C11-C22 Aromatics	122	NC	NC	NC	NC	NA	NA	NC	NC	NC
2-Methylnaphthalene	0.50	NC	NC	NC	NC	NA	NA	NC	NC	NC
Acenaphthene	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Acenaphthylene	0.39	NC	NC	NC	NC	NA	NA	NC	NC	NC
Anthracene	2.5	NC	NC	NC	NC	NA	NA	NC	NC	NC
Benzo(a)anthracene	6.0	1	2.8E-10	1	6.9E-11	7.3E-01	1.7E+00	3.8E-10	1.4E-10	5.2E-10
Benzo(a)pyrene	4.6	1	2.1E-10	1	5.2E-11	7.3E+00	1.7E+00	2.9E-11	1.1E-10	1.4E-10
Benzo(b)fluoranthene	6.7	1	3.1E-10	1	7.7E-11	7.3E-01	1.7E+00	4.2E-10	1.6E-10	5.8E-10
Benzo(g,h,i)perylene	2.5	NC	NC	NC	NC	NA	NA	NC	NC	NC
Benzo(k)fluoranthene	2.7	1	1.2E-10	1	3.1E-11	7.3E-02	1.7E+00	1.7E-9	6.4E-11	1.8E-9
Chrysene	6.3	1	2.9E-10	1	7.3E-11	7.3E-02	1.7E+00	4.0E-9	1.5E-10	4.1E-9
Dibenz(a,h)anthracene	3.2	1	1.5E-10	1	3.7E-11	7.3E+00	1.7E+00	2.0E-11	7.7E-11	9.7E-11
Fluoranthene	13	NC	NC	NC	NC	NA	NA	NC	NC	NC
Fluorene	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Indeno(1,2,3-cd)pyrene	3.9	1	1.8E-10	1	4.5E-11	7.3E-01	1.7E+00	2.4E-10	9.2E-11	3.4E-10
Naphthalene	0.62	NC	NC	NC	NC	NA	NA	NC	NC	NC
Phenanthrene	10	NC	NC	NC	NC	NA	NA	NC	NC	NC
Pyrene	12	NC	NC	NC	NC	NA	NA	NC	NC	NC
Aroclor-1248	0.32	0.85	1.2E-11	1	3.6E-12	2.0E+00	5.0E-01	6.2E-12	2.5E-11	3.2E-11
Aroclor-1254	0.79	0.85	3.1E-11	1	9.1E-12	2.0E+00	5.0E-01	1.5E-11	6.4E-11	7.9E-11
Antimony	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Arsenic	29	1	1.3E-9	1	3.3E-10	1.5E+00	4.3E+00	8.8E-10	2.7E-10	1.1E-9
Barium	74	NC	NC	NC	NC	NA	NA	NC	NC	NC
Beryllium	0.65	NC	NC	1	7.5E-12	NA	2.4E+00	NC	1.1E-11	1.1E-11
Cadmium	8.6	NC	NC	1	9.9E-11	NA	1.8E+00	NC	1.9E-10	1.9E-10
Chromium	19	NC	NC	1	2.2E-10	NA	1.2E+01	NC	6.5E-11	6.5E-11
Copper	35	NC	NC	NC	NC	NA	NA	NC	NC	NC
Lead	125	NC	NC	NC	NC	NA	NA	NC	NC	NC
Mercury	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Nickel	35	NC	NC	NC	NC	NA	NA	NC	NC	NC
Selenium	0.39	NC	NC	NC	NC	NA	NA	NC	NC	NC
Silver	0.12	NC	NC	NC	NC	NA	NA	NC	NC	NC
Thallium	0.45	NC	NC	NC	NC	NA	NA	NC	NC	NC
Vanadium	137	NC	NC	NC	NC	NA	NA	NC	NC	NC
Zinc	122	NC	NC	NC	NC	NA	NA	NC	NC	NC

ELCR = 7.7E-09 + 1.4E-09 = 9E-09

NOTES:

(a) EPCs presented in Table 2.

(b) SF, Unit Risk, and RAF values taken from Tables 5, 6, and 7, respectively.

(c) The fugitive dust gastrointestinal ingestion ADD is calculated by the following equation:

$\text{LADD}_{inhalation\text{-}GI} = [\text{OHM}]_{particulate} * 2 * \text{RAF}_{ing} * \text{NLADSIR}_{fugd}$ where, NLADSIR_{fugd} = 2.3E-11 mg soil/kg-day

(d) The fugitive dust respiratory system ADD is calculated by the following equation:

$\text{LADD}_{inhalation} = [\text{OHM}]_{particulate} * 0.5 * \text{RAF}_{inh} * \text{NLADSIR}_{fugd}$

(e) Ingestion ELCR = $\text{LADD}_{inhalation\text{-}GI}$ * SF

Respiratory ELCR = ($\text{LADD}_{inhalation}$ * Body Weight (70 Kg) / Daily Inhalation Rate (20 m^3/day)) * Unit Risk

and Hazard Index = Sum (Hazard Quotients)

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-40

LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE CHILD RECREATIONAL USER EXPOSURES TO FUGITIVE DUST FROM SOIL

		Chronic Soil GI Inhalation Exposure		Chronic Soil Respiratory Exposure				Chemical-Specific ELCR		Chemical-Specific
Contaminant of Concern	EPC(a) (mg/kg)	RAF (b)	LADD (c) (mg/kg-day)	RAF (b)	LADD (d) (mg/kg-day)	SF (b) (mg/kg-day)$^{-1}$	Unit Risk (b) (mg/m^3)$^{-1}$	Ingestion (e)	Respiratory (e)	ELCR (e)
C9-C18 Aliphatics	22	NC	NC	NC	NC	NA	NA	NC	NC	NC
C19-C36 Aliphatics	39	NC	NC	NC	NC	NA	NA	NC	NC	NC
C11-C22 Aromatics	122	NC	NC	NC	NC	NA	NA	NC	NC	NC
2-Methylnaphthalene	0.50	NC	NC	NC	NC	NA	NA	NC	NC	NC
Acenaphthene	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Acenaphthylene	0.39	NC	NC	NC	NC	NA	NA	NC	NC	NC
Anthracene	2.5	NC	NC	NC	NC	NA	NA	NC	NC	NC
Benzo(a)anthracene	6.0	1	2.8E-10	1	6.9E-11	7.3E-01	1.7E+00	3.8E-10	1.4E-10	5.2E-10
Benzo(a)pyrene	4.6	1	2.1E-10	1	5.2E-11	7.3E+00	1.7E+00	2.9E-11	1.1E-10	1.4E-10
Benzo(b)fluoranthene	6.7	1	3.1E-10	1	7.7E-11	7.3E-01	1.7E+00	4.2E-10	1.6E-10	5.8E-10
Benzo(g,h,i)perylene	2.5	NC	NC	NC	NC	NA	NA	NC	NC	NC
Benzo(k)fluoranthene	2.7	1	1.2E-10	1	3.1E-11	7.3E-02	1.7E+00	1.7E-9	6.4E-11	1.8E-9
Chrysene	6.3	1	2.9E-10	1	7.3E-11	7.3E-02	1.7E+00	4.0E-9	1.5E-10	4.1E-9
Dibenz(a,h)anthracene	3.2	1	1.5E-10	1	3.7E-11	7.3E+00	1.7E+00	2.0E-11	7.7E-11	9.7E-11
Fluoranthene	13	NC	NC	NC	NC	NA	NA	NC	NC	NC
Fluorene	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Indeno(1,2,3-cd)pyrene	3.9	1	1.8E-10	1	4.5E-11	7.3E-01	1.7E+00	2.4E-10	9.2E-11	3.4E-10
Naphthalene	0.62	NC	NC	NC	NC	NA	NA	NC	NC	NC
Phenanthrene	10	NC	NC	NC	NC	NA	NA	NC	NC	NC
Pyrene	12	NC	NC	NC	NC	NA	NA	NC	NC	NC
Aroclor-1248	0.32	0.85	1.2E-11	1	3.6E-12	2.0E+00	5.0E-01	6.2E-12	2.5E-11	3.2E-11
Aroclor-1254	0.79	0.85	3.1E-11	1	9.1E-12	2.0E+00	5.0E-01	1.5E-11	6.4E-11	7.9E-11
Antimony	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Arsenic	29	1	1.3E-9	1	3.3E-10	1.5E+00	4.3E+00	8.8E-10	2.7E-10	1.1E-9
Barium	74	NC	NC	NC	NC	NA	NA	NC	NC	NC
Beryllium	0.65	NC	NC	1	7.5E-12	NA	2.4E+00	NC	1.1E-11	1.1E-11
Cadmium	8.6	NC	NC	1	9.9E-11	NA	1.8E+00	NC	1.9E-10	1.9E-10
Chromium	19	NC	NC	1	2.2E-10	NA	1.2E+01	NC	6.5E-11	6.5E-11
Copper	35	NC	NC	NC	NC	NA	NA	NC	NC	NC
Lead	125	NC	NC	NC	NC	NA	NA	NC	NC	NC
Mercury	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Nickel	35	NC	NC	NC	NC	NA	NA	NC	NC	NC
Selenium	0.39	NC	NC	NC	NC	NA	NA	NC	NC	NC
Silver	0.12	NC	NC	NC	NC	NA	NA	NC	NC	NC
Thallium	0.45	NC	NC	NC	NC	NA	NA	NC	NC	NC
Vanadium	137	NC	NC	NC	NC	NA	NA	NC	NC	NC
Zinc	122	NC	NC	NC	NC	NA	NA	NC	NC	NC

ELCR = 7.7E-09 + 1.4E-09 = 9E-09

NOTES:

(a) EPCs presented in Table 2.

(b) SF, Unit Risk, and RAF values taken from Tables 5, 6, and 7, respectively.

(c) The fugitive dust gastrointestinal ingestion ADD is calculated by the following equation:

$\text{LADD}_{\text{inhalation-GI}} = [\text{OHM}]_{\text{particulates}} * 2 * \text{RAF}_{\text{ing}} * \text{NLADSIR}_{\text{fugd}}$ where, $\text{NLADSIR}_{\text{fugd}} =$ 2.3E-11 mg soil/kg-day

(d) The fugitive dust respiratory system ADD is calculated by the following equation:

$\text{LADD}_{\text{inhalation}} = [\text{OHM}]_{\text{particulates}} * 0.5 * \text{RAF}_{\text{inh}} * \text{NLADSIR}_{\text{fugd}}$

(e) Ingestion ELCR = $\text{LADD}_{\text{inhalation-GI}}$ * SF

Respiratory ELCR = ($\text{LADD}_{\text{inhalation}}$ * Body Weight (70 Kg) / Daily Inhalation Rate (20 m^3/day)) * Unit Risk

and Hazard Index = Sum (Hazard Quotients)

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-42
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE CHILD RECREATIONAL USER EXPOSURES TO SURFACE WATER

		Ingestion Exposure		Dermal Contact Exposure				Chemical-Specific ELCR		Chemical-Specific ELCR (e)
Contaminant of Concern	EPC(a) (ug/L)	RAF (b)	LADD (c) (mg/kg-day)	RAF (b)	Kp (cm/hr)	LADD (d) (mg/kg-day)	SF (b) $(mg/kg\text{-}day)^{-1}$	Ingestion (e)	Dermal (e)	
C9-C18 Aliphatics	3.0E+00	NC	NA	NC	0.032	NA	NA	NA	NA	NA
C19-C36 Aliphatics	4.1E+00	NC	NA	NC	0.032	NA	NA	NA	NA	NA
Arsenic	5.5E-01	1	3.6E-08	1	0.001	1.8E-09	1.5E+00	5.5E-08	2.7E-09	5.7E-08
Barium	5.4E+00	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Beryllium	3.0E-02	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Chromium	8.5E-02	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Nickel	4.6E-01	NC	NA	NC	0.0002	NA	NA	NA	NA	NA
Selenium	4.4E+00	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Vanadium	7.8E+01	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Zinc	6.3E-01	NC	NA	NC	0.001	NA	NA	NA	NA	NA

ELCR = 5.5E-08 + 2.7E-09 = 6E-08

NOTES:

(a) EPCs presented in Table 3.

(b) SF and RAF values taken from Tables 5 and 7, respectively.

(c) The surface water ingestion lifetime average daily dose LADD is calculated by the following equation:

SW Ingestion LADD = [OHM]sw * 10^{-3} mg/ug * RAFing * NLADSIRsw where, NLADSIRsw = 6.6E-05 L_{sw}/kg-day

(d) The SW dermal contact LADD is calculated by the following equation:

SW Contact LADD = [OHM]sw* 10^{-3} L/cm^3 *10^{-3}mg/ug *RAFderm *Kp* NLADSCRsw where, NLADSCRsw = 3.2E+00 cm^2_{sw}-hr/kg-day

TABLE A-43
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS FOR FUTURE ADULT RECREATIONAL USER EXPOSURES TO SOIL

		Chronic Soil Ingestion Exposure		Chronic Soil Dermal Contact Exposure		Chronic	Chemical-Specific Hazard Quotient		Chemical-Specific Hazard Index
Contaminant of Concern	EPC(a) (mg/kg)	RAF (b)	ADD (c) (mg/kg-day)	RAF (b)	ADD (d) (mg/kg-day)	RfD (b) (mg/kg-day)	Ingestion (e)	Dermal (e)	(e)
C9-C18 Aliphatics	22	1	3.4E-06	0.5	2.5E-05	1.0E-01	3.4E-05	2.5E-04	2.9E-04
C19-C36 Aliphatics	39	1	6.0E-06	0.1	8.8E-06	2.0E+00	3.0E-06	4.4E-06	7.4E-06
C11-C22 Aromatics	122	0.36	6.7E-06	0.1	2.7E-05	3.0E-02	2.2E-04	9.1E-04	1.1E-03
2-Methylnaphthalene	0.50	1	7.7E-08	0.1	1.1E-07	4.0E-02	1.9E-06	2.8E-06	4.8E-06
Acenaphthene	1.2	1	1.9E-07	0.2	5.6E-07	6.0E-02	3.2E-06	9.3E-06	1.2E-05
Acenaphthylene	0.39	0.91	5.5E-08	0.18	1.6E-07	4.0E-02	1.4E-06	4.0E-06	5.3E-06
Anthracene	2.5	1	3.8E-07	0.29	1.6E-06	3.0E-01	1.3E-06	5.4E-06	6.6E-06
Benzo(a)anthracene	6.0	0.91	8.4E-07	0.18	2.4E-06	4.0E-02	2.1E-05	6.1E-05	8.2E-05
Benzo(a)pyrene	4.6	0.91	6.3E-07	0.18	1.8E-06	4.0E-02	1.6E-05	4.6E-05	6.2E-05
Benzo(b)fluoranthene	6.7	0.91	9.3E-07	0.18	2.7E-06	4.0E-02	2.3E-05	6.7E-05	9.0E-05
Benzo(g,h,i)perylene	2.5	0.91	3.4E-07	0.18	1.0E-06	4.0E-02	8.6E-06	2.5E-05	3.4E-05
Benzo(k)fluoranthene	2.7	0.91	3.8E-07	0.18	1.1E-06	4.0E-02	9.4E-06	2.7E-05	3.7E-05
Chrysene	6.3	0.91	8.8E-07	0.18	2.6E-06	4.0E-02	2.2E-05	6.4E-05	8.6E-05
Dibenz(a,h)anthracene	3.2	0.91	4.5E-07	0.08	5.8E-07	4.0E-02	1.1E-05	1.5E-05	2.6E-05
Fluoranthene	13	1	1.9E-06	0.2	5.7E-06	4.0E-02	4.8E-05	1.4E-04	1.9E-04
Fluorene	1.2	1	1.9E-07	0.2	5.6E-07	4.0E-01	4.7E-07	1.4E-06	1.9E-06
Indeno(1,2,3-cd)pyrene	3.9	0.91	5.4E-07	0.18	1.6E-06	4.0E-02	1.4E-05	3.9E-05	5.3E-05
Naphthalene	0.62	1	9.4E-08	0.1	1.4E-07	2.0E-02	4.7E-06	6.9E-06	1.2E-05
Phenanthrene	10	0.91	1.3E-06	0.18	3.9E-06	4.0E-02	3.3E-05	9.7E-05	1.3E-04
Pyrene	12	1	1.9E-06	0.2	5.5E-06	3.0E-02	6.3E-05	1.8E-04	2.5E-04
Aroclor-1248	0.32	0.85	4.1E-08	0.067	4.7E-08	2.0E-05	2.0E-03	2.4E-03	4.4E-03
Aroclor-1254	0.79	0.85	1.0E-07	0.067	1.2E-07	2.0E-05	5.1E-03	6.0E-03	1.1E-02
Antimony	1.2	1	1.8E-07	0.1	2.7E-07	4.0E-04	4.6E-04	6.7E-04	1.1E-03
Arsenic	29	1	4.4E-06	0.03	1.9E-06	3.0E-04	1.5E-02	6.4E-03	2.1E-02
Barium	74	0.39	4.4E-06	0.3	5.0E-05	7.0E-02	6.3E-05	7.1E-04	7.7E-04
Beryllium	0.65	1	9.9E-08	0.03	4.4E-08	2.0E-03	5.0E-05	2.2E-05	7.2E-05
Cadmium	8.6	1	1.3E-06	0.14	2.7E-06	1.0E-03	1.3E-03	2.7E-03	4.0E-03
Chromium	19	1	2.9E-06	0.09	3.9E-06	3.0E-03	9.8E-04	1.3E-03	2.3E-03
Copper	35	1	5.4E-06	0.3	2.4E-05	4.0E-02	1.4E-04	6.0E-04	7.3E-04
Lead	135	0.5	1.0E-05	0.006	1.8E-06	7.5E-04	1.4E-02	2.4E-03	1.6E-02
Mercury	1.2	1	1.9E-07	0.05	1.4E-07	3.0E-04	6.3E-04	4.7E-04	1.1E-03
Nickel	35	1	5.4E-06	0.35	2.8E-05	2.0E-03	2.7E-03	1.4E-02	1.7E-02
Selenium	0.39	1	5.9E-08	0.002	1.7E-09	5.0E-03	1.2E-05	3.5E-07	1.2E-05
Silver	0.12	1	1.9E-08	0.25	6.9E-08	5.0E-03	3.8E-06	1.4E-05	1.8E-05
Thallium	0.45	1	6.9E-08	0.01	1.0E-08	8.0E-05	8.6E-04	1.3E-04	9.9E-04
Vanadium	137	1.86	3.9E-05	0.14	4.3E-05	9.0E-03	4.3E-03	4.8E-03	9.1E-03
Zinc	122	1	1.9E-05	0.02	5.5E-06	3.0E-01	6.2E-05	1.8E-05	8.1E-05

TOTAL HAZARD INDEX = 4.8E-02 + 4.4E-02 = 9E-02

NOTES:

(a) EPCs presented in Table 2.

(b) RfD and RAF values taken from Tables 5 and 7, respectively.

(c) The soil ingestion average daily dose ADD is calculated by the following equation:

Soil Ingestion ADD = [OHM]soil * 10^{-6} kg/mg * RAFing * NADSIRsoil where, NADSIRsoil = 1.5E-01 mg soil/kg-day

(d) The soil dermal contact ADD is calculated by the following equation:

Soil Contact ADD = [OHM]soil * 10^{-6} kg/mg * RAFderm * NADSCRsoil where, NADSCRsoil = 2.2E+00 mg soil/kg-day

(e) Hazard Quotient = ADD/RfD and Hazard Index = Sum (Hazard Quotients)

TABLE A-44
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE ADULT RECREATIONAL USER EXPOSURES TO SOIL

		Soil Ingestion Exposure		Soil Dermal Contact Exposure			Chemical-Specific ELCR		Chemical-Specific ELCR
Contaminant of Concern	EPC(a) (mg/kg)	RAF (b)	LADD (c) (mg/kg-day)	RAF (b)	LADD (d) (mg/kg-day)	SF (b) (mg/kg-day)$^{-1}$	Ingestion (e)	Dermal (e)	(e)
C9-C18 Aliphatics	22	NC	NC	NC	NC	NA	NC	NC	NC
C19-C36 Aliphatics	39	NC	NC	NC	NC	NA	NC	NC	NC
C11-C22 Aromatics	122	NC	NC	NC	NC	NA	NC	NC	NC
2-Methylnaphthalene	0.50	NC	NC	NC	NC	NA	NC	NC	NC
Acenaphthene	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Acenaphthylene	0.39	NC	NC	NC	NC	NA	NC	NC	NC
Anthracene	2.5	NC	NC	NC	NC	NA	NC	NC	NC
Benzo(a)anthracene	6.0	1	3.7E-07	0.2	1.1E-06	7.3E-01	2.7E-07	7.9E-07	1.1E-06
Benzo(a)pyrene	4.6	1	2.8E-07	0.2	8.2E-07	7.3E+00	2.0E-06	6.0E-06	8.0E-06
Benzo(b)fluoranthene	6.7	1	4.1E-07	0.2	1.2E-06	7.3E-01	3.0E-07	8.7E-07	1.2E-06
Benzo(g,h,i)perylene	2.5	NC	NC	NC	NC	NA	NC	NC	NC
Benzo(k)fluoranthene	2.7	1	1.7E-07	0.2	4.9E-07	7.3E-02	1.2E-08	3.6E-08	4.8E-08
Chrysene	6.3	1	3.9E-07	0.2	1.1E-06	7.3E-02	2.8E-08	8.3E-08	1.1E-07
Dibenz(a,h)anthracene	3.2	1	2.0E-07	0.09	2.6E-07	7.3E+00	1.4E-06	1.9E-06	3.4E-06
Fluoranthene	13	NC	NC	NC	NC	NA	NC	NC	NC
Fluorene	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Indeno(1,2,3-cd)pyrene	3.9	1	2.4E-07	0.2	7.0E-07	7.3E-01	1.7E-07	5.1E-07	6.8E-07
Naphthalene	0.62	NC	NC	NC	NC	NA	NC	NC	NC
Phenanthrene	10	NC	NC	NC	NC	NA	NC	NC	NC
Pyrene	12	NC	NC	NC	NC	NA	NC	NC	NC
Aroclor-1248	0.32	0.85	1.6E-08	0.07	1.9E-08	2.0E+00	3.3E-08	3.8E-08	7.1E-08
Aroclor-1254	0.79	0.85	4.1E-08	0.07	4.8E-08	2.0E+00	8.2E-08	9.5E-08	1.8E-07
Antimony	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Arsenic	29	1	1.8E-06	0.03	7.7E-07	1.5E+00	2.6E-06	1.2E-06	3.8E-06
Barium	74	NC	NC	NC	NC	NA	NC	NC	NC
Beryllium	0.65	NC	NC	NC	NC	NA	NC	NC	NC
Cadmium	8.6	NC	NC	NC	NC	NA	NC	NC	NC
Chromium	19	NC	NC	NC	NC	NA	NC	NC	NC
Copper	35	NC	NC	NC	NC	NA	NC	NC	NC
Lead	135	NC	NC	NC	NC	NA	NC	NC	NC
Mercury	1.2	NC	NC	NC	NC	NA	NC	NC	NC
Nickel	35	NC	NC	NC	NC	NA	NC	NC	NC
Selenium	0.39	NC	NC	NC	NC	NA	NC	NC	NC
Silver	0.12	NC	NC	NC	NC	NA	NC	NC	NC
Thallium	0.45	NC	NC	NC	NC	NA	NC	NC	NC
Vanadium	137	NC	NC	NC	NC	NA	NC	NC	NC
Zinc	122	NC	NC	NC	NC	NA	NC	NC	NC

ELCR = 7.0E-06 + 1.1E-05 = 2E-05

NOTES:

(a) EPCs presented in Table 2.

(b) SF and RAF values taken from Tables 5 and 7, respectively.

(c) The soil ingestion lifetime average daily dose LADD is calculated by the following equation:

Soil Ingestion LADD = [OHM]soil * 10^{-6} kg/mg * RAFing * NLADSIRsoil where, NLADSIRsoil = 6.1E-02 mg soil/kg-day

(d) The soil dermal contact ADD is calculated by the following equation:

Soil Contact LADD = [OHM]soil * 10^{-6} kg/mg * RAFderm * NLADSCRsoil where, NLADSCRsoil = 9.0E-01 mg soil/kg-day

(e) Excess Lifetime Cancer Risk = LADD * SF

TABLE A-45
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS
FOR FUTURE ADULT RECREATIONAL USER EXPOSURES TO FUGITIVE DUST FROM SOIL

Contaminant of Concern	EPC(a) (mg/kg)	Chronic Soil GI Inhalation Exposure		Chronic Soil Respiratory Exposure		Chronic RfD (b) (mg/kg-day)	Chronic RfC (b) (mg/m^3)	Chemical-Specific Hazard Quotient		Chemical-Specific Hazard Index (e)
		RAF (b)	ADD (c) (mg/kg-day)	RAF (b)	ADD (d) (mg/kg-day)			Ingestion (e)	Respiratory (e)	
C9-C18 Aliphatics	22	1	5.3E-9	1	1.3E-9	1.0E-01	2.0E-01	5.3E-8	2.3E-8	7.6E-8
C19-C36 Aliphatics	39	1	9.2E-9	1	2.3E-9	2.0E+00	NA	4.6E-9	NC	4.6E-9
C11-C22 Aromatics	122	0.36	1.0E-8	1	7.2E-9	3.0E-02	5.0E-02	3.4E-7	5.0E-7	8.4E-7
2-Methylnaphthalene	0.50	1	1.2E-10	1	3.0E-11	4.0E-02	7.1E-02	3.0E-9	1.5E-9	4.4E-9
Acenaphthene	1.2	1	2.9E-10	1	7.3E-11	6.0E-02	7.1E-02	4.9E-9	3.6E-9	8.5E-9
Acenaphthylene	0.39	0.91	8.4E-11	1	2.3E-11	4.0E-02	7.1E-02	2.1E-9	1.1E-9	3.2E-9
Anthracene	2.5	1	5.8E-10	1	1.5E-10	3.0E-01	7.1E-02	1.9E-9	7.2E-9	9.1E-9
Benzo(a)anthracene	6.0	0.91	1.3E-9	1	3.5E-10	4.0E-02	7.1E-02	3.2E-8	1.7E-8	5.0E-8
Benzo(a)pyrene	4.6	0.91	9.7E-10	1	2.7E-10	4.0E-02	7.1E-02	2.4E-8	1.3E-8	3.7E-8
Benzo(b)fluoranthene	6.7	0.91	1.4E-9	1	3.9E-10	4.0E-02	7.1E-02	3.6E-8	1.9E-8	5.5E-8
Benzo(g,h,i)perylene	2.5	0.91	5.3E-10	1	1.4E-10	4.0E-02	7.1E-02	1.3E-8	7.1E-9	2.0E-8
Benzo(k)fluoranthene	2.7	0.91	5.8E-10	1	1.6E-10	4.0E-02	7.1E-02	1.4E-8	7.8E-9	2.2E-8
Chrysene	6.3	0.91	1.3E-9	1	3.7E-10	4.0E-02	7.1E-02	3.4E-8	1.8E-8	5.2E-8
Dibenz(a,h)anthracene	3.2	0.91	6.9E-10	1	1.9E-10	4.0E-02	7.1E-02	1.7E-8	9.4E-9	2.7E-8
Fluoranthene	13	1	3.0E-9	1	7.4E-10	4.0E-02	7.1E-02	7.4E-8	3.7E-8	1.1E-7
Fluorene	1.2	1	2.9E-10	1	7.3E-11	4.0E-01	7.1E-02	7.3E-10	3.6E-9	4.3E-9
Indeno(1,2,3-cd)pyrene	3.9	0.91	8.3E-10	1	2.3E-10	4.0E-02	7.1E-02	2.1E-8	1.1E-8	3.2E-8
Naphthalene	0.62	1	1.4E-10	1	3.6E-11	2.0E-02	7.1E-02	7.2E-9	1.8E-9	9.0E-9
Phenanthrene	10	0.91	2.0E-9	1	5.6E-10	4.0E-02	7.1E-02	5.1E-8	2.8E-8	7.9E-8
Pyrene	12	1	2.9E-9	1	7.2E-10	3.0E-02	7.1E-02	9.6E-8	3.6E-8	1.3E-7
Aroclor-1248	0.32	0.85	6.3E-11	1	1.8E-11	2.0E-05	2.0E-05	3.1E-6	3.2E-6	6.4E-6
Aroclor-1254	0.79	0.85	1.6E-10	1	4.6E-11	2.0E-05	2.0E-05	7.9E-6	8.1E-6	1.6E-5
Antimony	1.2	1	2.8E-10	1	7.0E-11	4.0E-04	NA	7.0E-7	NC	7.0E-7
Arsenic	29	1	6.7E-9	1	1.7E-9	3.0E-04	NA	2.2E-5	NC	2.2E-5
Barium	74	0.39	6.7E-9	1	4.3E-9	7.0E-02	NA	9.6E-8	NC	9.6E-8
Beryllium	0.65	1	1.5E-10	1	3.8E-11	2.0E-03	2.0E-05	7.6E-8	6.7E-6	6.8E-6
Cadmium	8.6	1	2.0E-9	1	5.0E-10	1.0E-03	NA	2.0E-6	NC	2.0E-6
Chromium	19	1	4.5E-9	1	1.1E-9	3.0E-03	1.0E-04	1.5E-6	4.0E-5	4.1E-5
Copper	35	1	8.3E-9	1	2.1E-9	4.0E-02	NA	2.1E-7	NC	2.1E-7
Lead	135	0.5	1.6E-8	1	7.9E-9	7.5E-04	NA	2.1E-5	NC	2.1E-5
Mercury	1.2	1	2.9E-10	1	7.3E-11	3.0E-04	NA	9.7E-7	NC	9.7E-7
Nickel	35	1	8.3E-9	1	2.1E-9	2.0E-03	NA	4.1E-6	NC	4.1E-6
Selenium	0.39	1	9.1E-11	1	2.3E-11	5.0E-03	NA	1.8E-8	NC	1.8E-8
Silver	0.12	1	2.9E-11	1	7.2E-12	5.0E-03	NA	5.8E-9	NC	5.8E-9
Thallium	0.45	1	1.1E-10	1	2.6E-11	8.0E-05	NA	1.3E-6	NC	1.3E-6
Vanadium	137	1.86	6.0E-8	1	8.0E-9	9.0E-03	NA	6.6E-6	NC	6.6E-6
Zinc	122	1	2.9E-8	1	7.2E-9	3.0E-01	NA	9.6E-8	NC	9.6E-8

TOTAL HAZARD INDEX = 7.3E-05 + 5.8E-05 = 1E-04

NOTES:

(a) EPCs presented in Table 2.

(b) RfD, RfC, and RAF values taken from Tables 5, 6, and 7, respectively.

(c) The fugitive dust gastrointestinal ingestion ADD is calculated by the following equation:

$ADD_{inhalation-GI} = [OHM]_{particulate} * 2 * RAF_{ing} * NADSIR_{fugd}$ where, $NADSIR_{fugd}$ = 1.2E-10 mg soil/kg-day

(d) The fugitive dust respiratory system ADD is calculated by the following equation:

$ADD_{inhalation} = [OHM]_{particulate} * 0.5 * RAF_{inh} * NADSIR_{fugd}$

(e) Ingestion Hazard Quotient = $ADD_{inhalation-GI}$ / RfD

Respiratory Hazard Quotient = ($ADD_{inhalation}$ * Body Weight (70 Kg) / Daily Inhalation Rate (20 m^3/day)) / RfC

and Hazard Index = Sum (Hazard Quotients)

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-46
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE ADULT RECREATIONAL USER EXPOSURES TO FUGITIVE DUST FROM SOIL

Contaminant of Concern	EPC(a) (mg/kg)	Chronic Soil GI Inhalation Exposure RAF (b)	Chronic Soil GI Inhalation Exposure LADD (c) (mg/kg-day)	Chronic Soil Respiratory Exposure RAF (b)	Chronic Soil Respiratory Exposure LADD (d) (mg/kg-day)	SF (b) (mg/kg-day)$^{-1}$	Unit Risk (b) (mg/m^3)$^{-1}$	Chemical-Specific ELCR Ingestion (e)	Chemical-Specific ELCR Respiratory (e)	Chemical-Specific ELCR (e)
C9-C18 Aliphatics	22	NC	NC	NC	NC	NA	NA	NC	NC	NC
C19-C36 Aliphatics	39	NC	NC	NC	NC	NA	NA	NC	NC	NC
C11-C22 Aromatics	122	NC	NC	NC	NC	NA	NA	NC	NC	NC
2-Methylnaphthalene	0.50	NC	NC	NC	NC	NA	NA	NC	NC	NC
Acenaphthene	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Acenaphthylene	0.39	NC	NC	NC	NC	NA	NA	NC	NC	NC
Anthracene	2.5	NC	NC	NC	NC	NA	NA	NC	NC	NC
Benzo(a)anthracene	6.0	1	5.7E-10	1	1.4E-10	7.3E-01	1.7E+00	7.7E-10	2.9E-10	1.1E-9
Benzo(a)pyrene	4.6	1	4.3E-10	1	1.1E-10	7.3E+00	1.7E+00	5.9E-11	2.2E-10	2.8E-10
Benzo(b)fluoranthene	6.7	1	6.2E-10	1	1.6E-10	7.3E-01	1.7E+00	8.6E-10	3.2E-10	1.2E-9
Benzo(g,h,i)perylene	2.5	NC	NC	NC	NC	NA	NA	NC	NC	NC
Benzo(k)fluoranthene	2.7	1	2.5E-10	1	6.4E-11	7.3E-02	1.7E+00	3.5E-9	1.3E-10	3.6E-9
Chrysene	6.3	1	5.9E-10	1	1.5E-10	7.3E-02	1.7E+00	8.1E-9	3.1E-10	8.4E-9
Dibenz(a,h)anthracene	3.2	1	3.0E-10	1	7.6E-11	7.3E+00	1.7E+00	4.2E-11	1.6E-10	2.0E-10
Fluoranthene	13	NC	NC	NC	NC	NA	NA	NC	NC	NC
Fluorene	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Indeno(1,2,3-cd)pyrene	3.9	1	3.6E-10	1	9.1E-11	7.3E-01	1.7E+00	5.0E-10	1.9E-10	6.9E-10
Naphthalene	0.62	NC	NC	NC	NC	NA	NA	NC	NC	NC
Phenanthrene	10	NC	NC	NC	NC	NA	NA	NC	NC	NC
Pyrene	12	NC	NC	NC	NC	NA	NA	NC	NC	NC
Aroclor-1248	0.32	0.85	2.5E-11	1	7.4E-12	2.0E+00	5.0E-01	1.3E-11	5.2E-11	6.4E-11
Aroclor-1254	0.79	0.85	6.3E-11	1	1.9E-11	2.0E+00	5.0E-01	3.2E-11	1.3E-10	1.6E-10
Antimony	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Arsenic	29	1	2.7E-9	1	6.7E-10	1.5E+00	4.3E+00	1.8E-9	5.5E-10	2.3E-9
Barium	74	NC	NC	NC	NC	NA	NA	NC	NC	NC
Beryllium	0.65	NC	NC	1	1.5E-11	NA	2.4E+00	NC	2.2E-11	2.2E-11
Cadmium	8.6	NC	NC	1	2.0E-10	NA	1.8E+00	NC	3.9E-10	3.9E-10
Chromium	19	NC	NC	1	4.5E-10	NA	1.2E+01	NC	1.3E-10	1.3E-10
Copper	35	NC	NC	NC	NC	NA	NA	NC	NC	NC
Lead	135	NC	NC	NC	NC	NA	NA	NC	NC	NC
Mercury	1.2	NC	NC	NC	NC	NA	NA	NC	NC	NC
Nickel	35	NC	NC	NC	NC	NA	NA	NC	NC	NC
Selenium	0.39	NC	NC	NC	NC	NA	NA	NC	NC	NC
Silver	0.12	NC	NC	NC	NC	NA	NA	NC	NC	NC
Thallium	0.45	NC	NC	NC	NC	NA	NA	NC	NC	NC
Vanadium	137	NC	NC	NC	NC	NA	NA	NC	NC	NC
Zinc	122	NC	NC	NC	NC	NA	NA	NC	NC	NC

ELCR = 1.6E-08 + 2.9E-09 = 2E-08

NOTES:

(a) EPCs presented in Table 2.

(b) SF, Unit Risk, and RAF values taken from Tables 5, 6, and 7, respectively.

(c) The fugitive dust gastrointestinal ingestion ADD is calculated by the following equation:

$LADD_{inhalation-GI}$ = $[OHM]_{particulates}$ * 2 * RAF_{ing} * $NLADSIR_{fugd}$ where, $NLADSIR_{fugd}$ = 4.7E-11 mg soil/kg-day

(d) The fugitive dust respiratory system ADD is calculated by the following equation:

$LADD_{inhalation}$ = $[OHM]_{particulates}$ * 0.5 * RAF_{inh} * $NLADSIR_{fugd}$

(e) Ingestion ELCR = $LADD_{inhalation-GI}$ * SF

Respiratory ELCR = ($LADD_{inhalation}$ * Body Weight (70 Kg) / Daily Inhalation Rate (20 m^3/day)) * Unit Risk

and Hazard Index = Sum (Hazard Quotients)

NC = Not calculated

NA = Not Applicable/Available/Analyzed

TABLE A-47
AVERAGE DAILY DOSE AND HAZARD INDEX CALCULATIONS FOR FUTURE ADULT RECREATIONAL USER EXPOSURES TO SURFACE WATER

		Chronic Ingestion Exposure		Chronic Dermal Contact Exposure			Chronic	Chemical-Specific Hazard Quotient		Chemical-Specific Hazard
Contaminant of Concern	EPC(a) (ug/L)	RAF (b)	ADD (c) (mg/kg-day)	RAF (b)	Kp (cm/hr)	ADD (d) (mg/kg-day)	RfD (b) (mg/kg-day)	Ingestion (e)	Dermal (e)	Index (e)
C9-C18 Aliphatics	3.0E+00	1	4.5E-07	1	0.032	1.6E-06	1.0E-01	4.5E-06	1.6E-05	2.1E-05
C19-C36 Aliphatics	4.1E+00	1	6.2E-07	1	0.032	2.2E-06	2.0E+00	3.1E-07	1.1E-06	1.4E-06
Arsenic	5.5E-01	1	8.4E-08	1	0.001	9.5E-09	3.0E-04	2.8E-04	3.2E-05	3.1E-04
Barium	5.4E+00	1	8.2E-07	1	0.001	9.3E-08	7.0E-02	1.2E-05	1.3E-06	1.3E-05
Beryllium	3.0E-02	1	4.5E-09	1	0.001	5.1E-10	2.0E-03	2.3E-06	2.6E-07	2.5E-06
Chromium	8.5E-02	1	1.3E-08	1	0.001	1.5E-09	3.0E-03	4.3E-06	4.9E-07	4.8E-06
Nickel	4.6E-01	1	7.0E-08	1	0.0002	1.6E-09	2.0E-03	3.5E-05	8.0E-07	3.6E-05
Selenium	4.4E+00	1	6.7E-07	1	0.001	7.6E-08	5.0E-03	1.3E-04	1.5E-05	1.5E-04
Vanadium	7.8E+01	1.9	2.3E-05	1	0.001	1.3E-06	9.0E-03	2.5E-03	1.5E-04	2.7E-03
Zinc	6.3E-01	1	9.6E-08	1	0.001	6.5E-09	3.0E-01	3.2E-07	2.2E-08	3.4E-07

TOTAL HAZARD INDEX = 3.0E-03 + 2.2E-04 = 3E-03

NOTES:

(a) EPCs presented in Table 3.

(b) RfD and RAF values taken from Tables 5 and 7, respectively.

(c) The surface water ingestion average daily dose ADD is calculated by the following equation:
SW Ingestion ADD = [OHM]sw * 10^{-3} mg/ug * RAFing * NADSIRsw where, NADSIRsw = 1.5E-04 L_{sw}/kg-day

(d) The SW dermal contact ADD is calculated by the following equation:
SW Contact ADD = [OHM]sw* 10^{-3} L/cm^3 *10^{-3}mg/ug *RAFderm *Kp* NADSCRsw where, NADSCRsw = 1.7E+01 $cm^2{}_{sw}$-hr/kg-day

TABLE A-48
LIFETIME AVERAGE DAILY DOSE AND EXCESS LIFETIME CANCER RISK CALCULATIONS FOR FUTURE ADULT RECREATIONAL USER EXPOSURES TO SURFACE WATER

Contaminant of Concern	EPC(a) (ug/L)	Ingestion Exposure RAF (b)	Ingestion Exposure LADD (c) (mg/kg-day)	Dermal Contact Exposure RAF (b)	Dermal Contact Exposure Kp (cm/hr)	Dermal Contact Exposure LADD (d) (mg/kg-day)	SF (b) $(mg/kg-day)^{-1}$	Chemical-Specific ELCR Ingestion (e)	Chemical-Specific ELCR Dermal (e)	Chemical-Specific ELCR (e)
C9-C18 Aliphatics	3.0E+00	NC	NA	NC	0.032	NA	NA	NA	NA	NA
C19-C36 Aliphatics	4.1E+00	NC	NA	NC	0.032	NA	NA	NA	NA	NA
Arsenic	5.5E-01	1	3.4E-08	1	0.001	3.8E-09	1.5E+00	5.0E-08	5.7E-09	5.6E-08
Barium	5.4E+00	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Beryllium	3.0E-02	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Chromium	8.5E-02	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Nickel	4.6E-01	NC	NA	NC	0.0002	NA	NA	NA	NA	NA
Selenium	4.4E+00	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Vanadium	7.8E+01	NC	NA	NC	0.001	NA	NA	NA	NA	NA
Zinc	6.3E-01	NC	NA	NC	0.001	NA	NA	NA	NA	NA

ELCR = 5.0E-08 + 5.7E-09 = 6E-08

NOTES:
(a) EPCs presented in Table 3.
(b) SF and RAF values taken from Tables 5 and 7, respectively.
(c) The surface water ingestion lifetime average daily dose LADD is calculated by the following equation:
SW Ingestion LADD = [OHM]sw * 10^{-3} mg/ug * RAFing * NLADSIRsw where, NLADSIRsw = 6.1E-05 L_{sw}/kg-day
(d) The SW dermal contact LADD is calculated by the following equation:
SW Contact LADD = [OHM]sw* 10^{-3} L/cm^3 *10^{-3}mg/ug *RAFderm *Kp* NLADSCRsw where, NLADSCRsw = 6.9E+00 cm^2$_{sw}$-hr,kg-day

APPENDIX B TO ATTACHMENT I:

TOXICITY PROFILES

POLYCHLORINATED BIPHENYLS (PCBS) CAS# 1336-36-3

GENERAL BACKGROUND INFORMATION

The thermal stability, nonflammability, and dielectric capability of PCBs resulted in their use in electrical capacitors and transformers (NIOSH, 1986). The manufacturing, processing, distribution in commerce, and use of PCBs after January 1, 1978 was prohibited under Section 6(e) of the Toxic Substances Control Act. PCBs can be released to the environment during fires involving electrical equipment containing these compounds. PCBs are strongly adsorbed on solid surfaces, including glass and metal surfaces in laboratory apparatus, and onto soils, sediments, and particulates in the environment.

PHARMACOKINETICS

Gastrointestinal absorption of most PCB isomers is large. PCBs can also be absorbed by the inhalation and dermal routes but limited data are available (see section on Relative Absorption Factors). Distribution of PCBs follows a biphasic pattern. Initially, PCBs distribute to liver and muscle tissue. They are then redistributed to the fat, skin, and other fat-containing organs (ATSDR, 1989). PCBs are poorly metabolized in humans with major metabolites being 3- or 4-hydroxy compounds. Metabolism may proceed through formation of arene oxide intermediates (U.S. EPA, 1988). The slow metabolism of PCB congeners to more polar compounds is responsible for long biological half-lives of PCBs. Excretion occurs primarily through the feces (Goto et al., 1974).

HUMAN TOXICOLOGICAL PROFILE

Dermatologic signs are the most persistent indicator of PCB toxicity. Skin manifestations have been observed also in newborn infants of mothers exposed to high levels of PCBs and related compounds. Cases of severe chloracne were reported in a work environment in which PCB air levels were found to be between 5.2 and 6.8 mg/m^3. The workers developing chloracne had been exposed for 2 to 4 years. Other analyses revealed worker complaints of dry sore throat, skin rash, gastrointestinal disturbances, eye irritation, and headache at work area concentrations of 0.013 to 0.15 mg PCB/m^3. Higher blood PCB levels are associated with higher serum triglyceride and/or cholesterol levels, as well as high blood pressure. Air PCB concentrations as low as 0.1 mg/m^3 can produce toxic effects, and exposure to levels producing no overt toxicity can affect liver function. Recovery after termination of exposure occurs but is slow and depends upon the amount of PCBs stored in adipose tissue (Clayton and Clayton, 1981). Human exposures to PCBs resulting in toxic effects have almost all resulted from the ingestion of rice oil contaminated with "Kanechlor 400" in Japan (resulting in Yusho or rice oil disease) or from industrial exposure. Clinical symptoms of poisoning included acne-like skin eruptions (chloracne), eyelid edema, conjunctival discharge, skin and nail pigmentation, and hyperkeratosis. Yusho patients are estimated to have ingested approximately 0.07 mg/kg/day for at least 50 days. The rice oil was found to be contaminated with polychlorinated dibenzofuran, which is believed to have played a significant role in the observed toxicity (Bandiera et al., 1984; Kashimoto et al., 1981). As suggested by laboratory experiments with Rhesus monkeys, fetal and newborn primates, including humans, may be particularly susceptible to PCBs. Fein et al. (1984) studied the effects of low-level chronic exposure to PCBs in pregnant women and their newborn offspring from consumption of Lake Michigan fish. Low levels of PCBs were reported to cause decreases in birth weight, head circumference, and gestational age of the newborn. PCBs were apparently transmitted to the fetus across the placenta and to the newborn through breast milk. Behavioral deficiencies, including immaturity of reflexes and depressed responsiveness, were reportedly observed in infants exposed to PCBs. Jacobson et al. (1984) correlated maternal consumption of PCB-contaminated fish with behavioral abnormalities in newborns, including autonomic immaturity and depressed responsiveness. The authors likened these responses to similar effects in laboratory animals.

MAMMALIAN TOXICOLOGICAL PROFILE

PCBs are only slightly toxic in acute exposures to laboratory animals. LD_{50} values for rats, rabbits, and mice are generally in the range of 1 to 10 g/kg body weight (U.S. EPA, 1980). Nonhuman primates seem to be particularly sensitive to PCB-induced reproductive effects (U.S. EPA, 1980). Dietary exposures of cynomolgus and Rhesus monkeys to 200 ug of Aroclor 1254/kg-day, 5 days per week for 28 months, resulted in symptoms of enlarged tarsal glands, conjunctivitis, loss of eyelashes, progressive detachment of fingernails, exuberant nail beds, hyperplasia of biliary ducts, hepatocellular enlargement and necrosis, and normocytic anemia (Tryphonos et al., 1986a; Tryphonos et al., 1986b). Effects were less pronounced in cynomolgus monkeys.

Monkeys that were fed diets containing 1.0 ppm of Aroclor 1016 for approximately 7 months prior to mating and during pregnancy delivered infants with reduced birth weights (Barsotti and Van Miller, 1984). Fetal mortality occurred at >2.5 ppm (0.1 mg/kg/day) of Aroclor 1248 in the diet in other studies with monkeys (Allen and Barsotti, 1976; Barsotti et al., 1976; Allen et al., 1980). In rats, a dose of 269 ppm of Aroclor 1254 given continuously in the food over the duration of pregnancy caused a decrease in the number of impregnated rats that delivered litters. Pups that were born were underweight, and most died within 7 days of birth. Two lower doses (26 and 2.5 ppm) caused altered neurobehavioral and somatic ontogeny (Overmann et al., 1987). PCBs have been shown to be teratogenic in mice. Cleft palate, dilated kidney pelvis, and thymus hypoplasia were observed. The ED50 (effective dose for 50% of the animals) for formation of cleft palate was a single 100 mg/kg dose, with peak sensitivity occurring on the twelfth day of gestation (d'Argy et al., 1987).

Immunological effects (decreased IgM, IgG induction) were noted in monkeys following a 27 month exposure at a dose of 0.005 mg/kg/day (Tryphonos et al., 1989).

GENOTOXICITY

Most genotoxicity assays of PCBs have been negative. The majority of microbial assays of PCB mixtures and various congeners show no evidence of mutagenic effects (U.S. EPA, 1980). The carcinogenic effects of PCBs have been studied in rats and mice. In a study conducted by Kimbrough et al. (1975) rats were exposed via the diet to 100 ppm Aroclor 1260 for 21 months. Hepatocellular carcinomas were observed in 26 of the 184 treated rats but only in one of the 173 controls. Neoplastic nodules were not found in controls but occurred in 144/184 of treated rats. The National Cancer Institute (NCI, 1978) reported a high incidence of hepatocellular proliferative lesions in male and female Fischer 344 rats fed three dose levels of Aroclor 1254 for 104-105 weeks, but, in part due to the small number of animals tested, carcinogenicity was not statistically demonstrable. Norback and Weltman (1985) fed a diet containing relatively high concentrations Aroclor 1260 (100 ppm for 16 months followed by 50 ppm for an additional 8 months) to Sprague-Dawley rats. In the PCB-exposed group, neoplastic nodules were observed at 12 months followed by trabecular carcinoma at 15 months and adenocarcinoma at 24 months (52/93). In the control rats, the incidence of hepatocellular neoplasms was low (1/81). Metastases to distant organs was not observed and mortality in the PCB exposed animals was not increased. The incidence of these slow-growing hepatocellular neoplasms was strikingly higher in female rats than in male rats.

PCBs (Clophen C) have also been shown to be cocarcinogenic. When PCBs were mixed with diethylnitrosamine (DENA), twice as many tumors were observed as were observed in animals treated with DENA alone (Brunn, 1987).

Based on the positive evidence for carcinogenicity of Aroclor 1254, Aroclor 1260, Kaneclor 500, and Clophen A-30 and A-60 in animals, along with adequate evidence in humans, the U.S. EPA has placed these PCBs in category B2 - probable human carcinogen (U.S. EPA, 1988).

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Total Petroleum Hydrocarbons

Petroleum is a mixture of hundreds of compounds containing both hydrogen and carbon. Performance based criteria dictate the composition of refined petroleum products such as gasoline, diesel fuel, or heating oil. The composition of petroleum products is complex, and when released to the environment, the composition is further altered by volatilization, leaching, or biodegradation.

The toxicity of petroleum products are comprised of two general categories; aliphatic/alicyclic hydrocarbons and aromatic/alkene hydrocarbons. Aromatic/alkene hydrocarbons appear to be more toxic than aliphatic/alicyclic compounds. Furthermore, the toxicity of the aliphatic compounds appears to be related to the number of carbons atoms present.

Aliphatic compounds (alkanes), such as, propane, hexane, and nonane, are straight- or branched-chain organic compounds and alicyclic compounds (cycloalkanes) are organic compounds characterized by a ring structure. Exposure to the aliphatic/alicyclic compounds can cause irritation of the eyes, nose, and skin. Chronic exposure to low molecular weight aliphatic/alicyclic compounds (C_5-C_8) can disrupt the central nervous system (CNS). There is insufficient evidence regarding the carcinogenicity of aliphatic/alicyclic compounds.

Aromatic/alkene compounds include benzene and its derivatives, polycyclic aromatic hydrocarbons (PAHs), and straight- and branched-chain organic compounds possessing one or more double-bonds. The toxicity of these compounds is linked to the presence of double bonds rather than to carbon-chain length. Aromatic/alkene compounds target the central nervous system, liver, kidney, and hematopoietic system. Common threshold effects associated with PAH exposures include dermal irritation, hematopoietic disruption, nephrotoxicity, and hepatotoxicity. Benzene and several PAHs are known carcinogens.

The toxicity of total petroleum hydrocarbons (TPH) is evaluated by grouping the hydrocarbons by size and general chemical structure. Each range is represented by a compound within that fraction selected as a surrogate indicator to conservatively define the toxicity of the entire range.

The C_9-C_{18} aliphatics are defined by n-nonane (C_9). n-Nonane is an eye irritant and affects the CNS. CNS effects include mild tremors and incoordination which decrease as the carbon number increases beyond C_9. However the irritant effects increase as carbon number increases.

The C_{19}-C_{36} aliphatics are defined by eicosane. Eicosane exhibits irritation and functional changes to the liver in rats. Prolonged excessive human exposures to mineral oils revealed structural changes in the liver, spleen, and mesenteric lymph nodes which were minor in nature. C_{12}-C_{30} alkanes may act as cocarcinogens or promoters of carcinogenic activity.

The C_9-C_{10} and C_{11}-C_{22} aromatics are defined by pyrene. Pyrene is a human skin irritant and has induced liver and kidney effects after exposures in rats and mice.

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jmd898

POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)

General Background

Polycylic aromatic hydrocarbons (PAHs) are a class of compounds that are formed during the incomplete combustion or pyrolysis of organic materials containing carbon and hydrogen. Several hundred different PAHs have been identified from combustion and pyrolysis sources (Grimmer, 1983). In this discussion, only 15 PAHs will be considered. These include the following: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene and pyrene.

Physical/Chemical Properties

The molecular weight of the aforementioned PAHs range from 154.2 to 278.35. They exist as solids, plates, needles, tablets or prisms having a melting point of 92 °C to 273 °C and a boiling point of 96.2 °C to 495 °C. Their water solubilities vary from being insoluble to 3.93 mg/l in water. Their octanol-water partition coefficients vary from 5.3×10^{3} to 6.9×10^{6}. Their vapor pressures vary from 1×10^{-10}mm Hg (20 °C) to 10 mm Hg (146 °C) and from 10^{-11} torr (20 °C) to 9.6×10^{-4} torr (25 °C). The Henry's law constant varies from 7.3×10^{-8} to 1.45×10^{-3} (HHS, 1990).

Environmental Fate Characteristics

In surface water, PAHs can volatilize, photodegrade, oxidize, biodegrade, bind to particulates, or accumulate in aquatic organisms. In sediments, PAHs can biodegrade or accumulate in aquatic organisms. PAHs in soil can biodegrade or accumulate in plants; PAHs can enter groundwater and be transported within an aquifer.

Transport and partitioning of PAHs in the environment are determined to a large extent by physical/chemical properties such as water solubility, vapor pressure, Henry's law constant, octanol-water partition coefficient (K_{ow}). In general, PAHs have low water solubilities.

PAHs are present in the atmosphere in the gaseous phase or sorbed to particulates. PAHs in urban air are primarily associated with submicron diameter soot particles that have residence times of weeks and are subject to long-range transport (Butler and Crossley, 1981). PAHs are removed from the atmosphere by both wet and dry deposition; the relative importance of each process varies with the individual PAH. For example, Perwak et al. (1982) estimated that a total of 23% of benzo(a)pyrene released to the atmosphere is deposited on soil and water surfaces. Dry deposition of benzo(a)pyrene adsorbed onto atmospheric aerosols accounts for most of the removal; wet deposition is less significant by a factor of 3 to 5.

PAH compounds tend to be removed from the water column by volatilization to the atmosphere, binding to particulates or sediments or by being accumulated by or sorbed onto aquatic biota. Compounds with Henry's law constants in the range of 10^{-3} to 10^{-5}, are associated with significant volatilization, while compounds with values less than 10^{-5} volatilize from water only to a limited extent (Lyman et al., 1982).

Because of their low solubility, PAHs in aquatic systems are primarily found sorbed to particles that either have settled to the bottom or are suspended in the water column. In an estuary, volatilization and adsorption to suspended sediments with subsequent deposition are the primary removal processes for medium and high molecular weight PAHs, whereas volatilization and microbial degradation are the major removal processes for low molecular weight compounds (Readman et al., 1982). In an enclosed marine ecosystem study, less than 1% of the original amount of radio-labelled benz(a)anthracene added to the system remained in the water column after 30 days; losses were attributed to adsorption to settling particles and to a lesser extent to photodegradation (Hinga and Pilson, 1987).

High molecular weight PAHs having K_{oc} values in the range of 10^5 to 10^6 indicate stronger tendencies to adsorb to organic carbon. Sorption of PAHs to soil and sediments increases with increasing organic carbon content and is also directly dependent on particle size. Karickhoff et al. (1979) reported partition coefficients (Kp) for sorption of pyrene to sediments as follows: sand 9.4 to 68; silt 1,500 to 3,600; and clay 1,400 to 3,800. Gardner et al. (1979) found that three to four times more anthracene and about twice as much fluoranthene, benz(a)anthracene and benzo(a)pyrene were retained by marsh sediments than by sand. PAHs may also volatilize from soil. Volatilization of acenaphthene, anthracene, fluorene and phenanthrene (low molecular weight PAHs) from soil may be substantial (Coover and Sims, 1987). Lower molecular weight compounds may also volatilize from sediments whereas this process is not significant for the higher molecular weight compounds (Southworth, 1979).

PAHs have been detected in groundwater either as a result of migration directly from contaminated surface waters or through the soil (Ehrlich et al., 1982; Wilson et al., 1986). Fluorene from an abandoned creosoting pit migrated through sand and clay into groundwater (Wilson et al., 1986).

PAHs can be accumulated in aquatic organisms from water, sediments and food. In general, bioconcentration was greater for the higher molecular weight compounds than for the lower molecular weight compounds. In fish, biotransformation of the parent compound can occur. Biotransformation by the mixed function oxidase system in fish liver can result in the formation of carcinogenic and mutagenic intermediates; exposure to PAHs has been linked to the development of tumors in fish (Eisler, 1987). The ability of fish to metabolize PAHs may explain why benzo(a)pyrene is frequently not detected or found at only very low levels in fish from environments heavily contaminated with PAHs (Varanasi and Gmur, 1980, 1981). Varanasi et al. (1985) ranked the amount of benzo(a)pyrene metabolized by aquatic organisms as follows: fish > shrimp > amphibod crustaceans > clams. Half lives for elimination of PAHs in fish ranged from less than 2 days to 9 days (Niimi, 1987).

Sediment-associated PAHs can be accumulated by bottom-dwelling invertebrates and fish (Eisler, 1987). Varanasi et al. (1985) found that benzo(a)pyrene was accumulated in fish, amphibod crustaceans, shrimp, and clams when estuarine sediment was the source of the compound. Approximate tissue to sediment ratios were 0.6-1.2 for amphibods, 0.1 for clams and 0.05 for fish and shrimp.

PAHs can accumulate in terrestrial plants. Some terrestrial plants can take up PAHs via the roots or foliate; uptake rates are dependent on the concentration, solubility and molecular weight of the PAH and on the plant species (Edwards, 1983). Ratios of PAH concentrations in vegetation to those in soil ranged from 0.001 to 0.18 for total PAHs and from 0.002 to 0.33 for benzo(a)pyrene. About 30%-70% of atmospheric PAHs (indeno(1,2,3-cd)pyrene, fluoranthene, and benzo(a)pyrene) deposited on a forest were sorbed onto tree foliage (i.e., leaves and needles) and then deposited as litterfall (Matzner, 1984).

PAHs may accumulate in terrestrial animals through the food chain or by ingestion of soil (Gile et al., 1982).

PAHs can undergo photooxidation and can react in the atmosphere with pollutants such as ozone, nitrogen oxides, sulfur dioxide and peroxyacetylnitrate (NRC, 1983). Atmospheric half lives are generally less than 30 days. Some PAHs are degraded by oxidation reactions that have been measured in the dark (to eliminate the possibility of photodegradation). Korfmacher et al. (1980) found that, while fluorene was completely oxidized, fluoranthene and phenanthrene were not oxidized and benzo(a)pyrene and anthracene underwent minimal oxidation. These compounds were tested adsorbed to coal fly ash; the investigators stated that the form of the compound (adsorbed or pure) and the nature of the adsorbent greatly affect the rate and extent of the process.

The most important processes contributing to the degradation of PAHs in water are photooxidation, chemical oxidation, and biodegradation by aquatic microorganisms (Neff, 1979). Hydrolysis is not considered to be an important degradation process for PAHs (Radding et al., 1976). In natural aquatic systems, photooxidation and biodegradation can significantly contribute to the degradation of PAHs, depending on environmental conditions.

In general, PAHs can be significantly metabolized by microbes in water under oxygenated conditions. However, under anoxic conditions, degradation will be extremely slow (Neff, 1979). Some PAHs are partially or completely degraded by some species of aquatic bacteria and fungi.

In soil, microbial metabolism is the major process for degradation of PAHs in soil environments. Photolysis, hydrolysis and oxidation are not considered important processes for the degradation of PAHs in soil (Sims and Overcash, 1983). The rate and extent of degradation of PAHs in soil are affected by environmental factors, characteristics of the microbial population and the physical and chemical properties of the PAHs. Environmental factors that may influence the rate of PAH degradation in soil include temperature, pH, oxygen concentration, PAH concentrations and contamination history of soil, soil type, mixture, nutrients and other substances that may act as substrate co-metabolites (Sims and Overcash, 1983).

Anthracene and fluoranthene showed slightly higher biodegradation rates than benz(a)anthracene or benzo(a)pyrene in a study with fine and medium sands and marsh sediments (Gardner et al., 1979). Degradation rates expressed as percentage of the mass removed per week for the four compounds were anthracene 2.0%-3.0%, fluoranthene 1.9%-2.4%, benz(a)anthracene 1.4%-1.8% and benzo(a)pyrene 0.84%-1.4%. The rate of biodegradation may be altered by the degree of contamination (Ya Khesina et al., 1969).

Absorption, Transport and Degradation

No studies were located regarding the absorption of PAHs in humans following inhalation exposure. However, absorption of PAHs following inhalation may be inferred from the presence of urinary metabolites of PAHs in workers exposed to these compounds in an aluminum plant (Becher and Bjorseth, 1983). The high concentration of PAHs in the occupational setting did not correspond to the amount of PAHs deposited, metabolized and excreted in the urine in this study. Researchers suggested that PAHs adsorbed to airborne particulate matter may not be bioavailable and that the dose-uptake relationship may not be linear over the entire PAH concentration range.

In animal studies following inhalation exposure, Sun et al. (1982) administered radioactive benzo(a)pyrene (0.6 ug/l) adsorbed on Ga_2O_3 particles as an aerosol. After 30 minutes of exposure, the fraction of the total amount of aerosol particles deposited in the lung was approximately 20% for Ga_2O_3 and approximately 10% for the pure hydrocarbon aerosol. After two weeks, complete absorption of the initially instilled hydrocarbon had occurred. The association of benzo(a)pyrene with the particles increased the absorption of the compound.

The size of the particles on which benzo(a)pyrene is absorbed affects the pulmonary absorption of the chemical (Cresia et al., 1976).

Intratracheal administration of radioactive benzo(a)pyrene to rats resulted in its rapid absorption. Radioactivity in the liver reached a maximum of 21% of the dose within 10 minutes of instillation (Weyand and Bevan, 1986, 1988). Similar results were also seen in guinea pigs and hamsters following intratracheal exposure (Weyand and Bevan, 1986, 1987b, 1988). In monkeys and dogs, there was either little or very slow direct transfer of benzo(a)pyrene or its metabolites into the blood (Petridou-Fischer et al., 1988). Monkeys and dogs received nasal instillation of radioactive benzo(a)pyrene at doses of 0.16-0.21 mg/kg. Radio-labelled metabolites were detected in the nasal cavity, but little or no activity was detected in the blood and excreta of either species during the 48 hours after exposure.

Via the oral route, indirect evidence suggests that benzo(a)pyrene may not be readily absorbed following exposure in humans. In human volunteers who ingested broiled meat that contained approximately 9 ug of benzo(a)pyrene, Hecht et al., 1979, detected less than 0.1 ug/person (i.e., below the detection limit) of benzo(a)pyrene in the feces of these individuals.

Via the dermal route of exposure, application of 2% crude coal tar to the skin of humans for 8-hour periods on 2 consecutive days yielded evidence of PAH absorption (Storer et al., 1984). Phenanthrene, anthracene, pyrene and fluoranthene were detected in the blood, but benzo(a)pyrene was not detected; thus absorption of

PAHs in crude coal tar was variable. This variability was attributed to differences in percutaneous absorption, rapid tissue deposition after absorption or metabolic conjugation with rapid urinary excretion. An in vitro study using human skin revealed that the extent of permeation after 24 hours was established as 3% of the applied dose of radioactive benzo(a)pyrene (10 ug/cm^2) (Kao et al., 1985).

In conclusion, via the dermal route, PAHs are absorbed through the skin of humans. Therefore, skin contact with soil and water contaminated with PAHs at hazardous waste sites can result in exposure to these compounds. Systemic absorption of PAHs from the skin is variable among these compounds.

No studies were located regarding the distribution of PAHs in humans following oral, inhalation and dermal routes of exposure. However, rat studies indicate that benzo(a)pyrene is distributed to the lung, liver, kidney, gastrointestinal tract and carcass after inhalation exposure (Weyand and Bevan, 1986, 1987a, 1988) and to the liver, lung and kidneys after oral exposure (Yamazaki et al., 1987). In animal studies via the dermal route, PAHs can readily penetrate the skin but very little is distributed to tissues. Only 1.3% of the applied dose of radioactive anthracene (9.3 ug/cm^2) was detected in tissues of rats at six days after administration (Yang et al., 1986).

The metabolism of PAHs alters these chemicals both chemically and structurally, rendering them more water-soluble and more excretable. Benzo(a)pyrene is metabolized to several arene oxides. Once formed, these arene oxides may rearrange spontaneously to phenols, undergo hydration to the corresponding trans-dihydrodiols or react covalently with glutathione. Phenols may also be formed by direct oxygen insertion, although unequivocal proof for this mechanism is lacking. 6-Hydroxybenzo(a)pyrene is further oxidized either spontaneously or metabolically to the 1,6-, 3,6-, or 6,12-quinones. Evidence exists for the further oxidative metabolism to two additional phenols. The phenols, quinones and dihydrodiols can all be conjugated to glucuronides and sulfate esters; the quinones also form glutathione conjugates (IARC, 1983).

Non-Carcinogenic Health Effects

Acute Toxicity

Humans: No studies were located regarding immunological effects in humans following exposure to the PAHs covered in this profile. Benzo(a)pyrene is immunogenic when applied dermally to the skin of animals. In mice, acute application of benzo(a)pyrene elicited an allergic contact hypersensitivity in mice (Klemme et al., 1987). Contact hypersensitivity was also observed in guinea pigs following two dermal applications of benzo(a)pyrene given over a period of 2-3 weeks. (Old et al., 1963).

Laboratory animals: Mice acutely administered benz(a)anthracene by oral gavage for 2 days exhibited increased incidences of hepatomas and pulmonary adenomas (Klein, 1963). No malignant tumors were observed in this study. Other acute-duration studies reporting oral exposure to benzo(a)pyrene and increased incidence of benign and malignant tumors of the forestomach in animals include Hartwell (1951), Shubik and Hartwell (1957), Thompson (1971), Tracor/Jitco (1973a and b). After acute oral exposure to benzo(a)pyrene, Wattenberg and Bueding 1986 reported forestomach papillomas in animals. Neal and Rigdon (1967) reported that mice fed benzo(a)pyrene for 2 or more days exhibited gastric neoplasms. Chu and Malmgrem (1965) reported papillomas and carcinomas of the alimentary tract in hamsters fed benzo(a)pyrene. Mammary tumors were observed in rats administered a single oral dose of benzo(a)pyrene (McCormick, 1981).

Chronic Toxicity

Humans: No chronic studies of PAHs were reported in the available literature.

Laboratory animals: No chronic studies of PAHs were reported in the available literature.

Carcinogenic Health Effects

Acute Exposure

Humans: No studies were located regarding cancer in humans following inhalation exposure to any of the 15 PAHs discussed in this profile. However, epidemiologic studies have shown increased mortality due to lung cancer in humans exposed to coke-oven emissions (Lloyd, 1971; Mazumdar et al., 1975; Redmond et al., 1976), roofing-tar emissions (Hammond et al., 1976), and cigarette smoke (Maclure and MacMahon, 1980; Wynder and Hoffmann, 1967). Each of these mixtures contains benzo(a)pyrene, chrysene, benz(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene as well as other potentially carcinogenic PAHs and other carcinogenic and potentially carcinogenic nitrosamines, coal tar pitch and creosote. It is thus impossible to evaluate the contribution of any individual PAH to the total carcinogenicity of these mixtures in humans because of the complexity of the mixtures and the presence of other carcinogens.

No studies were located that gave evidence of a direct association between human dermal exposure to individual PAHs and cancer induction. However, reports of skin tumors among individuals exposed to mixtures containing PAHs lend some qualitative support to their potential for carcinogenicity in humans. Pott (1775) reported scrotal cancer among chimney sweeps. Skin cancer among those dermally exposed to shale oils has been reported (Purde and Etlin, 1980). These reports provide only qualitative suggestions pertaining to the human carcinogenic potential of compounds found in chimneys and shale oils, such as benzo(a)pyrene, chrysene, dibenz (a,h) anthracene, benz(a)anthracene or benz(b)fluoranthene.

Laboratory animals: Studies in laboratory animals have demonstrated the ability of benz(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene to induce skin tumors following dermal exposure. In a long-term chronic bioassay using mice receiving benzo(b)fluoranthene throughout their lifetime, malignant tumors appeared as early as 4 months in the high dose group. The lowest dose at which benzo(b)fluoranthene elicited malignant tumors was 0.1%, which is approximately equal to a dose of 2.9 mg/kg received 3x weekly or an average daily dose of 1.2 mg/kg (Wynder and Hoffmann, 1959b). Mice topically administered 2 ug benzo(a)pyrene throughout their lifetime developed increased skin tumor incidences of papillomas and carcinomas (Habs et al., 1984). Mice administered 12.5 ug benzo(a)pyrene for 99 weeks exhibited malignant skin tumors (Warshawsky and Barkley, 1987). Incidences of tumors in these dermal studies was related to the dosage of the compound.

Other studies reporting the carcinogenicity of selected PAHs in laboratory animals include the following: Bingham and Falk 1979, Cook et al., 1933, Cook 1933, Horton and Christian 1974, Wynder and Hoffmann 1959a, Van Duuren et al., 1967, Lijinsky et al., 1965, Ranadine and Karande 1963, Hoffmann and Wynder 1966, Horton and Christian 1974.

Chronic Exposure

Humans: No information is available.

Animals: Chronic inhalation studies of animals given benzo(a)pyrene reported a dose-response relationship between inhaled benzo(a)pyrene particles and respiratory tract tumorigenesis. Tumors were formed in the nasal cavity, pharynx, larynx, trachea, esophagus and forestomach of hamsters (Thyssen et al., 1981). Other studies reporting the association between inhalation exposure to benzo(a)pyrene and other atmospheric irritants and tumors in animals are Heinrich et al., 1986 and Laskin et al., 1970.

Mutagenicity and Teratogenicity

Mutagenicity

No studies were located regarding genotoxic effects in humans following exposure to PAHs. Oral exposure to benzo(a)pyrene produced gene mutations in mice in the mouse coal color spot test (Davidson and Dawson, 1976 and 1977). Gene mutations were produced in bacteria that were injected intraperitoneally into mice after they were exposed to benz(a)anthracene (Simmon et al., 1979).

Developmental Toxicity/Reproductive Studies

No studies were located regarding developmental effects in humans following oral exposure to PAHs. Prenatal exposure to benzo(a)pyrene produced reduced viability of litters at parturition, reduced mean pup weight during postnatal development and a high incidence of sterility in the progeny of mice with associated alterations in gonadal morphology and germ-cell development (Mackenzie and Angevine, 1981). In mice, increased incidence of stillborns, resorptions and malformations were observed in offspring of animals exposed to benzo(a)pyrene (Legraverend et al., 1984).

No studies were located regarding reproductive effects in humans following oral exposure to PAH compounds. Mackenzie and Angevine 1981 reported that benzo(a)pyrene administered by gavage to pregnant mice decreased the percentage of pregnant females at parturition and produced a high incidence of sterility in the progeny. Rigdon and Rennels (1964) found that benzo(a)pyrene administered in the diet reduced the incidence of pregnancy in female rats.

IARC Carcinogenicity Classification

The IARC (1983, 1984) has classified PAHs as carcinogenic generally according to the weight-of-evidence categories they developed, as shown in Table 1. Carcinogenic PAHs were defined as those for which IARC has stated there is either "sufficient" or "limited" evidence of carcinogenicity. In addition, several PAHs for which IARC has stated that there is "inadequate" evidence of carcinogenicity are also classified as carcinogenic on the basis of their structural similarity to known carcinogenic PAHs. Finally, PAHs were classified as carcinogenic if they were reported in the analytic data to be simple methyl derivatives of known or suspected carcinogenic PAHs where the position of methylation was unspecified, e.g., "methylbenzo(a)pyrene."

All PAHs for which IARC has found "inadequate" data to assess carcinogenicity and do not have a structural similarity to a suspected carcinogen were classified as noncarcinogenic. Those for which the available data do not provide any evidence of carcinogenicity were classified as noncarcinogenic.

Table 1

CARCINOGENICITY OF PAHs

Chemicals for which there is sufficient evidence that they are carcinogenic in animals:

Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(j)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene
Dibenzo(a,h)acridine
Dibenzo(a,j)acridine
Dibenzo(a,h)anthracene
7H-Dibenzo(c,g)carbazole
Dibenzo(a,e)pyrene
Dibenzo(a,h)pyrene
Dibenzo(a,i)pyrene
Dibenzo(a,l)pyrene
Indeno(1,2,3-c,d)pyrene
5-Methylchrysene

Chemicals for which there is limited evidence that they are carcinogenic in animals:

Anthanthrene
Benzo(c)acridine
Carbazole
Chrysene
Cyclopenta(c,d)pyrene
Dibenzo(a,c)anthracene
Dibenzo(a,j)anthracene
Dibenzo(a,e)fluoranthene
2-,3-,4-,and 6-methylchrysene
2- and 3-methylfluoranthene

Chemicals for which the evidence is inadequate to assess their carcinogenicity:

Benzo(a)acridine
Benzo(g,h,i)fluoranthene
Benzo(a)fluorene
Benzo(b)fluorene
Benzo(c)fluorene
Benzo(g,h,i)perylene
Benzo(c)phenanthrene
Benzo(e)pyrene
Coronene
1,4-Dimethylphenanthrene
Fluorene
1-Methylchrysene
1-Methylphenanthrene
Perylene
Phenanthrene
Triphenylene

Chemicals for which the available data provide no evidence that they are carcinogenic:

Anthracene
Pyrene
Fluoranthene

Source: IARC 1983, 1984.

EPA Carcinogenic Classification and EPA Dose-Response Parameters

EPA Carcinogenic Classification

No carcinogenic classification was reported in the available literature for PAHs, as a group. Individual compounds do have EPA cancer classes. For example, EPA classified benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, indeno(1,2,3-cd)pyrene as B2 carcinogens (IRIS, 1996). Pyrene was classified in group D because of insufficient evidence of carcinogenicity in humans and animals (IRIS, 1996).

EPA Dose-Response Parameters

Carcinogenic Effects: The EPA derived an oral cancer potency factor of 11.5$(mg/kg/day)^{-1}$ based on the study of Neal and Rigdon (1967) (EPA, 1991a). In this study, benzo(a)pyrene administered orally to mice for 2 or more days induced gastric tumors. An inhalation cancer potency factor of 6.1 $(mg/kg/day)^{-1}$ was derived by the EPA based on the study of Thyssen et al., 1990 (EPA, 1991a). In this study, chronic inhalation exposure to benzo(a)pyrene induced respiratory tract tumors in hamsters.

EPA has derived oral cancer slope factors for some PAHs (IRIS, 1996): benzo(b)fluoranthene 7.3E-1; benzo(k)fluoranthene 7.3E-1; benzo(a)pyrene 7.3E+00; chrysene 7.3E-2; and indeno(1,2,3-cd)pyrene 7.3E-1.

Noncarcinogenic Effects: An oral RfD is not available for benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and phenanthrene (EPA, 1996).

EPA has derived an oral RfD of 3.0E-2 for pyrene based on kidney effects (renal tubular degeneration and decreased kidney weight) (IRIS, 1996).

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ANTIMONY CAS# 7440-36-0

PHARMACOKINETICS

No data were found regarding the pharmacokinetics of antimony.

HUMAN TOXICOLOGICAL PROFILE

No data were found regarding the human toxicity of antimony.

MAMMALIAN TOXICOLOGICAL PROFILE

No data were found regarding the mammalian toxicity of antimony.

GENOTOXICITY

No data were found regarding the genotoxicity of antimony.

Arsenic

Arsenic is difficult to characterize as a single analyte because it has complex chemistry. It may be trivalent or pentavalent and is widely distributed in nature. Both inorganic and organic forms of arsenic are readily absorbed via oral and inhalation routes. Soluble forms are more readily absorbed than insoluble forms (U.S. EPA 1984). Approximately 95% of soluble inorganic arsenic administered to rats is absorbed from the gastrointestinal tract (Coulson, Remington, and Lynch 1935; Ray-Bettley and O'Shea 1975). Approximately 70–80% of arsenic deposited in the respiratory tract of humans has been shown to be absorbed (Holland, McCall, and Lanz 1959). Dermal absorption is not significant (U.S. EPA 1984). At mining sites, arsenic is expected to occur in naturally occurring mineral assemblages with considerably lower bioavailability than expected in soluble inorganic arsenic salts (Davis, Ruby, and Bergstrom 1992).

Acute exposure in humans by ingestion of metallic arsenic has been associated with gastrointestinal effects, hemolysis, and neuropathy (U S. EPA 1984). Chronic human arsenicism (by drinking water ingestion) is associated with increased risk of nonmelanoma, typically nonlethal, skin cancer and a peripheral vascular disorder that results in gangrene of the extremities, especially feet, known as blackfoot disease (Tseng 1977). Additionally, there is strong evidence to suggest ingested inorganic arsenic causes cancers of the bladder, kidney, lung, and liver, and possibly other sites (Bates, Smith, and Hopenhayn-Rich 1992; Chen et al. 1992; Chen et al. 1986). It is well known that hyperpigmentation and keratosis are also associated with chronic arsenicism (Neubauer 1947) and arsenic can produce toxic effects on both the peripheral and CNS, precancerous dermal lesions, and cardiovascular damage (U.S. EPA 1984; Tseng 1977). Arsenic is embryotoxic, fetotoxic, and teratogenic in several animal species (U.S. EPA 1984). No evidence of reproductive toxicity was found (Calabrese and Kenyon 1991). Epidemiological studies of workers in smelters and in plants manufacturing arsenical pesticides have shown inhalation of arsenic is strongly associated with lung cancer and less so, with hepatic angiosarcoma (U.S. EPA 1984).

There is substantial evidence that establishes the nutritional essentiality of trace levels of arsenic. Deficiency has been shown to depress growth and impair reproduction in rats, minipigs, chickens, and goats (U.S. EPA 1988; NRC 1989). Methylation of arsenic to less toxic, more rapidly excreted chemical species provides an effective detoxification mechanism *in vivo*. In humans, this system may become saturated at daily oral intake rates greater than 250–1,000 μg/day^{-1}. For this reason, the dose-response curve for arsenic, for carcinogenicity and systemic toxicity, may have nonlinearities, i.e., a portion of the dose-response curve exists over which increases in dose do not result in comparable increases in physiological response (Petito and Beck 1990).

U.S. EPA's weight-of-evidence classification places arsenic as a Group A, Human Carcinogen (U.S. EPA 1998). U.S. EPA (1998, 1988) derived an oral unit risk of 5×10^{-5} (μg/L)$^{-1}$ for arsenic. U.S. EPA (1998) derived an oral cancer slope factor of 1.5 (mg/kg/day)$^{-1}$. The oral drinking water unit risk and cancer slope factor were based on two epidemiological studies (Tseng et al. 1968; Tseng 1977) which indicated an increased incidence of skin cancer in individuals exposed to arsenic in drinking water. An oral chronic RfD of 3×10^{-4} mg/kg/day was calculated for arsenic based on incidence of keratosis and hyperpigmentation in humans (Tseng 1977; U.S. EPA 1996). An uncertainty factor of 3 and a modifying factor of 1 were used to derive the chronic oral RfD. Applying U.S. EPA's RfD methodology, strong scientific arguments can be made for various values within a factor of 2 or 3 of the recommended RfD (i.e., 0.1–0.8 μg/kg/day) (U.S. EPA 1998).

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BARIUM

Background

Barium (Ba) is a naturally occurring metallic element that constitutes about 0.04 per cent of the earth's crust, with the greatest occurrence in rock formations. Naturally occurring concentrations in soils may vary considerably as indicated by the range of reported background concentrations (i.e., 10-1,500 ppm) (Shackelette and Boerngen, 1984). Concentrations in surface water range between 7-15000 (average 50) mg/l (Reeves, 1986). A survey of water quality in 100 U.S. cities found concentrations in drinking water samplings from 2-380 mg/l, with a median of 43 mg/l (WHO, 1984). Data collected by the EPA show the mean level of barium in air ranges from 0.0015 to 0.95 mg/m^3 (USEPA, 1985). The environmental release of barium is also associated with anthropogenic activities including release from oil and gas drilling muds, coal-fired power plants, fillers for automotive paint, and specialty compounds used in bricks, tiles and jet fuels (USEPA, 1985).

Barium has been found in essentially all biological materials assayed. Marine animals concentrate the element 7-100 times, and marine plants 1000 times from seawater (Reeves, 1986). Barium content of edible crops ranges from 10 mg/g found in wheat and corn to 3-4 mg/g found in brazil nuts (Reeves, 1986). Typical barium concentrations in milk are 45-136 mg/g, in wheat flour, 1300 mg/g, and in oatmeal, 2320-8290 mg/g.

The toxicity of barium compounds varies by compound with the more soluble forms being the most toxic (Proctor et al., 1988). Soluble barium compounds include barium nitrate, barium sulfide, barium carbonate, and barium chloride.

Pharmacokinetics Soluble forms of barium are readily absorbed throughout the respiratory tract (Reeves, 1986). Nasal absorption of radiolabelled barium chloride ($^{133}BaCl_2$) was estimated at 60 to 80 percent of the dose at 4 hours after exposure; alveolar absorption is believed to be of the same magnitude (Reeves, 1986). Gastrointestinal (GI) absorption of barium compounds also is dependent on solubility. For example, barium sulfate is essentially unabsorbed through the GI, while in one study barium chloride was absorbed with an efficiency of about 11 to 32 percent (Cuddihy and Ozog, 1973). The highest concentration of barium is found in bone (90 percent), with the remaining barium body-burden (in descending order) found in eggs, lungs, connective tissue, skin, and adipose tissue (Reeves, 1986). Elimination of barium occurs predominantly in feces (75 to 90 percent) with sweat and urine being minor excretory pathways (Reeves, 1986). The rate of elimination is highly variable depending on solubility and route of exposure.

Sensitive Populations No information is available on potentially sensitive populations.

Chemical Interactions No information is available on interactions with other chemical exposures.

Non-Carcinogenic Health Effects

Acute Toxicity

Humans: Acute exposure to barium in humans results in a variety of cardiac, gastrointestinal (GI), and neuromuscular effects (USEPA, 1985). Acute poisoning exerts a strong, prolonged stimulant action on all muscles, including cardiac and smooth muscles of the GI tract and bladder (NAS, 1977). Certain compounds of barium, such as barium hydroxide and barium oxide are irritants of the eyes, mucous membranes and skin. Occupational intoxications from barius salts are unknown; reports do exist of accidental or suicidal poisonings. Initial symptoms of barium poisoning are gastrointestinal, including nausea, vomiting, colic, and diarrhea, followed by myocardial (heart muscle) and general muscular stimulation with tingling in the extremities. Severe cases progress to a loss of tendon reflexes, general muscular paralysis, and death from respiratory arrest or ventricular fibrillation (irregular heartbeat) (Proctor et al., 1988). The threshold dose of toxic effects in human (adults) is about 0.2 to 0.5 g barium (Reeves, 1988). The barium ion is a physical antagonist of potassium in vivo, and symptoms of barium poisoning are attributed to hypokalemia (lack of potassium in the blood) (Proctor et al., 1988). The effect is probably due to a transfer of potassium from extracellular to intracellular compartments rather than to urinary or gastrointestinal losses. Inhalation of insoluble-barium containing dust (e.g., barium sulfate) may produce a benign clinically insignificant pneumoconosis referred to as baritosis (Proctor et al., 1988). For example, workers exposed to barium sulfate at concentrations up to 92 mg/m^3 displayed no signs nor symptoms and experienced decrements in pulmonary function (Proctor et al., 1988). However, acute poisoning through physician mishaps with insoluble barium sulfate used as an X-ray contrast material, has caused granulomas and embolisms (Reeves, 1986).

Laboratory animals: Limited information is available on the acute toxicity of barium in animals. Acute effects of barium are known to produce neuromuscular and respiratory ailments in rats (USEPA 1985).

Chronic Toxicity

Humans: Chronic exposure to barium is considered to be a concern for cardiac and hypertensive effects. The role of waterborne barium in the etiology of human hypertension remains unclear (USEPA, 1985). Two communities exposed to barium in drinking water were evaluated for increases in blood pressure, with no significant differences in blood pressure noted between communities exposed to barium at a concentration of 1.5 l/day (USEPA, 1990a).

Laboratory animals: Rats receiving concentrations of barium chloride of 1, 10, or 100 ppm in drinking water for up to 16 months showed no signs of toxicity at barium dose levels of 0.051, 0.51, or 5.1 mg/kg/day, based on water consumption data (USEPA, 1984). Slight increases in blood pressure were noted in rats receiving doses of 0.51 and 5.1 mg/kg/day; however, this increase may have been due to a restricted intake of calcium and potassium (USEPA, 1990a).

Carcinogenic Health Effects

Acute Toxicity

Humans: Pertinent data regarding the potential carcinogenicity of barium to humans following either oral or inhalation exposure are not available (USEPA, 1990a).

Laboratory animals: In experimental animal studies, barium acetate was administered to rats in drinking water containing 5 mg Ba/l over their lifetime. No significant increase in total tumors or malignant tumors were found (USEPA, 1984).

Chronic Toxicity

Humans: No information is available.

Laboratory animals: No information is available.

Mutagenicity and Teratogenicity

Mutagenicity: Very little data exist on the mutagenicity of barium compounds, but barium chloride produced no increased mutation frequency in repair-deficient strains of *Bacillus subtillis* (USEPA, 1984).

Reproductive/Developmental Effects: Male rats exposed (for one cycle of spermatogenesis) to airborne barium carbonate at a concentration of 22.6 mg/m^3 (daily duration of exposure not reported) displayed a decrease in the number of spermatazoids and reduced sperm mortality (USEPA, 1984). Females exposed to concentrations of 13.4 mg/m^3 barium carbonate (daily duration of exposure was not reported) for four months displayed increased litter mortality and a general underdevelopment of the newborn pups (USEPA, 1984).

EPA Carcinogenicity Classification and Dose-Response Parameters

EPA Carcinogenicity Classification: The EPA has reviewed the available data on carcinogenicity and has not classified barium based on inadequate data from animal and human studies (USEPA, 1997).

Dose-Response Parameter Estimates: The dose-response parameter estimates for carcinogens and noncarcinogens are computed differently by the EPA; therefore, these estimates are presented separately below.

Carcinogenic Effects: Barium has not been shown to be carcinogenic in humans or animals, thus the EPA has not computed dose-response estimates for carcinogenicity.

Non-Carcinogenic Effects: The reference dose committee of the EPA has derived an oral reference dose (RfD) for barium of 7 x 10^{-2} mg/kg/day based on the chronic drinking water study in rats, discussed above (USEPA, 1997). A no-observed-adverse-effect-level (NOAEL) for increased blood pressure was identified as 0.21 mg/kg/day. An uncertainty factor of 3 was incorporated to account for sensitive populations (USEPA, 1997).

An inhalation RfD of 1 x 10^{-4} mg/kg/day was derived by the Office of Health and Environmental Assessment (USEPA, 1990b). This value is based on identification of a NOAEL (no-observed-adverse-effect-level) of 0.14 mg/kg/day in rats exposed to airborne $BaCO_3$ (Tarasenko et al., 1977). Higher doses produced fetotoxic effects. An uncertainty factor of 1000 was incorporated.

Oral RfD: 7 X 10^{-2} mg/kg/day (USEPA, 1997).

Inhalation RfD: 1 X 10^{-4} mg/kg/day (USEPA, 1990b).

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BERYLLIUM CAS# 7440-41-7

GENERAL BACKGROUND INFORMATION

The solubility and speciation of beryllium in air and water media vary, with ambient air characterized by relatively insoluble beryllium compounds such as beryllium oxide and metallic beryllium, and water characterized by more soluble forms. Carcinogenic potency varies according to the form of beryllium present. Human equivalent doses were calculated using a human body weight of 70 kg, an animal weight of 0.325 kg and length of exposure, experiment and life span of 1126 days for treated and control animals.

HUMAN TOXICOLOGICAL PROFILE

Human data were used for the inhalation exposure quantitation despite limitations in the study. Humans are most likely to be exposed by inhalation to beryllium oxide, rather than other beryllium salts. Animal studies by inhalation of beryllium oxide have utilized intratracheal instillation, rather than general inhalation exposure.

Effective dose was determined by adjusting for duration of daily (8/24 hours) and annual (240/365 days) exposure, and the fraction of the lifetime at risk (i.e., time from onset of employment to termination of follow-up). The risk estimates were based on the data of Wagoner et al. (1980) in which the smoking adjusted, expected lung cancer deaths were found to range from 13.91 to 14.67, in comparison to 20 observed. Relative risk estimates of 1.36 and 1.44 were derived and the 95% confidence limits of these estimates, 1.98 and 2.09, respectively, were used to estimate the lifetime cancer risk. Note that all of the above estimates are based on one data set using a range of estimated exposure and exposure times. Because of uncertainties regarding workplace beryllium concentration and exposure duration, unit risks were derived using two estimates each of concentration, fraction of lifetime exposed and relative risk. The recommended value is the arithmetic mean of the 8 derived unit risks.

Wagoner et al. (1980) observed 47 deaths from cancer among 3055 white males employed in beryllium-processing with a median duration of employment of 7.2 months. Among the 2068 followed for 25 years or more, 20 lung cancer deaths were observed. These increased incidences were statistically significant. when lung cancer mortality data became available for 1968-1975, the number of expected deaths was recalculated and the increased incidence was statistically significant only among workers followed 25 years or more (Bayliss, 1980; MacMahon, 1977, 1978). When the number of expected deaths was adjusted for smoking, the increased incidence was no longer significant (U.S. EPA, 1986).

An earlier study of workers from this same beryllium processing plant, and several studies of workers from this plant combined with workers from other beryllium plants, have reported a statistically significant increased incidence of lung cancer (Bayliss and Wagoner, 1977; Mancuso, 1970, 1979, 1980). No adjustment was made for smoking in these studies, and all were limited in their ability to detect a possible increased incidence of lung cancer because of methodological constraints and deficiencies.

MAMMALIAN TOXICOLOGICAL PROFILE

Fifty-two weanling Long-Evans rats of each sex received 0 or 5 ppm beryllium (as $BeSO_4$, beryllium sulfate) in drinking water. Exposure was for the lifetime of the animals. At natural death the rats were dissected and gross and microscopic changes were noted in heart, kidney, liver, and spleen. There were no effects of treatment on these organs or on life span, urinalysis, serum glucose, cholesterol, and uric acid, or on numbers of tumors. Male rats experienced decreased growth rates from 2 to 6 months of age.

Similar studies were carried out on Swiss (CD strain) mice in groups of 54/sex at doses of approximately 0.95 mg/kg/day (Schroeder and Mitchner, 1975).Female animals showed decreased body weight compared with untreated mice at 6 of 8 intervals. Male mice exhibited slight increases in body weight. These effects were not considered adverse, therefore, 0.95 mg/kg/day is considered a NOAEL.

GENOTOXICITY

No data were found regarding the genotoxicity of beryllium.

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Cadmium

Gastrointestinal absorption of cadmium in humans ranges from 5 to 6% (U.S. EPA 1985a). Based on a comprehensive model for inhaled cadmium, the deposition rate of particulate airborne cadmium is 5–50% (i.e., 5% of particles greater than 10 microns and up to 50% of particles less than 0.1 microns), and 50–100% of the cadmium deposited was absorbed (Nordberg, Kjellstrom, and Nordberg 1985). Cadmium bioaccumulates in humans, particularly in the kidney and liver (U.S. EPA 1985a,b). Acute oral exposure to cadmium in laboratory animals resulted in systemic, immunological, neurological, developmental, and reproductive effects at doses of 2–138 mg/kg/day (ATSDR 1991). Chronic oral or inhalation exposure of humans to cadmium has been associated with renal dysfunction, itai-itai disease (bone damage), hypertension, anemia, endocrine alterations, and immunosuppression. Renal toxicity occurs in humans chronically exposed to cadmium in food at LOAEL of 0.0075 mg/kg/day. In laboratory animals (i.e., rat, mouse) chronic oral exposure to cadmium results in increased blood pressure, hematological, and renal effects at LOAELs ranging from 0.014 to 57 mg/kg/day (ATSDR 1991). Teratogenic and reproductive effects (i.e., deceased fetal and birth weight, delayed ossification, behavioral impairment, and reduced fertility) were reported in laboratory animals (i.e., rat, mice, dogs) subchronically exposed to cadmium in drinking water at LOAELs ranging from 0.04 to 40 mg/kg/day (ATSDR 1991). Epidemiological studies have demonstrated a strong association between inhalation exposure to cadmium and cancers of the lung, kidney, and prostate (U.S. EPA 1985b; Thun et al. 1985). In experimental animals, cadmium induces injection-site sarcomas and testicular tumors. When administered by inhalation, cadmium chloride is a potent pulmonary carcinogen in rats. Cadmium is a well-documented animal teratogen (U.S. EPA 1985b).

U.S. EPA (1998) classified cadmium as a Group B1 agent (Probable Human Carcinogen) by inhalation. This classification applies to agents for which there is limited evidence of carcinogenicity in humans from epidemiologic studies. Using renal toxicity as an endpoint, and a safety factor of 10, U.S. EPA (1998) derived two separate oral RfDs. The RfD associated with oral exposure to drinking water is 5×10^{-4} mg/kg/day, and is based on the LOAEL of 0.005 mg/kg in humans (U.S. EPA 1985a; Friberg et al. 1974). The RfD associated with exposure to cadmium in food is 1×10^{-3} mg/kg/day.

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Chromium

Chromium exists in two states, as chromium (III) and as chromium (VI). Following oral exposure, absorption of chromium (III) has been reported to be 0.4% while absorption of chromium (VI) has been observed to be as high as 10% (ATSDR 1991). However, chromium (VI) is rapidly reduced to chromium (III) after penetration of biological membranes and in the gastric environment (ATSDR 1991). Chromium is an essential micronutrient and is not toxic in trace quantities (U.S. EPA 1980). Alterations in liver enzyme activities were noted in rats administered an oral dose of 13.5 mg/kg/day chromium (VI) for 20 days (Kumar, Rana, and Prakash 1985). Rats subchronically administered higher concentrations of chromium VI (98 mg/kg/day) have exhibited adverse effects on renal function (Diaz-Mayans, Laborda, and Nunez 1986). No significant changes, however, were detected in the livers or kidneys of rats exposed to 2.7 mg/kg/day or 3.5 mg/kg/day chromium (III) or chromium (VI), respectively, in the drinking water for 1 year (MacKenzie et al. 1958; ATSDR 1991). CNS effects including hypoactivity have been reported in rats when exposed to subchronic levels of 98 mg/kg/day chromium VI in drinking water (Diaz-Mayans, Laborda, and Nunez 1986). Workers exposed to 2 $\mu g/m^3$ chromic acid vapors (mean duration of 2.5 years), a soluble chromium (VI) compound, exhibited atrophy and ulceration of the nasal mucosa and transient decrease in lung function (Lindberg and Hedenstierna 1983). There is, however, insufficient scientific evidence that chromium (III) compounds by themselves elicit atrophy of the nasal mucosa or adverse respiratory effects in humans (ATSDR 1991). Furthermore, epidemiological studies of worker populations have clearly established that inhaled chromium (VI) is a human carcinogen; the respiratory passages and the lungs are the target organs (Mancuso 1975; U.S. EPA 1984). Inhalation of chromium (III) or ingestion of chromium (VI) or (III) has not been associated with carcinogenicity in humans or experimental animals (U.S. EPA 1984). Oral exposure of pregnant mice (gestational days, 1 to 19) to 57 mg/kg/day chromium (VI) resulted in embryolethal effects (e.g., increased resorptions and postimplantation loss), reduced ossification and gross anomalies (Trivedi et al. 1989). Chromium (III) does not appear to cause fetotoxic or teratogenic effects in rats (ATSDR 1991). Reproductive effects in the form of decreased sperm count were noted in mice administered oral doses of 4.6 mg/kg/day chromium (VI) (225 ppm) and 3.5 mg/kg/day chromium (III) (172 ppm) for 7 weeks (Zahid et al. 1990).

U.S. EPA (1998) classified inhaled chromium (VI) in Group A—Human Carcinogen by the inhalation route. Inhaled chromium (III) and ingested chromium (III) and (VI) have not been classified with respect to carcinogenicity (U.S. EPA 1996). U.S. EPA (1996) derived a chronic oral RfD of 5×10^{-3} mg/kg/day for chromium (VI) based on a study by MacKenzie et al. (1958) in which no adverse effects were observed in rats exposed to 2.4 mg chromium (VI)/kg/day in drinking water for 1 year. A safety factor of 500 was used to derive the RfD. U.S. EPA (1998) developed an oral RfD of 1 mg/kg/day for chromium (III) based on a study in which rats were exposed to chromic oxide baked in bread. No effects due to chromic oxide treatment were observed at any dose level (Ivankovic and Preussman 1975); however, hepatotoxicity was the effect of concern. An uncertainty factor of 1,000 was used to calculate the RfD.

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COPPER CAS# 7440-50-8

GENERAL BACKGROUND INFORMATION

Copper is a reddish metal that occurs naturally in rock, soil, water, sediment, and air. Its average concentration in the earth's crust is about 50 parts copper per million parts soil. Copper also occurs naturally in plants and animals. It is an essential element for all known living organisms including humans and other animals.

PHARMACOKINETICS

Chromosomal aberrations were induced in isolated rat hepatocytes when incubated with copper sulfate (Sina et al., 1983). Casto et al. (1979) showed enhanced cell transformation in Syrian hamster embryo cells infected with simian adeno virus with the addition of cuprous sulfide and copper sulfate. High concentrations of copper compounds have been reported to induce mitosis in rat ascites cells and recessive lethals in Drosophila melanogaster. Law (1938) reported increases in the percent lethals observed in Drosophila larvae and eggs when exposed to copper by microinjection (0.1% copper sulfate) or immersion (concentrated aqueous copper sulfate), respectively.

HUMAN TOXICOLOGICAL PROFILE

Hematological effects in workers employed in a copper processing factory have been reported by Finelli et al. (1981). However, interpretation of the study results is limited by the finding of elevated iron, lead, and cadmium in hair samples of exposed workers.

Metal fume fever, has been reported in factory workers exposed to copper dust or fumes (Armstrong et al. 1983; Gleason 1968; Stokinger 1981).

GENOTOXICITY

Moriya et al. (1983) reported no increase in mutations in E. coli and S. typhimurium strains TA98, TA1535, TA1537 and TA1538 incubated with up to 5 mg copper quinolinolate/plate and in S. typhimurium TA98 and TA100 incubated with up to 5 mg copper sulfate/plate.

Demerec et al. (1951) reported dose-related mutagenic effects in E. coli with 2 to 10 ppm copper sulfate in a reverse mutation assay. Negative results were obtained with copper sulfate or copper chloride in assays using S. cerevisiae (Singh, 1983) and Bacillus subtilis (Nishioka, 1975, Matsui, 1980, Kanematsu et al., 1980). Errors in DNA synthesis frpm poly(c)templates have been induced in viruses incubated with copper chloride or copper acetate (Sirover and Loeb, 1976).

Bionetics Research Labs (1968) studied the carcinogenicity of a copper-containing compound, copper hydroxyquinoline, in two strains of mice (B6C3F1 and B6AKF1). Groups of 18 male and 18 female 7-day-old mice were administered 1000 mg copper hydroxyquinoline/kg bw (180.6 mg Cu/kg) suspended in 0.5% gelatin daily until they were 28 days old, after which they were administered 2800 ppm (505.6 ppm Cu) in the feed for 50 additional weeks. No statistically significant increases in tumor incidence were observed in the treated 78-week-old animals. In the same study, Bionetics Research Labs (1968) administered a single subcutaneous injection of gelatin (control) or 1000 mg of copper hydroxyquinoline/kg bw (180.6 mg Cu/kg) suspended in 0.5% gelatin to groups of 28-day-old mice of both strains. After 50 days of observation, the male B6C3F1 had an increased incidence of reticulum cell sarcomas compared with controls. No tumors were observed in the treated male B6AKF1 mice, and a low incidence of reticulum cell sarcomas was observed in the treated female mice of both strains.

Gilman (1962) administered intramuscular injections containing 20 mg of cupric oxide (16 mg Cu), cupric sulfide (13.3 mg Cu), and cuprous sulfide (16 mg Cu) into the left and right thighs of 2- to 3-month-old Wistar rats. After 20 months of observations, no injection-site tumors were observed in any animals, but other tumors were observed at very low incidence in the animals receiving cupric sulfide (2/30) and cuprous sulfide (1/30). As the relevance of the organic copper compound to the observation of sarcoma induction is uncertain and the incidence of tumors in rats treated i.m. with inorganic copper was very low, data are considered inadequate for classification.

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LEAD

General Background

Occurrence and Use

Lead (Pb) is a major environmental contaminant and one of the most common pollutants at hazardous waste sites. Combustion of gasoline is the major source of lead, and it is a component of automotive batteries paint, ceramics, bullets, solder, cable coverings, caulking lead, piping, type metal, brass and bronze, and bearing metals. Air emissions from combustion sources and lead paint are the primary anthropogenic sources of environmental lead.

Lead is found in the earth's crust and in all compartments of the geosphere and biosphere. Both natural and anthropogenic processes are responsible for the distribution of lead throughout the environment. Typical concentrations of lead in top soils range from 15-95 mg/kg (Kabata-Pendias and Pendias, 1984). Concentrations of lead in rural soils, away from industrial emissions and roadbeds, range from 5-30 µg/g. Lead concentrations near roadbeds can be much higher (30-2000 µg/g) and vary with past and present traffic density and vehicle speed (Page and Gange 1970; Quarles *et al.*, 1974; Wheeler and Rolfe 1979). Much higher levels (greater than 30,000 µg/g) can occur in the immediate vicinity of industrial sources (Yankel *et al.*, 1977; EPA 1986b). Concentrations of lead in US ambient waters are typically low. Mean values tend to be less than 3-28 µg/l (NAS 1980; EPA 1986b). In contrast to ambient water, levels in drinking water can be much higher (10-1,000 µg/l) because of leaching of lead from lead pipe and leaded solder joints. Ambient concentrations in urban air are estimated to range from 0.02 to 10 µg/m^3 (Carson *et al.*, 1987, *Toxicology and Biological Monitoring of Metals in Humans*, Lewis Publishers Inc., Chelsea, Michigan.)

Physical/Chemical Properties

Lead is a gray-white metal of silvery luster that has a low melting point (327.5°C) and a boiling point of 1740°C. The metal is soft, malleable and ductile, a poor electrical conductor and highly impervious to corrosion. A listing of the solubilities and physical properties of the more common compounds of lead is given in Weast 1982 and EPA 1986a. Most inorganic lead salts are sparingly soluble (eg., PBF_2, $PbCl_2$) or virtually insoluble ($PbSO_4$, $PbCrO_4$) in water; the notable exceptions are lead nitrate, $PB(NO_3)_2$ and lead acetate, $Pb(OCOCH_3)_2$. Inorganic lead (II) salts are, for the most part, relatively high-melting-point solids with correspondingly low vapor pressures at room temperatures. The vapor pressures of the most commonly encountered lead salts are tabulated in EPA 1986a.

Molecular Weight	207
Water Solubility, mg/l	0
Bioaccumulation Factor for Fish	100
Bioaccumulation Factor for Shellfish	100

Source: Multi-Media Exposure Assessment Manual, 1989

Environmental Fate Characteristics

Although the chief source of environmental exposure is the atmosphere, Pb enters soil and water as fallout. Lead deposited on soils can bind to naturally occurring materials, including other dusts, clays, hydrous oxides and humic and fulvic acids. Once it enters the soil, opportunities are enhanced for lead to be absorbed and recycled into the human food chain through grazing animals, home gardening and general agricultural activity. The highest concentrations of anthropogenic Pb have been found close to heavily travelled roads. Lead enters the human body via inhalation and ingestion.

At one time, automobile exhaust accounted for about 90% of Pb air emissions in the United States. The phase-down of lead content of gasoline and reductions in usage of leaded gasoline have, and will continue to, substantially decrease the contribution of automobile exhaust to lead in air (EPA 1986b). Lead in automobile exhaust originates from combustion of gasoline containing organic lead additives, primarily tetraethyl and tetramethyl lead. Lead is emitted from vehicles primarily as particles of inorganic lead, with a small percentage as volatile lead alkyls.

Lead released to the air deposits on terrestrial surfaces and enters the soil, where it can have several possible fates. Lead can be retained in organic complexes near the soil surface. For example, insoluble lead species may be free or adsorbed on solid inorganic or organic matrices. Studies of lead/soil interactions show that soil fixation of lead is mainly affected by pH, cation exchange capacity and organic matter content of soil. Lead appears most strongly associated with soil organic carbon fraction. If little or no organic material is in the soil, other components can regulate lead fixation. These include hydrous manganese oxide (Forstner *et al.*, 1981) and hydrous ferric oxide (Swallow *et al.*, 1980). Lead bound to organic constituents in soil can remain in soil for long periods of time. As a result, elevated levels can persist long after sources of deposition have been reduced (Prpic-Majic *et al.*, 1984).

Dust is an important source of oral lead intake in infants and children. The term "dust" refers to house and outdoor dust; house dust is dust in the interior of buildings and includes such things as material from fabrics (carpet) and paint and soil tracked or blown into the house. Outdoor dust includes anthropogenic materials deposited on outside surfaces, referred to as "street dust," and the mobile uppermost layer of natural soil, referred to as "soil dust" (EPA 1986b). Outdoor dusts can be transported by wind and rain runoff (Laxen and Harrison 1977). Lead persistence in dust depends on the amount and size of particles; big particles tend to persist in air for less time than smaller ones. Levels in outdoor dust near point sources have been shown to decline within 1-2 years after atmospheric emissions decreased (Morse *et al.*, 1979; Prpic-Majic *et al.*, 1984).

Lead can enter ambient water from atmospheric deposition and surface runoff, where it tends to form insoluble salts and precipitates. Lead concentrations in drinking water vary with the amount of lead in the household plumbing and corrosiveness of the water. Soft or acidic waters tend to be more corrosive and promote higher concentrations of dissolved lead in the drinking water (Worth *et al.*, 1981). Drinking water can be a major source of lead intake for infants and young children who consume large amounts of infant formula prepared with household water.

Absorption, Transport and Degradation

Oral intake, rather than inhalation, is generally the predominant route of intake for nonoccupationally exposed populations. Intake occurs through ingestion of food and beverages, and in infants and children, through ingestion of dust and soil.

Ingestion of lead-based paint is one of the most frequent causes of severe lead intoxication in children (Chisolm 1984). Although the US Consumer Product Safety Commission banned the use of household paints containing greater than 0.06% lead in 1977, the hazard persists in homes and apartments constructed before the ban. Infants and children can be exposed to lead in paint from ingesting and inhaling house dust contaminated with paint dust and from intentionally ingesting paint chips (paint pica). Exposure can occur outside the house from ingestion of street and soil dust.

Absorption of ingested lead is quantitatively the most significant route of uptake of inorganic lead in most human populations; the exception is occupational exposures in which inhalation of airborne lead results in significant uptake. Percutaneous absorption (ie., dermal uptake) is not considered a significant route of absorption of inorganic lead. Alkyl lead compounds (e.g., triethyl, trimethyl, tetraethyl and tetramethyl lead) are more highly lipophilic than inorganic lead and are readily absorbed from the lung and skin.

For inhalation, amounts and patterns of deposition of particulate aerosols in the respiratory tract are affected by the size of the inhaled particles, age-related factors that determine breathing patterns (e.g., nose breathing vs mouth breathing), airway geometry and airstream velocity within the respiratory tract. Estimates for fractional absorption of large particles (greater than 2.5 µm) deposited in the upper respiratory tract range from 40-50% (Kehoe, 1961a,b,c; Chamberlain and Heard, 1981).

Chamberlain *et al.*, (1978) exposed adult human subjects to radioactive lead in engine exhaust, lead oxide or lead nitrate (less than 1 um particle size) and observed that 90% of the deposited lead was cleared from the lung within 14 days.

Morrow *et al.*, (1980) reported 50% absorption of deposited lead inhaled as lead chloride or lead hydroxide within 14 hours. An analysis of the radioisotopic dilution studies of Rabinowitz *et al.*., (1977) in which adult human subjects were exposed daily to ambient air lead indicated that about 90% of the deposited lead was absorbed daily (EPA 1986b).

Quantitative analyses of the relationship between aerosol particle size and deposition in the human respiratory tract have been combined with information on size distributions of ambient air lead aerosols to estimate deposition and absorption efficiencies for inhaled lead in adults and children (EPA 1986b; Cohen 1987). It was estimated that 38% of the inhaled lead in adults living in the vicinity of an industrial source is absorbed. For some urban and rural atmospheres, where submicron particles dominate the airborne lead mass, the estimated fractional absorption is 15-30% (Cohen, 1987).

The retention and absorption of gaseous tetraethyl and tetramethyl lead has been examined in volunteers who inhaled radioactively-labelled tetraalkyl lead (Heard *et al.*, 1979). Initial lung retention was 37 and 51% for tetraethyl and tetramethyl lead, respectively. Of these amounts, 40% of tetraethyl lead and 20% of tetramethyl lead was exhaled within 48 hours; the remaining fraction (tetraethyl, 60%; tetramethyl, 80%) was absorbed.

The gastrointestinal tract is the primary site of absorption of lead in children and most adult populations, with the exception of those subject to occupational exposure (EPA 1986b). Gastrointestinal absorption of lead varies with age, diet and nutritional status as well as the chemical species and particle size of the ingested lead. Dietary balance studies have yielded estimates ranging from 7-15% for gastrointestinal absorption in adults (Kehoe, 1961 a,b,c; Chamberlain *et al.*, 1978; Rabinowitz *et al.*, 1980). Gastrointestinal absorption of dietary lead is greater in infants and children than in adults. A mass balance study in infants aged 2 weeks to 2 years yielded estimates of 42% for children with dietary intakes of greater than or equal to 5 µg/kg body weight. Lower dietary intakes were associated with highly variable absorption (Ziegler *et al.*, 1978). A study conducted with infants and children aged 2 months to 8 years (daily intake, 10 µg/kg body weight) yielded estimates of 53% for gastrointestinal absorption (Alexander *et al.*, 1973). Individuals with poor nutritional status may absorb more lead from environmental sources (EPA, 1986b).

Inorganic lead is not readily absorbed through the skin (percutaneous absorption). Values of 0-0.3% of the administered dose were reported for humans exposed to dermal applications of cosmetic preparations containing lead acetate.

Mineralized tissues (e.g., bone and teeth) are the single largest pool for absorbed lead, accounting for about 95% of the total lead burden in adults and slightly less in children (Barry 1975, 1981). Lead not contained in mineralized tissue is distributed in soft tissues, primarily blood, liver and kidneys. Small amounts accumulated in other soft tissues such as brain, although not quantitatively significant to the overall distribution of the body burden, are of considerable toxicological importance. Lead readily transfers across the placenta and distributes to fetal tissues (Horiuchi *et al.*, 1959; Barltrop, 1959; Lauwerys *et al.*, 1978; Kovar *et al.*, 1984; Tsuchiya *et al.*, 1984; Korpela *et al.*., 1986). Lead distributes to a variety of tissues after exposure to lead alkyls. Levels of lead in humans that have been exposed to tetraethyl and tetramethyl lead are highest in liver followed by kidney and brain (Bolanowska *et al.*, 1967; Grandjean and Nielsen 1979).

Metabolism of inorganic lead consists primarily of reversible ligand reactions including the formation of complexes with amino acids and nonprotein thiols, and binding to various cellular proteins (Bruenger *et al.*, 1973; Raghavan and Gonick, 1977; Everson and Patterson 1980; Ong and Lee 1980; DeSilva 1981). Tetraethyl and tetramethyl lead undergo oxidative dealkylation to the corresponding trialkyl derivatives that are thought to be the neurotoxic forms of these compounds. Dealkylation of tetralkyl lead occurs in a variety of species, including humans (EPA 1986b).

Non-Carcinogenic Health Effects

Acute Toxicity

Humans: Acute lead encephalopathy, characterized by vomiting, apathy, drowsiness, stupor, ataxia, hyperactivity, seizures and other neurological signs and symptoms is the most common toxic response to lead poisoning. Another toxic response is acute lead-induced nephrotoxicity, characterized by proximal tubular nephropathy of the kidney. Acute nephrotoxicity has been observed in children with lead encephalopathy and is associated with relatively high blood lead levels (ie., greater than 80 µg/dl) (Chisolm *et al.*, 1955; Chisolm 1962, 1968; Pueschel *et al.*, 1972; EPA 1986b).

Animals: Limited information is available on the acute toxicity of lead in animals. However, characteristic lesions described in both humans and animals include nuclear inclusion bodies and mitochondrial changes in the epithelial cells of the pars recta of the proximal tubule and impaired solute reabsorption (eg., glucose, amino acids, phosphate) of the kidney.

Chronic Toxicity

Effects of Lead on the Nervous System

Adults: Severe lead neurotoxicity is characterized by overt symptoms of irritability, shortening of attention span, headache, muscular tremor, peripheral neuropathy, abdominal pain, loss of memory and hallucinations. Delirium, convulsions, paralysis and death can also occur. In adults, some of these overt symptoms may become apparent at blood lead levels in the range of 40-60 µg/dl (EPA 1986b). Nonovert symptoms of neurotoxicity associated with lead exposure in adults include impaired performance on psychomotor tests, decreased nerve conduction velocity and impaired cognitive function. Blood lead levels associated with these effects range upwards from 30 µg/dl (EPA 1986b).

Children: Symptoms of overt neurotoxicity in children are similar to those observed in adults. Nonovert symptoms of neurotoxicity that have been reported in children include impairments or abnormalities in psychomotor and cognitive function. Severe psychomotor and cognitive deficits appear to be associated with blood lead levels at the range of greater than or equal to 40-60 µg/l in "high-risk" populations of children (EPA 1986b). High risk populations include children with previous histories of lead encephalopathy or paint pica and children with possible occupational exposure (eg., lead pottery manufacture).

Several large-scale studies (EPA 1986b) reported effects on mental development and cognitive ability associated with blood lead levels greater than or equal to 10-15 µg/dl.

An inverse linear association between Stanford-Binet IQ scores and contemporary blood lead levels was seen over the entire range of 6-47 µg/dl in a study of uniformly low socioeconomic status black children, 3-7 years old (Hawk *et al.*, 1986; Schroeder and Hawk, 1987). A study of 6-9-year old children in Edinburgh, Scotland, also indicated a negative linear correlation between blood lead and scores on tests of cognitive ability (Fulton *et al.*, 1987). The correlation extended across a range of 5-22 µg/dl mean blood lead levels.

A nerve conduction velocity study in children (aged 5-9 years) living in the vicinity of a lead smelter (Schwartz *et al.*, 1988) indicated a threshold for decreased maximal nerve conduction and estimated it to be within the range of 20-30 µg/dl.

Animals: Effects of lead on the nervous system were not in the available literature.

Effects of Lead on Heme Biosynthesis and Erythropoiesis:

Humans: Lead interferes with heme biosynthesis by decreasing the activity of enzymes in this pathway (EPA 1986b). Significant impairment of hemoglobin synthesis occurs in adults only at relatively high blood levels. The threshold for a decrease in blood hemoglobin in adults and children is achieved at a blood lead level of 50 µg/dl (Meredith *et al.*, 1977; Fischbein, 1977; Alvares *et al.*, 1975). Frank anemia in adults has been associated with levels greater than 80 µg/dl (Tola *et al.*, 1973; Grandjean 1979; Lilis *et al.*, 1978; Wada *et al.*, 1973; Baker *et al.*, 1979). Available information indicates the potential for undesirable effects on heme biosynthesis and erythroblast pyrimidine metabolism in children with blood lead levels greater than 10-15 ug/dl and possibly at lower levels (EPA 1990).

Laboratory animals: Effects of lead on the heme biosysnthesis and erythropoiesis were not in the available literature.

Effects of Lead on the Kidney:

Humans: Chronic toxicity in the kidney is characterized by interstitial fibrosis and decreased glomerular filtration rate (Goyer 1982; EPA 1986b, ATSDR/EPA 1988). Chronic nephropathy, indicated by nuclear inclusion bodies, mitochondrial changes, interstitial fibrosis and glomerular changes, have been associated with prolonged (greater than 10 years) occupational exposures and blood lead levels greater than 40-60 µg/dl (Lilis *et al.*, 1968; Cramer *et al.*, 1974; Biagini *et al.*, 1977; Wedeen *et al.*, 1975, 1979; Buchet *et al.*, 1980; Hong *et al.*, 1980).

Animals: Effects of lead on the kidney in animals were not in the available literature.

Effects of Lead on Blood Pressure:

Humans: The relationship between concurrent blood lead levels and blood pressure in adults has been examined in several epidemiological studies (Pocock *et al.*,1984, 1985, 1988; Harlan *et al.*, 1985; Pirkle *et al.*, 1985; Landis and Flegal 1987; Elwood *et al.*, 1988 a, b; Neri *et al.*, 1988; Sharp *et al.*, 1988; Weiss *et al.*, 1988; Moreau *et al.*, 1988). The weight of evidence provided by the several large- and small-scale epidemiology studies supports the existence of a positive correlation between blood lead level and blood pressure.

The correlation between blood lead levels and blood pressure in humans appears to extend to blood lead levels less than 20 µg/dl and possibly to as low as 7 µg/dl. This suggests that as blood lead level increases greater than 7 µg/dl to levels greater than or equal to 20 µg/dl, the risk for increased blood pressure increases.

Animals: In addition, the results of numerous animal studies suppport a dose-response relationship between lead exposure and elevated blood pressure. Chronic exposure to inorganic lead increases blood pressure in laboratory animals (Victery 1988).

Effects of Lead on Serum Vitamin D Levels:

Humans: Serum levels of 1,25-dihydroxycholecalciferol are inversely correlated with blood lead in children (Rosen *et al.*, 1980; Mahaffey *et al.*, 1982). The correlation persists when examined across a range of blood lead levels extending from 12-60 µg/dl; however, the dose-effect relationship has not been characterized. Based on a linear regression analysis of data on serum 1,25-dihydroxycholecalciferol and blood lead levels in children as well as data on 1,25-dihydroxycholecalciferol levels in other vitamin D related clinical disorders in children, it has been predicted that increasing the blood lead levels from 12-60 µg/dl will lower serum 1,25-dihydroxycholecalciferol to clinically adverse levels (Mahaffey *et al.*, 1982). Chronic depression of 1,25-dihydroxycholecalciferol levels of a much smaller magnitude than that associated with frank clinical disorders of calcium and phosphate metabolism have the potential to alter bone development and growth in children; therefore, blood lead levels greater than 12 µg/dl should be considered potentially undesirable with respect to changes in 1,25-dihydroxycholecalciferol levels in children. 1,25-dihydroxy-cholecalciferol, the active form of vitamin D, is a hormone that plays an important role in the regulation of gastrointestinal absorption and renal excretion of calcium and phosphorus and in the mineralization of bone. Deficiencies in 1,25-dihydroxy-cholecalciferol are associated with decreased bone mineralization and clinical syndrome of rickets in children. 1,25-dihydroxy-cholecalciferol may also stimulate gastrointestinal absorption of lead (Smith *et al.*, 1978).

Animals: Effects of serum vitamin D levels in animals were not in the available literature.

Carcinogenic Health Effects

Humans: Epidemiological studies of industrial workers, where the potential for lead exposure is usually greater than for a "normal population," have been conducted to evaluate the role of lead in the induction of human neoplasia (Cooper 1976, 1981; Cooper and Gaffey 1975; Chrusciel 1975; Dingwall-Fordyce and Lane 1963; Lane 1964, McMichael and Johnson 1982; Nelson *et al.*, 1982). Two studies (Dingwall-Fordyce and Lane 1963 and Nelson *et al.*, 1982) did not find any association between exposure and cancer mortality. Selevan *et al.*, (1984), in their retrospective cohort mortality study of primary lead smelter workers, found a slight decrease in the total cancer mortality compared to controls. Apparent excesses were observed for respiratory cancer and kidney cancer. Cooper and Gaffey (1975) and Cooper (1985) performed a cohort mortality study of battery plant workers and lead smelter workers. They found statistically significant excesses for total cancer mortality, stomach cancer and lung cancer in the battery plant workers. Although similar excesses were observed in the smelter workers, they were not statistically significant. Cooper and Gaffey (1975) felt it was possible that individual subjects were monitored primarily on the basis of obvious signs of lead exposure, while others who showed no symptoms of lead poisoning were not monitored. This possible bias in clinical evaluation decreases the validity of this study.

In general, these studies made no attempt to consider types of lead compounds to which workers were exposed, to the probable routes of exposure, or workers'smoking habits. All studies also included exposures to other metals such as arsenic, cadmium (both known carcinogens) and zinc for which no adjustment was done. The cancer excesses observed in the lung and stomach were relatively small. There was no consistency of site among the various studies and no study showed any dose-response relationship. Thus, the available human evidence is considered to be inadequate to refute or demonstrate any potential carcinogenicity for humans from lead exposure.

Animals: the carcinogenic potential of lead salts (primarily phosphates and acetates) administered via the oral route or by injection has been demonstrated in rats and mice by more than 10 investigators (Zollinger 1953; Boyland *et al.*, 1962; Van Esch *et al.*, 1962; Baldwin *et al.*, 1964; Balo *et al.*, 1965; Hass *et al.*, 1967; Mao and Molnar 1967; Epstein and Mantel 1968; Zawirska and Medras 1968; Van Esch and Kroes 1969; Zawirska and Medras 1972; Azar *et al.*, 1973; Furst *et al.*, 1976; Koller *et al.*, 1985). The most characteristic cancer response is bilateral renal carcinoma. Rats given lead acetate or subacetate orally have developed gliomas and lead subacetate also produced lung adenomas in mice after intraperitoneal administration. Most of these investigations found a carcinogenic response only at the highest tolerated doses. The lead compounds tested in animals are almost all soluble salts. Metallic lead, lead oxide and lead tetralkyls have not been tested adequately. Studies of inhalation exposure have not been located in the literature (EPA 1991a).

Mutagenicity and Teratogenicity

Mutagenicity: Structural chromosomal aberrations and increased sister chromatid exchanges in peripheral lymphocytes have been associated with chronic exposure to lead resulting in blood lead levels in the range of 24-89 µg/dl, although clinically significant effects were not observed over this range of blood levels in numerous studies (EPA 1986b). Studies reviewed by EPA (1989b) demonstrated that lead compounds induce cell transformation in mouse cells and rat embryo cells infected with the Rauscher murine leukemia virus.

Teratogenicity:

Humans: Severe occupational exposure to lead has been associated with increased incidence of spontaneous abortion (EPA 1986b) in exposed women. In the Port Pirie cohort study, pregnancy outcome in populations near and distant from a lead smelter indicated that the risk for pre-term delivery was positively related to maternal blood lead, over a range of 8-32 ug/dl (McMichael *et al.*, 1986). Depressed sperm production and development has been associated with occupational exposure to lead. Based on studies by Lancranjan *et al.*, 1975 and Wildt *et al.*, 1983, the EPA concluded that undesirable effects on sperm or testes may occur in men as a result of chronic exposures leading to blood lead levels of 40-50 µg/dl (EPA 1986b).

The effects of prenatal and neonatal lead exposure on perinatal status and postnatal mental and motor development have been examined in several epidemiologic studies. Four prospective studies initiated in the cities of Boston, Cincinnati, Cleveland and Port Pirie, Australia, are notable (Bellinger *et al.*, 1987 a,b, 1989 a; Dietrich *et al.*, 1987, 1989; Ernhart *et al.*, 1986; McMichael *et al.*, 1986; Vimpani *et al.*,1985; Baghurst *et al.*, 1987). Based on an extensive evaluation of these studies, the EPA concluded that "all of these studies taken together suggest that neurobehavioral deficits, including declines in Bayley Mental Development Index (MDI) scores and other assessments of neurobehavioral function, are associated with prenatal blood lead exposure levels on the order of 10-15 µg/dl, and possibly even lower, as indexed by maternal or cord blood lead concentrations" (EPA 1986b).

Animals: No information is available on the teratogenic effects of lead in animals.

EPA Carcinogenic Classification and EPA Dose-Response Parameters

EPA Carcinogenic Classification: EPA has classified lead as a probable human carcinogen (Class B2) (IRIS 1996). Currently, toxicological parameters for lead are not available in IRIS.

EPA Dose-Response Parameters: The EPA has not derived oral and inhalation cancer potency factors for lead (EPA 1991 a,b).

Noncarcinogenic Effects: Dose-response estimates for oral and inhalation exposures are not available for the noncarcinogenic effects of lead (IRIS, 1996). An old RfD for non-cancer effects is available for the non-cancer impacts of lead exposure on humans. It is LOE-03 mg/kg-day. However, the EPA has determined that an RfD would not be appropriate to protect children from adverse developmental impacts of lead exposure due to the complex relationship between lead exposures by various routes, blood-lead levels, and the occurrence of adverse effects. Instead, EPA had developed a biokinetic model for assessing the impacts of multi-route lead exposures on childrens' blood-lead levels (EPA 1994) and recommends that it be used to evaluate the health significance of lead exposures, using a target blood lead level of 10 µcg/dl as an indicator of potential adverse effects. This model applies to infants and young children (0 to 6 years old).

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MERCURY CAS# 7439-97-6

GENERAL BACKGROUND INFORMATION

Mercury has been used in the past for medicinal purposes (Gosselin et al., 1984). There are a number of occupations associated with mercury exposure, particularly through inhalation. These include mining, smelting, chloralkali production, and the manufacture of mercury-containing products such as batteries, measuring devices (thermometers) and paints. Mercury has also been used agriculturally as a seed and cereal protectant and as a fungicide.

PHARMACOKINETICS

The pharmacokinetics and pharmacodynamics of mercury depend largely on its chemical form, organic, inorganic or elemental. Absorption efficiencies vary depending on route of exposure and chemical form (see section on Relative Absorption Factors). Distribution, metabolism and excretion depend largely on the lipid solubility, ionization state and molecular size of the specific chemical form (ATSDR, 1989).

HUMAN TOXICOLOGICAL PROFILE

Exposure to most forms of mercury is associated with a high degree of toxicity. Elemental (metallic) mercury causes behavioral effects and other nervous system damage. Inorganic mercury salts do not generally reach the brain, but will produce kidney damage. Divalent (mercuric) mercury is substantially more toxic in this regard than the monovalent (mercurous) form. Organic mercury compounds are also toxic. Symptoms of chronic mercury poisoning can be both neurological and psychological in nature as the central nervous system is the primary target organ. Hand and finger tremors, slurred or scanning speech patterns, and drunken, stupor-like (ataxic) gait are some motor-control impairments that have been observed in chronic mercurial toxicity. Visual disturbances may also occur, and the peripheral nervous system may be affected. A psychological syndrome known as erethism is know to occur. It is characterized by changes in behavior and personality including depression, fearfulness, restlessness, irritability, irascibility, timidity, indecision, and early embarrassment. Advanced cases may also experience memory loss, hallucination, and mental deterioration.

MAMMALIAN TOXICOLOGICAL PROFILE

In a study by Mitsumori et al. (1981), male and female mice were fed methyl mercury chloride in their diet for up to 78 weeks. Most of the high dose group died from neurotoxicity before the 26th week. Renal tumors developed in 13 of 16 males in the intermediate dosage group by 53 weeks while only 1 male in the control group developed tumors. No renal tumors occurred in exposed or control females. Studies on rats have reported similar effects such as damage to kidneys and the peripheral nervous system (U.S. EPA, 1980). Mice treated with alkyl mercury phosphate were reported to have an increased frequency of offspring with cleft palates (Oharazawa, 1968) while mice treated with methylmercury had offspring with significantly lowered birth weights and possible neurological damage (Fujita, 1969). No adequate epidemiological studies exist on the teratogenic effects of methylmercury on humans (U.S. EPA, 1980).

GENOTOXICITY

Skerfving et al. (1974) reported a statistical relationship between chromosome breaks and concentrations of methyl mercury in the blood of Swedish subjects on fish diets. Concentrations were reported to be from 14-116 ng Hg/ml in the blood of exposed subjects and from 3-18 ng/ml in nonexposed subjects.

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NICKEL CAS# 7440-02-0

GENERAL BACKGROUND INFORMATION

Nickel in the ambient atmosphere typically exists as a constituent of suspended particulate matter (U.S. EPA, 1985). The greatest volume of nickel emitted into the atmosphere is the result of fossil fuel combustion. Other sources of nickel emissions are primary production, incinerators, metallurgy, chemical manufacturing, cement manufacturing, coke ovens, nickel recovery, asbestos mining/milling and cooling towers.

PHARMACOKINETICS

Studies of nickel absorption have shown that it is absorbed by all routes of exposure to varying degrees, primarily dependent on the chemical form (see section on Relative Absorption Factors). Absorbed nickel is bound to serum components and distributed to body organs, reaching highest concentrations in kidney and lung tissue (Whanger, 1973). Nickel is not known to be biotransformed. Excretion of absorbed nickel is primarily through urine, with minor excretory routes through hair and sweat (ATSDR, 1988).

HUMAN TOXICOLOGICAL PROFILE

Nickel carbonyl $Ni(CO)_4$ is a particularly toxic form of nickel upon inhalation and causes chest pain, dry coughing, hyperpnea, cyanosis, occasional gastrointestinal symptoms, sweating, visual disturbances and severe weakness. This is often followed by pulmonary hemorrhage, edema and cellular derangement. Survivors may be left with pulmonary fibrosis. In the workplace, nickel dermatitis may result at high nickel concentrations. At lower concentrations some susceptible individuals develop eczema-like lesions. The threshold for these health effects is much greater than exposures which occur in the ambient environment. The major adverse effects of nickel in man are dermatitis, chemical pneumonitis, and lung and nasal cancers.

MAMMALIAN TOXICOLOGICAL PROFILE

Deaths occurred in rats and mice at concentrations greater than 3.3 and 1.7 mg/m^3 nickel, respectively, upon extended inhalation exposure to $NiSO_4$ (Dunnick et al., 1987). Mice exposed to Ni_3S_2 died due to necrotizing pneumonia at 7.3 mg/m^3 nickel (Benson et al., 1987). Prolonged exposure of hamsters to nickel oxide at 41.7 mg/m^3 resulted in decreased survival due to emphysema (Wehner et al., 1975). Oral LD_{50}s in rats vary depending upon the nickel-containing compound to which the rats were exposed. These range from 355 mg compound/kg (118 mg Ni/kg) for nickel acetate (Haro, 1968) to greater than 5000 mg compound/kg for nickel oxide, nickel sulfide, and nickel subsulfide (Mastromatteo, 1986). Rats fed diets containing nickel sulfate hexahydrate at 0, 250, 500 and 1000 ppm nickel showed no adverse effects over three generations in fertility, gestation, viability or lactation.

GENOTOXICITY

Weak evidence exists for the mutagenicity of nickel in bacterial and mammalian cells. Nickel appears to induce chromosomal aberrations in cultured mammalian cells (Larramendy et al., 1981), but not in vivo (Waksvik and Boysen, 1982). Occupational studies of human exposure indicate that certain nickel compounds appear to be carcinogenic via inhalation. However, there is no evidence of carcinogenicity in mammals through ingestion or dermal exposure (U.S. EPA, 1985). Nickel subsulfide has been found to be carcinogenic via the inhalation route in rats (Ottolenghi et al., 1974). Studies on nickel exposure via the oral route are inadequate to reach conclusions on carcinogenicity (ATSDR, 1988).

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SELENIUM and Compounds CAS# 7782-49-2

GENERAL BACKGROUND INFORMATION

Selenium is an essential micronutrient for several species, including humans, and is part of several enzymes such as glutathione peroxidase, an enzyme involved in cellular defense against oxidative damage, and heme oxidase. While low doses of selenium are essential, high doses of selenium or a deficiency of dietary selenium may cause a toxic response. Additionally, selenium may be protective against tumor development. The greatest daily exposure to selenium is via food. Bioavailability of selenium is dependent on numerous factors, including the intake levels, chemical form and nutritional status. Organic forms of selenium are more bioavailable than inorganic forms; selenates and selenites are the inorganic forms more readily absorbed. Sodium selenate and selenite are soluble in water, but the extent to which they are absorbed dermally or through the gastrointestinal tract has not been fully elucidated (U.S. EPA, 1989).

PHARMACOKINETICS

The essentiality and toxicity of selenium varies according to the valence state of selenium when incorporated into biomolecules and the form in which selenium is fed or administered. This is especially true when comparing the LD50 value as an index of toxicity for the various selenium compounds. Although it is difficult to make an assessment for several selenium compounds by a similar mode of administration in a common species, there is general agreement that sodium selenite, sodium selenate, selenomethionine and selenoglutathione are among the more toxic species (Combs and Combs, 1986).

The relative potency of systemic toxicity for selenium compounds is also similar in experiments examining potency of anti-tumorigenic activity. In vitro examination of potency of effect of selenium compounds on incubated Ehrlich ascites tumor cells (EATC) showed that sodium selenite is more efficacious in significantly reducing EATC viability than an equivalent concentration of sodium selenate. Although selenium dioxide, selenomethionine and selenocystine ultimately decreased viability of the EATC, nearly 50% more incubation time was required for the same effect (Poirier and Milner, 1979).

HUMAN TOXICOLOGICAL PROFILE

A group of 142 volunteers in South Dakota and Wyoming were recruited by Longnecker et al. (1991) at random from households listed in a telephone directory or from ranches with suspected high selenium intake based on previous cases of livestock selenosis. The geographical areas were chosen because of known seleniferous topsoil and high concentrations of selenium in plants and food. The subjects were followed for 1 year and completed health questionnaires, underwent physical examinations, provided blood samples for clinical assessment, and provided blood, urine, toenails and duplicate-plate food collections for selenium analysis. The average selenium intake was 239 ug/day, approximately 2-3 times higher than the national average. The concentration of selenium in whole blood, serum, urine and toenails and the amount in diet were highly correlated. Blood selenium concentration was highly correlated with selenium intake. The correlation was very similar to that reported by Yang et al. (1989a). Liver function (prothrombin time and alanine aminotransferase, aspartate aminotransferase, gamma glutamyltransferase and alkaline phosphatase), hematologic function (leukocyte count, hemoglobin and hematocrit) and clinical chemistry (sodium, potassium and chloride concentration) were not found to be altered as a result of selenium intake. High regression coefficient predictor variables for selenium toxicity (muscle twitching, paresthesia, nail loss, nail lines, hair loss and garlic breath) were not found in increased frequency for this population. No signs of selenium toxicity were found in this population, including individuals whose selenium intake was as high as 724 ug/day. This report corroborates that of Yang et al. (1989b), which showed that a selenium intake of up to 853 ug/day is not associated with characteristic nail or hair loss typical of selenium intoxication.

The essentiality for selenium has been well-documented in livestock based upon the alleviation of specific deficiency conditions by selenium supplementation of the diet (Combs and Combs, 1986). Selenium has been clearly demonstrated to be a cofactor of glutathione peroxidase, a hydrogen and lipid peroxide reducing enzyme and is therefore essential (Rotruck et al., 1973). Human requirements for selenium were not conclusively established until 1979 when an association was made between low selenium status and cardiomyopathy (Keshan disease) in China for young children and women of child-bearing age (Keshan Disease Research Group, 1979a,b).

The NAS (1989) has determined the recommended dietary allowance for selenium to be 0.87 ug/kg, or approximately 70 and 55 ug/day for the reference adult North American male and female, respectively. Requirements for selenium increase during pregnancy to 65 ug/day and for lactation to 75 ug/day. Selenium requirements for infants and children vary according to age. However, based on the reference weights of NHANES II, these populations demonstrate an increased requirement per unit weight relative to adults. For infants, the selenium requirement is 1.67 ug/kg and for children the requirement ranges from 1.07-1.53 ug/kg. It should be noted that the most recent RDA for selenium did not consider the 1989 results of Yang et al. (1989a,b) discussed above, but an earlier preliminary report by the same authors (Yang et al., 1983).

MAMMALIAN TOXICOLOGICAL PROFILE

Long-Evans rats (approximately 50/sex/group at study initiation) received 2 ppm (as selenium) sodium selenate or sodium selenite in drinking water for 1 year, then 3 ppm for the remainder of the study (Schroeder and Mitchener, 1971). The treatment of the control group was not discussed. The animals were observed for the duration of their natural life span, approximately 36 months, although one selenate-treated female lived for 5 years. Selenite produced 50% mortality in males by 58 days. At this time, 2 ppm selenate was substituted for selenite in the male group. The concentration of selenium was raised to 3 ppm in this group when the animals were 1 year old; however, the high mortality rendered the group size too small for further statistical analysis. Selenite produced 50% mortality in females by 348 days; selenite- treated females were sacrificed at 23 months due to high mortality.

Selenate produced 50% mortality in females by 1014 days and in males by 962 days. In the control groups 50% mortality was achieved by 872 and 853 days in females and males, respectively. Survival of rats receiving selenate was comparable to controls and median life span was increased by >100 days. Body weights of treated males were comparable to controls throughout the study. Body weights of females fed selenate were significantly greater than controls at 24 and 36 months; body weights of females fed selenite were significantly less than controls at all times but 18 months. Incidence of all tumors and of malignant tumors was significantly increased in the selenate-treated rats compared with the controls. Incidence of all tumors in controls, selenate- and selenite-treated rats was 20/65 (30.8%), 30/48 (62.5%) and 4/32 (12.5%), respectively. Incidence of malignant tumors in the same groups was 11/65 (16.9%), 20/48 (41.7%) and 4/32 (12.5%), respectively. The earliest tumor occurred on day 833 in the control males, on day 633 in the control females, on day 344 in selenate males and on day 633 in selenate females. The shortened survival time of the selenite groups was thought to be responsible for the small number of tumors. This study is considered inadequate because only the heart, lung, liver, kidney and spleen tissues from animals necropsied were examined histologically, and an increase in longevity was observed in selenate-treated female rats.

Shamberger (1985) reported that the oral administration of 0.1-6 ppm or dermal application of 0.005% of selenium reduced incidences of skin, liver, tracheal, intestinal and lung tumors induced by several carcinogens in rats, mice and hamsters. Shamberger theorized that selenium may reduce cellular damage caused by peroxidation of fat. In another study, natural killer (NK) cell activity was significantly increased in female rats administered 0.5 or 2.0 ppm selenium (sodium selenate) in the drinking water for 10 weeks (Koller et al., 1986), suggesting to the authors that NK-sensitive tumors may be prevented by using selenium therapy.

GENOTOXICITY

Data on the mutagenicity of selenium and its compounds are equivocal. Selenate and selenite (12 uM) were mutagenic in a reverse mutation assay using Salmonella typhimurium strains TA98, TA100 and TA1537 (Noda et al., 1979) in the absence of rat hepatic homogenates. In a second assay, sodium selenate, but not sodium selenite, was mutagenic; the S. typhimurium strains used were not reported (Lofroth and Ames, 1978). Selenite (selenious acid and sodium selenite) produced DNA damage in Bacillus subtilis strains 17A and 45T; however, selenate (selenic acid and sodium selenate) was negative in the Rec assay (Nakamuro et al., 1976).

Sodium selenide, sodium selenite, and sodium selenate (in order of decreasing activity) caused an increase in unscheduled DNA synthesis in the presence or absence of glutathione in Chinese hamster ovary cells at concentrations of 1.0E-4 M (Whiting et al., 1980). Increased chromosomal aberrations were also produced by sodium selenite at E-5 M in rat lymphocytes (Newton and Lilly, 1986) and by sodium selenite, selenious acid, selenic acid, and selenium oxide at 2.6E-6 M in human lymphocytes (Nakamuro et al., 1976). Sodium selenite produced an increase in chromosomal aberrations in the bone marrow of rats administered a total of 10-12 mg/kg intravenously (near-lethal doses) (Newton and Lilly, 1986). Selenium (elemental), selenium dioxide, sodium selenide, and sodium selenite (in order of decreasing activity) induced an increase in SCEs in human whole-blood cultures; sodium selenate was not mutagenic in this assay (Ray and Altenburg, 1980).

The first animal experiment which demonstrated anticarcinogenic effects of selenium was performed by Clayton and Baumann (1949). An approximate 50% reduction in dimethylaminoazobenzene-induced tumor incidence occurred in rats fed a diet supplemented with 5 ppm Se as selenite. Additional evidence subsequently reported, further illustrated the inhibitory effect of selenium on transplantable tumors in rats (Weisberger and Suhrland, 1956a) and leukemia in humans (Weisberger and Suhrland, 1956b).

The National Cancer Institute sponsored an extensive study on selenium toxicity in rats in order to resolve the issue of selenium carcinogenicity. Diets containing up to 8 ppm selenium did not increase tumor incidence (Tinsley et al., 1967; Harr et al., 1967). Since 1970, there has been an increased interest in characterizing the anti- carcinogenic and anti-tumorigenic properties of selenium. The number of reports characterizing these properties are too numerous to discuss in detail here. The reader is referred to a review by Milner and Fico (1987) for a more comprehensive treatment of the data base.

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SILVER

Silver in various forms is absorbed to a limited extent following oral and inhalation exposures (U.S. EPA 1985). The acute toxic effects in humans following oral exposure to silver include corrosive damage to the gastrointestinal tract leading to shock, convulsions, and death. In animals, acute exposure has been shown to affect the CNS and to cause respiratory paralysis (Hill and Pillsbury 1939). The primary effect of silver in humans following chronic exposures is argyria, a permanent bluish-metallic discoloration of the skin and mucous membranes, which can be either localized or generalized. Silver also accumulates in the blood vessels and connective tissue (U.S. EPA 1985).

U.S. EPA (1996) derived a chronic oral RfD for silver of 5×10^{-3} mg/kg/day based on the human case report of Gaul and Staud (1935). In this study, a LOAEL of 0.014 mg/kg/day was identified for argyria. An uncertainty factor of 3 was used to calculate the RfD.

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THALLIUM CAS# 7440-28-0

GENERAL BACKGROUND INFORMATION

Pure thallium is a soft bluish-white metal that is widely distributed in trace amount in the earth's crust. It is used in the manufacture of electronic devices, switches, and closures. It is also used to a limited extent in the manufacture of special glasses and for medical procedures that evaluate heart disease. Up until 1972, thallium was also used as a rat poison (ATSDR, 1991).

PHARMACOKINETICS

Thallium appears to be nearly completely absorbed from the gastrointestinal tract. No information was located on absorption following inhalation or dermal exposure. However, animal studies following intratracheal administration suggested that uptake through respiratory epithelium was rapid and complete. There is little information on the distribution of thallium in humans. Analysis of human tissues indicates that thallium is distributed throughout the body. The highest levels were found in the scalp hair, kidney, heart, bone, and spleen. In animals, the highest levels are found in the kidneys and liver. Excretion of thallium occurs by both the urinary and fecal routes (ATSDR, 1991).

HUMAN TOXICOLOGICAL PROFILE

Thallium is acutely lethal to humans following oral exposure at doses of 54-110 mg thallium/kg of body weight as thallium sulfate (Davis et al., 1981). The estimated lethal dose is approximately 14-15 mg/kg (Gosselin et al., 1984). Thallium compounds can affect the respiratory, cardiovascular, and gastrointestinal systems, the liver, kidneys and the male reproductive system. Alopecia (hair loss) and changes in the nervous system are characteristic of thallium exposure. A retrospective study was conducted which compared the incidence of congenital abnormalities in children born to mothers who had been exposed to thallium during pregnancy (Dolgner et al., 1983). The number of anomalies in the exposed group did not exceed the number of expected birth defects in the general population.

MAMMALIAN TOXICOLOGICAL PROFILE

In animals, the lowest doses showing lethality for a brief exposure period ranged from 5 to 30 mg/kg body weight for several species (Downs et al., 1960). Exposure to low doses (1.4 mg thallium as thallium sulfate/kg body weight/day) for longer durations (40-240 days) also cause death (Manzo et al., 1983). Electromyographic abnormalities without changes in the myocardium are seem following a single oral dose (56 mg thallium/kg as thallium sulfate) in rabbits (Grunfeld et al., 1963). Parenteral injection in animals has been observed to cause liver effects. Thallium did not cause renal effects in rats following oral exposure, but parenteral exposure studies demonstrated that thallium affects the kidneys following subcutaneous administration. Rats exposed prenatally to 0.08 mg thallium/kg/day or greater during gestation evidenced impairment of learning. These effects occurred at dose levels below those at which other neurological effects (e.g. structural and functional alterations of peripheral nerves) have been observed. Cultured rat embryos exposed to thallium at concentrations of 10, 30, or 100 ug/ml showed dose-related growth retardation at all levels showing embryotoxic effects (Anschutz et al., 1981). Administration by intraperitoneal injection to pregnant rats at a dose of 2.0 mg thallium/kg/day (as thallium sulfate) during gestation days 8-10 resulted in reduced fetal body weights, hydronephrosis, and the absence of vertebral bodies (Gibson and Becker, 1970).

GENOTOXICITY

Animal and bacterial assays suggest than thallium is genotoxic. Thallium-induced dominant lethal mutations in male rats in vivo. The overall embryonic mortality increased at doses of 0.04 ug thallium/kg day or greater as thallium carbonate. In vitro DNA damage tests employing rat embryo cells were positive (Zasukhina et al., 1983). Thallium enhanced viral-induced transformations in Syrian hamster embryo cells (Casto et al., 1979) and was positive in bacterial assays (Kanematsu et al., 1980). No studies are available on the carcinogenic effects of inhalation, oral or dermal exposure to thallium.

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ZINC CAS# 7440-66-6

GENERAL BACKGROUND INFORMATION

Zinc is used most commonly as a protective coating for other metals and in alloys such as bronze and brass. Zinc is emitted to the atmosphere during mining and refining, manufacturing processes, and combustion of zinc-containing materials. Zinc is an essential trace element in nutrition and is found in many foods (ATSDR, 1989).

PHARMACOKINETICS

It has been reported that about 20 to 30 percent of ingested zinc is absorbed and the mechanism may be homeostatically controlled and carrier-mediated. When zinc levels in the body are sufficient to sustain normal physiological functions, zinc absorption decreases. Absorption occurs by the inhalation and dermal routes as well. Once absorbed, zinc is distributed throughout the body where it is used as an essential cofactor in many enzyme systems. Excretion occurs primarily through the feces (ATSDR, 1989).

HUMAN TOXICOLOGICAL PROFILE

Zinc compounds are of relatively low toxicity by ingestion. In humans, exposure to 2 g or more of zinc produces symptoms of fever, nausea, vomiting, stomach cramps, and diarrhea 3-12 hours after ingestion. Zinc chloride is a primary component of smoke bombs, and pathologic changes in humans due to acute inhalation exposure to ZnCl include laryngeal, tracheal, and bronchial mucosal edema and ulceration, interstitial edema, interstitial fibrosis, alveolar obliteration and bronchiolitis obliterans. Severe acute injury is associated with a high mortality (Matarese and Matthews, 1986). Metal fume fever results from occupational inhalation of freshly formed fumes of zinc oxides. It is characterized by transient chills and fever, profuse sweating, and weakness some hours after exposure. The fumes usually consist of extremely fine particles containing other metals in addition to zinc. The very small size (submicronic) of the fume particles with their potential for alveolar deposition is thought to be an important aspect of this phenomenon. It has generally been estimated that fume fever does not occur at zinc oxide levels less than 15 mg/m^3 although some occurrence of fume fever has been reported at levels as low as 5 mg/m^3. This occupational hazard is not considered to be a general public health problem (U.S. EPA, 1987a; U.S. EPA, 1987b). Poorly ionized zinc compounds have low dermal toxicity and have been used therapeutically and cosmetically for many years as mild astringents, antiseptics and perspirants (Gilman et al., 1985).

MAMMALIAN TOXICOLOGICAL PROFILE

The highly ionizable zinc salts such as zinc chloride can be acutely toxic. Acute toxicity in laboratory animals was reported to be 250 mg/kg (LD_{LO}) for the guinea pig. A TC_{LO} of 4800 mg/m^3 for 30 minutes was calculated for humans (Clayton and Clayton, 1981). Zinc has a low oral chronic toxicity. In a study involving dogs and cats, 175 to 1000 mg/kg per day of ZnO, administered orally for 3 to 53 weeks, was tolerated. Some of the dogs showed glucosuria and some of the cats showed fibrous degeneration of the pancreas. A number of other animal feeding studies demonstrate the low oral toxicity of zinc (Clayton and Clayton, 1981; U.S. EPA, 1987a).

Generally adverse but minor effects have been demonstrated in guinea pigs inhaling large amounts (1-5 mg/m^3) of zinc oxides (Lam et al., 1982,1985; Amdur et al., 1982). Lam et al. (1985) measured pulmonary function in guinea pigs exposed to zinc oxide fume at 5 mg/m^3 three hours daily for a period of six days. Vital capacity, functional residual capacity, alveolar volume, and single breath diffusive capacity for carbon monoxide decreased following the final exposure and did not return to normal after 72 hours. Flow resistance increases, and decreases in compliance and total lung capacity returned to normal after this period. Fibroblasts in interstitial infiltrates (including a fibrotic reaction) were observed. It was concluded that pulmonary changes may occur with relatively few exposures at the workplace threshold limit value. Zinc does not appear to be teratogenic except perhaps at very high doses; intraperitoneal injections of relatively large doses (20 mg/kg) in mice during pregnancy results in some malformations in fetal ossifications (Chang et al., 1977).

GENOTOXICITY

Various studies have indicated that zinc is not mutagenic. In vitro analyses of zinc chloride demonstrated that the fidelity of DNA synthesis was unaffected (Sirover and Loeb, 1976a,b; Miyaki et al., 1977). Zinc industry employees have shown a greater number of chromosomal aberrations in peripheral blood lymphocytes than did controls (Bauchinger et al., 1976). However, these workers were also exposed to other agents known to cause chromosome structural alterations (Leonard, 1985). There is no evidence that the inhalation, ingestion or parenteral administration of zinc induces the formation of tumors.

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ATTACHMENT J

STATEMENT OF LIMITATIONS

Metcalf & Eddy

STATEMENT OF LIMITATIONS

The data presented and the opinions expressed in this report are qualified as follows:

1. The sole purpose of the investigation and of this report is to assess the physical characteristics of the Site with respect to the presence or absence in the environment of oil or hazardous materials and substances as defined in the applicable state and federal environmental laws and regulations and to gather information regarding current and past environmental conditions at the Site.

2. Metcalf & Eddy (M&E) derived the data in this report primarily from visual inspections, examination of records in the public domain, interviews with individuals with information about the Site, and a limited number of subsurface explorations made on the dates indicated. The passage of time, manifestation of latent conditions or occurrence of future events may require further exploration at the Site, analysis of the data, and reevaluation of the findings, observations, and conclusions expressed in the report.

3. In preparing this report, M&E has relied upon and presumed accurate certain information (or the absence thereof) about the Site and adjacent properties provided by governmental officials and agencies, the Client, and others identified herein. Except as otherwise stated in the report, M&E has not attempted to verify the accuracy or completeness of any such information.

4. The data reported and the findings, observations, and conclusions expressed in the report are limited by the Scope of Services, including the extent of subsurface exploration and other tests. The Scope of Services was defined by the requests of the Client, the time and budgetary constraints imposed by the Client, and the availability of access to the Site.

5. Because of the limitations stated above, the findings, observations, and conclusions expressed by M&E in this report are not, and should not be considered, an opinion concerning the compliance of any past or present owner or operator of the site with any federal, state or local law or regulation. No warranty or guarantee, whether express or implied, is made with respect to the data reported or findings, observations, and conclusions expressed in this report. Further, such data, findings observations, and conclusions are based solely upon site conditions in existence at the time of investigation.

6. This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in connection with the Agreement and the provisions thereof.