REVISED DRAFT

OPERABLE UNIT 1 & OPERABLE UNIT 2 FEASIBILITY STUDY

OLIN CHEMICAL SUPERFUND SITE
WILMINGTON, MASSACHUSETTS

Prepared for:

Olin Corporation
3855 North Ocoee Street; Suite 200
Cleveland, TN 37312

Prepared by:

Wood Environment & Infrastructure Solutions, Inc.
511 Congress Street
Portland, ME 04101

Project No. 6107190016

May 2019

SEMS Doc ID 640854

REVISED DRAFT

OPERABLE UNIT 1 & OPERABLE UNIT 2 FEASIBILITY STUDY

OLIN CHEMICAL SUPERFUND SITE
WILMINGTON, MASSACHUSETTS

Prepared for:

Olin Corporation
3855 North Ocoee Street; Suite 200
Cleveland, TN 37312

Prepared by:

Wood Environment & Infrastructure Solutions, Inc.
511 Congress Street
Portland, ME 04101

Project No. 6107190016

May 2019

Draft	*Draft*
Peter Thompson	Michael Murphy
Project Manager	Project Principal

TABLE OF CONTENTS

1.0 INTRODUCTION 1-1

1.1 PURPOSE, SCOPE AND REPORT ORGANIZATION 1-2
1.1.1 Purpose and Scope 1-2
1.1.2 Report Organization 1-2
1.2 BACKGROUND INFORMATION 1-3
1.3 SITE DESCRIPTION 1-4
1.4 NATURE AND EXTENT OF CONTAMINATION 1-6
1.4.1 OU1 Soil 1-7
1.4.2 OU1/OU2 Surface Water - South Ditch 1-7
1.4.3 OU1/OU2 Sediment 1-9
1.4.4 OU2 Soil (EA5) 1-10
1.4.5 OU2 Surface Water – East Ditch 1-10
1.5 CONTAMINANT FATE AND TRANSPORT 1-12
1.6 BASELINE RISK ASSESSMENT 1-14
1.6.1 Human Health Risk Assessment 1-14
1.6.2 Ecological Risk Assessments 1-15
1.6.3 Conclusions 1-16

2.0 REMEDIAL ACTION OBJECTIVES 2-1

2.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS 2-2
2.2 CHEMICALS OF CONCERN 2-5
2.3 DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS 2-5
2.3.1 Human Health Risk-Based PRGs for Indoor Air 2-5
2.3.2 Ecological PRGs for Sediment, Soil, and Surface Water 2-6
2.3.3 Volumes and Areas of Media with Concentrations Above PRGs 2-8

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES 3-1

3.1 GENERAL RESPONSE ACTIONS 3-1
3.2 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS 3-2
3.2.1 Identification and Screening of Technologies 3-2
3.2.2 Evaluation of Technologies and Selection of Representative Technologies 3-3

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES 4-1

4.1 ALTERNATIVE SCREENING CRITERIA 4-1
4.2 IDENTIFICATION AND DEVELOPMENT OF ALTERNATIVES 4-2
4.2.1 Remedial Alternatives for Trimethylpentenes (TMPs) in Soil 4-3
4.2.2 Remedial Alternatives for OU1/OU2 Sediment and EA5 Soil 4-4
4.2.3 Remedial Alternatives for South Ditch Surface Water 4-5
4.3 SCREENING OF ALTERNATIVES 4-6
4.3.1 Remedial Alternatives for TMPs in Soil 4-6
4.3.2 Remedial Alternatives for OU1/OU2 Sediment and EA5 Soil 4-7

4.3.3 Remedial Alternatives for South Ditch Surface Water 4-8
4.3.4 Screening of Alternatives Conclusions 4-9

5.0 DETAILED ANALYSIS OF ALTERNATIVES 5-1

5.1 ALTERNATIVE 1: NO ACTION 5-2
5.1.1 Overall Protection of Human Health and the Environment 5-2
5.1.2 Compliance with Applicable or Relevant and Appropriate Requirements 5-2
5.1.3 Short-term Effectiveness 5-2
5.1.4 Long-term Effectiveness and Permanence 5-2
5.1.5 Reduction of Toxicity, Mobility, or Volume through Treatment 5-3
5.1.6 Implementability 5-3
5.1.7 Cost 5-3
5.2 ALTERNATIVE 2: LIMITED ACTION AND VAPOR BARRIER/SSDS FOR TMPS IN SOIL; EXCAVATION, STABILIZATION, AND OFF-SITE DISPOSAL OF LOWER SOUTH DITCH SEDIMENT AND EA5 SOIL; AND LIMITED ACTION FOR SOUTH DITCH SURFACE WATER 5-3
5.2.1 Overall Protection of Human Health and the Environment 5-7
5.2.2 Compliance with Applicable or Relevant and Appropriate Requirements 5-8
5.2.3 Short-term Effectiveness 5-8
5.2.4 Long-term Effectiveness and Permanence 5-8
5.2.5 Reduction of Toxicity, Mobility, or Volume through Treatment 5-9
5.2.6 Implementability 5-9
5.2.7 Cost 5-9
5.3 ALTERNATIVE 3: LIMITED ACTION AND VAPOR BARRIER/SSDS FOR TMPS IN SOIL; EXCAVATION, STABILIZATION, AND OFF-SITE DISPOSAL OF LOWER SOUTH DITCH SEDIMENT AND EA5 SOIL; AND IN-SITU CHEMICAL ADSORPTION FOR SOUTH DITCH SURFACE WATER 5-10
5.3.1 Overall Protection of Human Health and the Environment 5-12
5.3.2 Compliance with Applicable or Relevant and Appropriate Requirements 5-12
5.3.3 Short-term Effectiveness 5-13
5.3.4 Long-term Effectiveness and Permanence 5-13
5.3.5 Reduction of Toxicity, Mobility, or Volume through Treatment 5-14
5.3.6 Implementability 5-14
5.3.7 Cost 5-14
5.4 ALTERNATIVE 4: AS/SVE FOR TMPS IN SOIL; EXCAVATION, STABILIZATION, AND OFF-SITE DISPOSAL OF LOWER SOUTH DITCH SEDIMENT AND EA5 SOIL; AND LIMITED ACTION FOR SOUTH DITCH SURFACE WATER 5-15
5.4.1 Overall Protection of Human Health and the Environment 5-16
5.4.2 Compliance with Applicable or Relevant and Appropriate Requirements 5-17
5.4.3 Short-term Effectiveness 5-17
5.4.4 Long-term Effectiveness and Permanence 5-18
5.4.5 Reduction of Toxicity, Mobility, or Volume through Treatment 5-18
5.4.6 Implementability 5-18
5.4.7 Cost 5-18
5.5 ALTERNATIVE 5: AS/SVE FOR TMPS IN SOIL; EXCAVATION, STABILIZATION, AND OFF-SITE DISPOSAL OF LOWER SOUTH DITCH SEDIMENT AND EA5 SOIL; AND IN-SITU CHEMICAL ADSORPTION FOR SOUTH DITCH SURFACE WATER 5-19

5.5.1 Overall Protection of Human Health and the Environment 5-20
5.5.2 Compliance with Applicable or Relevant and Appropriate Requirements 5-21
5.5.3 Short-term Effectiveness 5-21
5.5.4 Long-term Effectiveness and Permanence 5-22
5.5.5 Reduction of Toxicity, Mobility, or Volume through Treatment 5-22
5.5.6 Implementability 5-22
5.5.7 Cost 5-23
5.6 COMPARATIVE ANALYSIS OF ALTERNATIVES 5-23
5.6.1 Overall Protection of Human Health and the Environment 5-23
5.6.2 Compliance with Applicable or Relevant and Appropriate Requirements 5-24
5.6.3 Short-term Effectiveness 5-25
5.6.4 Long-term Effectiveness and Permanence 5-25
5.6.5 Reduction of Toxicity, Mobility, or Volume through Treatment 5-25
5.6.6 Implementability 5-26
5.6.7 Cost 5-26
5.6.8 Recommended Alternative 5-27

6.0 REFERENCES 6-1

LIST OF FIGURES

Figure 1.2-1 Site Location
Figure 1.2-2 Site Features

Figure 1.3-1 Site Features (Current and Historic)
Figure 1.3-2 HHRA Exposure Areas
Figure 1.3-3 BERA Exposure Areas

Figure 1.4-1 Distribution of Soil (1 to 10 ft) Concentrations for Total Trimethylpentenes
Figure 1.4-2 Distribution of Soil (Greater Than 10 ft) Concentrations for Total Trimethylpentenes
Figure 1.4-3 Distribution of Surface Water Concentrations for Chromium in South Ditch
Figure 1.4-4 Distribution of Surface Water Concentrations for Ammonia in South Ditch
Figure 1.4-5 Distribution of Sediment Concentrations for Chromium in South Ditch
Figure 1.4-6 Distribution of Sediment Concentrations for Bis(2-ethylhexyl)phthalate in South Ditch
Figure 1.4-7 Distribution of Surface Soil Concentrations for Chromium – EA5
Figure 1.4-8 Distribution of Surface Soil Concentrations for BEHP – EA5

Figure 2.3-1 Areas Exceeding Soil PRGs for Chromium and BEHP at HQ = 1
Figure 2.3-2 Areas Exceeding Soil PRGs for Chromium and BEHP at HQ = 10
Figure 2.3-3 Areas Exceeding Sediment PRGs for Chromium and BEHP at HQ = 1
Figure 2.3-4 Areas Exceeding Sediment PRGs for Chromium and BEHP at HQ = 10

LIST OF TABLES

Table 2.1-1 Location-Specific ARARs, Criteria, Advisories, and Guidance; TMPs in Soil
Table 2.1-2 Chemical-Specific ARARs, Criteria, Advisories, and Guidance; TMPs in Soil
Table 2.1-3 Action-Specific ARARs, Criteria, Advisories, and Guidance; TMPs in Soil
Table 2.1-4 Location-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and EA5 Soil
Table 2.1-5 Chemical-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and EA5 Soil
Table 2.1-6 Action-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and EA5 Soil
Table 2.1-7 Location-Specific ARARs, Criteria, Advisories, and Guidance; South Ditch Surface Water
Table 2.1-8 Chemical-Specific ARARs, Criteria, Advisories, and Guidance; South Ditch Surface Water
Table 2.1-9 Action-Specific ARARs, Criteria, Advisories, and Guidance; South Ditch Surface Water

Table 2.3-1 Risks for Chromium, BEHP, and Ammonia in OU1 and OU2
Table 2.3-2 Ecological PRGs for EA5 Soil
Table 2.3-3 Ecological PRGs for Lower South Ditch Sediment
Table 2.3-4 Ecological PRGs for South Ditch Surface Water

Table 3.2-1 Screening of Remedial Technologies – TMPs in Soil
Table 3.2-2 Screening of Remedial Technologies – OU1/OU2 Sediment and EA5 Soil
Table 3.2-3 Screening of Remedial Technologies – South Ditch Surface Water

Table 5.2-1 Location-specific ARARs – Alternative 2
Table 5.2-2 Chemical-specific ARARs – Alternative 2
Table 5.2-3 Action-specific ARARs – Alternative 2
Table 5.2-4 Cost Estimate for Alternative 2
Table 5.3-1 Location-specific ARARs – Alternative 3
Table 5.3-2 Chemical-specific ARARs – Alternative 3
Table 5.3-3 Action-specific ARARs – Alternative 3
Table 5.3-4 Cost Estimate for Alternative 3
Table 5.4-1 Location-specific ARARs – Alternative 4
Table 5.4-2 Chemical-specific ARARs – Alternative 4
Table 5.4-3 Action-specific ARARs – Alternative 4
Table 5.4-4 Cost Estimate for Alternative 4
Table 5.5-1 Location-specific ARARs – Alternative 5
Table 5.5-2 Chemical-specific ARARs – Alternative 5
Table 5.5-3 Action-specific ARARs – Alternative 5

LIST OF TABLES (continued)

Table 5.5-4 Cost Estimate for Alternative 5
Table 5.6-1 Comparative Analysis of Remedial Alternatives

LIST OF APPENDICES

Appendix A Evaluation of Groundwater Interaction with South Ditch Surface Water and Sediment
Appendix B Evaluation of Groundwater Interaction with East Ditch Surface Water and Sediment
Appendix C Soil and Sediment Exceeding PRGs

LIST OF ACRONYMS

AMEC	Amec Environment & Infrastructure, Inc.
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirements
AS	Air Sparging
BEHP	Bis(2-ethylhexyl)phthalate
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Chemical of Concern
CTE	Central Tendency Exposure
DAPL	Dense Aqueous Phase Liquid
EA	Exposure Area
EPH	Extractable Petroleum Hydrocarbon
floc	flocculent
FS	Feasibility Study
HQ	Hazard Quotient
IAFS	Interim Action Feasibility Study
IRSWP	Interim Response Steps Work Plan
LNAPL	Light Non-Aqueous Phase Liquid
LOAEL	Lowest Observed Adverse Effect Level
LOEC	Lowest Observed Effect Concentration

LIST OF ACRONYMS (cont.)

MACTEC	MACTEC Engineering and Consulting, Inc.
MassDEP	Massachusetts Department of Environmental Protection
MBTA	Massachusetts Bay Transportation Authority
MCP	Massachusetts Contingency Plan
µg/L	microgram per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
MMB	Maple Meadow Brook
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDMA	N-nitrosodimethylamine
ng/L	nanogram per liter
NPL	National Priorities List
NRWQC	National Recommended Water Quality Criteria
O&M	Operation and Maintenance
OCSS	Olin Chemical Superfund Site
OSWER	Office of Solid Waste and Emergency Response
off-PWD	off-Property West Ditch
Olin	Olin Corporation
on-PWD	on-Property West Ditch
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PID	Photoionization Detector
ppm	parts per million
PRB	Permeable Reactive Barrier
PRG	Preliminary Remediation Goal
Property	Olin Property
PRRT	Pumping Rate Reduction Test
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RME	Reasonable Maximum Exposure

LIST OF ACRONYMS (cont.)

SASR	Semi-Annual Status Report
SOW	Statement of Work
SSDS	Sub-Slab Depressurization System
SVE	Soil Vapor Extraction
TMPs	Trimethylpentenes
TOC	Total Organic Carbon
USEPA	United States Environmental Protection Agency
VI	Vapor Intrusion
VPH	Volatile Petroleum Hydrocarbon
Wood	Wood Environment and Infrastructure Solutions, Inc.

EXECUTIVE SUMMARY

This revised Draft Feasibility Study (FS) has been prepared for Operable Units (OU) 1 and OU2 at the Olin Chemical Superfund Site (OCSS) in Wilmington, MA. This Draft FS addresses the United States Environmental Protection Agency (USEPA) review comments dated September 25, 2018 and March 8, 2019, on the Draft OU1/OU2 FS submitted to the USEPA March 30, 2018 (Amec Foster Wheeler, 2018a).

Consistent with the conclusions of the USEPA approved (USEPA, 2015) OU1/OU2 Remedial Investigation (RI) (AMEC Environment & Infrastructure, Inc. (AMEC), 2015), this FS presents an evaluation of remedial alternatives that address areas of OU1 (on-Property soil, surface water, and sediment) and OU2 (off-Property surface water and sediment) impacts that potentially pose current and/or potential future unacceptable risk to human or ecological receptors based on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) criteria. In addition, this FS evaluates, from an ecological and human health risk perspective, groundwater in proximity to Plant B as a potential source to East Ditch surface water in the absence of the Plant B groundwater capture and treatment system.

It should be noted that the Containment Area, which is considered part of OU1, was previously included in the Draft OU1/OU2 FS (Amec Foster Wheeler, 2018a). However, based on USEPA review comments, the Containment Area, including associated soils, is included in the Interim Action FS (IAFS). The recommended alternative presented in the IAFS for the Containment Area is an impermeable permanent composite cap with a geosynthetic clay liner and geomembrane that would be an effective vapor barrier, effectively eliminate infiltration inhibiting leaching and address any potential human exposure. Further, the proposed Interim Action for the Containment Area also includes institutional controls in the form of deed covenant modifications to limit and restrict future exposure to subsurface soils and activities within the Containment Area. Hence the Containment Area is not evaluated further in this OU1/OU2 FS. The IAFS also addressed other on-going potential sources at the Site, including Dense Aqueous Phase Liquid (DAPL), Plant B Light Non-Aqueous Phase Liquid and migration control of impacted downgradient groundwater in the Ipswich watershed. The IAFS was submitted to USEPA on April 11, 2019 (Wood Environment and Infrastructure Solutions, Inc. [Wood], 2019) and is pending USEPA review/approval.

This OU1/OU2 FS evaluates remedial alternatives to address the following at the OCSS based on the results of the USEPA-approved human health and ecological risk assessments provided in the Final OU1/OU2 RI report:

- Potential for vapor intrusion into future occupied buildings associated with trimethylpentenes (TMPs) in soil (where future buildings may be constructed) and potential construction worker inhalation exposure to TMPs during future excavation activities within Baseline Human Health Risk Assessment (BHHRA) Exposure Area (EA) 1, EA3 and EA7.
- Chromium and Bis(2-ethylhexyl)phthalate (BEHP) in Lower South Ditch sediment and EA5 soil that pose potential risk to ecological receptors
- Chromium and ammonia in South Ditch surface water that pose potential risk to aquatic receptors in the South Ditch and in downstream surface water.

Based on the above-listed conditions and USEPA comments, the following Remedial Action Objectives (RAOs) have been developed:

<u>RAO for TMPs in soil:</u>

- Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into buildings at the OCSS and TMP release to excavation air during future excavation activities.

<u>RAO for chromium and BEHP in Lower South Ditch sediment and EA5 soil:</u>

- Restore soils and sediment to levels of Site-related chemicals of concern that do not exceed Lowest Observed Adverse Effect Level (LOAEL) risk-based soil concentrations derived in the Baseline Ecological Risk Assessment (BERA), Lowest Observed Effect Concentration (LOEC) risk-based sediment concentrations derived in the BERA, and do not exceed 20% effect levels in sediment acute and chronic in-situ or laboratory toxicity tests compared to control sediment.

<u>RAO for chromium and ammonia in South Ditch surface water:</u>

- Restore surface water to achieve the National Recommended Water Quality Criteria (NRWQC) for Site-related chemicals of concern (e.g., ammonia, chromium) and eliminate acute and chronic toxicity to aquatic organisms, as measured by in-situ or laboratory toxicity tests.

As part of the USEPA review comments on the Draft OU1/OU2 FS (Comment 9 of Appendix 6), the USEPA noted "chromium appears to be leaching from the soils in the Containment Area and ammonia from soils adjacent to the Lower South Ditch at concentrations that are likely to be having adverse ecological impacts." USEPA therefore requested that an additional RAO be

included that stipulates prevention of leaching of site chemicals of concern (e.g., ammonia and chromium) from soil into sediment and surface water as follows:

RAO to Prevent Leaching of Site-related chemicals of concern into sediment and surface water:

- Prevent leaching of Site-related chemicals of concern into sediment and surface water to levels that exceed NRWQC, LOEC risk-based concentrations in surface water or sediment, or concentrations that have toxicity to aquatic organisms.

Olin has evaluated this request in context of what additional alternatives would be required in this OU1/OU2 FS to meet this RAO. The proposed alternative for the Containment Area in the IAFS includes a low permeability composite final cover system or cap in combination with sealing the equalization window. These actions will complete the hydraulic isolation of the soils within the Containment Area and effectively eliminate infiltration of precipitation and leaching of chromium from vadose soils located between the cap and the water table within the Containment Area. There were no additional alternatives identified for this FS that would enhance or improve upon the recommended IAFS alternative to prevent leaching of chromium or other chemicals of concern, to the extent that occurs, in the Containment Area.

Appendix A of this FS presents an analysis of the sources of ammonia and chromium to groundwater and surface water in vicinity of South Ditch. This evaluation includes an assessment of ammonia in soil adjacent to Lower South Ditch. Ammonia concentrations in the organic rich soil adjacent to Lower South Ditch are consistent with background concentrations for soil and sediment. Ammonia at these concentrations in soil do not pose a leaching concern. Ammonia in soil at these concentrations would only be expected to result in di minimis contribution to surface water or sediment.

Appendix B of this FS presents an analysis of groundwater and surface water interaction for East Ditch including a hypothetical scenario under which Plant B is not pumping and impacted groundwater discharges to East Ditch. That evaluation compared anticipated groundwater quality to surface water ecological screening levels (considering East Ditch has poor to low value ecological habitat) and concluded if the Plant B groundwater collection and treatment system was no longer in operation, the discharge of groundwater to the East Ditch would not pose a potential hazard to (hypothetical) ecological receptors in the East Ditch.

A preliminary list of medium-specific remedial alternatives was developed separately for TMPs in soil, Lower South Ditch sediment and EA5 soil, and South Ditch surface water. The preliminary alternatives were screened against the CERCLA evaluation criteria of effectiveness, implementability, and cost and one or more alternatives were retained for further evaluation for

each RAO. Consistent with CERCLA guidance (USEPA, 1998b) a No-Action Alternative was retained for baseline comparison. Actions taken to limit potential for exposure (e.g., institutional or engineering controls and monitoring) are identified as Limited Action alternatives in accordance with guidance (USEPA, 1998b page 4-7 footnote 5 and page C-6) and the NCP (USEPA, 1990). The following remedial alternatives for OU1/OU2 were developed and evaluated in detail:

Alternative 1: No Action

Alternative 2: Limited Action and Vapor Barrier/SSDS for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and Limited Action for South Ditch Surface Water

Alternative 3: Limited Action and Vapor Barrier/SSDS for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and In-situ Chemical Adsorption for South Ditch Surface Water

Alternative 4: AS/SVE for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and Limited Action for South Ditch Surface Water, and

Alternative 5: AS/SVE for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and In-situ Chemical Adsorption for South Ditch Surface Water.

Based on the detailed evaluation and comparative analysis of alternatives, Olin has identified the following recommended alternative for OU1/OU2:

Alternative 3: Limited Action and Vapor Barrier/SSDS for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and In-situ Chemical Adsorption for South Ditch Surface Water.

Alternative 3 is protective of human health and the environment, would be designed and implemented to comply with Applicable or Relevant and Appropriate Requirements (ARARs), provides short-term and long-term effectiveness, provides a reduction in toxicity, mobility, or volume of contaminants through treatment, and is readily implemented at a reasonable cost, as compared to the other alternatives evaluated.

Alternative 3 will achieve the site-specific Preliminary Remediation Goals (PRGs) presented in this FS that are based on the identified ARARs. This alternative should also have a positive effect on

surface water quality exiting South Ditch and entering the East Ditch. USEPA's Specific Comment 29 identified a surface water cleanup criterion of 1.9 milligrams per liter (mg/L) for ammonia (at pH of 7 and temperature of 20 degrees Celsius) as the criteria used for cleanup at the Halls Brook Holding Area Pond for the Industri-Plex Superfund Site, which is located downstream of the OCSS and downstream of the confluence of Landfill Brook That criteria is protective of salmonid fish which are cold water species not supported by the aquatic habitat of East Ditch or South Ditch. Alternative 3 will improve surface water quality leaving the OCSS such that it meets the USEPA's cleanup criterion of 1.9 mg/L.

1.0 INTRODUCTION

This revised Draft Feasibility Study (FS) has been prepared for Operable Unit (OU) 1 and OU2 at the Olin Chemical Superfund Site (OCSS) in Wilmington, MA. This Draft FS addresses the United States Environmental Protection Agency (USEPA) review comments dated September 25, 2018 and March 8, 2019, on the Draft OU1/OU2 FS submitted to the USEPA March 30, 2018 (Amec Foster Wheeler Environment & Infrastructure, Inc. [Amec Foster Wheeler], 2018a).

Consistent with the conclusions of the USEPA-approved (USEPA , 2015) OU1/OU2 Remedial Investigation (RI) Report (AMEC Environment & Infrastructure, Inc. (AMEC), 2015), this FS presents an evaluation of remedial alternatives that address areas of OU1 (on-Property soil, surface water, and sediment) and OU2 (off-Property soil, surface water, and sediment) where contaminant concentrations present current and/or potential future unacceptable risk to human or ecological receptors based on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) criteria. In addition, this FS evaluates overburden groundwater as a potential source to South Ditch surface water and groundwater in proximity to Plant B as a potential source to East Ditch surface water.

It should be noted that the Containment Area, which is considered part of OU1, was previously included in the Draft OU1/OU2 FS (Amec Foster Wheeler, 2018a). However, based on USEPA September 2018 comments, the Containment Area was recently included in the Interim Action FS (IAFS) (Wood Environment and Infrastructure Solutions, Inc. [Wood], 2019). The IAFS addressed other on-going sources at the Site, including Dense Aqueous Phase Liquid (DAPL), Plant B Light Non-Aqueous Phase Liquid (LNAPL) and migration control of impacted downgradient groundwater in the Ipswich watershed. Vapor intrusion (VI) remedial alternatives have not been developed for the Containment Area in this FS because the recommended alternative for the Containment Area in the IAFS is a permanent cap with a geomembrane that would be an effective vapor barrier and by eliminating infiltration, limits potential leaching of contaminants from said soils. Further, the proposed IAFS alternative for the Containment Area also includes institutional controls in the form of deed covenant modifications, consistent with CERCLA, to limit and restrict future exposure to subsurface soils in this area and subsurface activities in this area. Hence, the Containment Area is not discussed further in this OU1/OU2 FS.

1.1 Purpose, Scope and Report Organization

1.1.1 Purpose and Scope

The purpose of this document is to develop and present an appropriate range of remedial alternatives in a manner necessary to select a remedy that is consistent with CERCLA, National Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] Part 300), CERCLA Guidance for Complying with Other Laws (USEPA, 1988a) and Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (Office of Solid Waste and Emergency Response [OSWER] Directive 9355.3-01) (USEPA, 1988b). The alternatives for remediation presented in this document are developed by assembling combinations of technologies into alternatives that address contamination for the media and areas identified in OU1 and OU2.

1.1.2 Report Organization

The remainder of this section presents background information, a description and history of the OCSS, including past response actions, where applicable, and the remedial investigations conducted under CERCLA. This is followed by a summary of the nature and extent of contamination, the fate and transport of chemicals of concern (COCs), and the conclusions of the Baseline Human Health Risk Assessment (BHHRA) and Baseline Ecological Risk Assessment (BERA).

Section 2 presents the Remedial Action Objectives (RAOs) and discusses Applicable or Relevant and Appropriate Requirements (ARARs), COCs, and the development of Preliminary Remediation Goal (PRGs).

Section 3 presents the identification and screening of technologies. This section develops the general response actions to meet the RAOs and identifies technologies specific to each media to be remediated and screens those technologies for feasibility and implementability. Candidate technologies that meet screening criteria are retained for development of alternatives.

Section 4 presents the development and screening of alternatives for each RAO and evaluates each alone for effectiveness, implementability and cost.

Section 5 then provides a detailed analysis of the retained remedial alternatives for each RAO, and identifies five composite remedial alternatives to address the scope of this FS which addresses: Trimethylpentenes (TMPs) in OU1 soil; OU1/OU2 sediment and EA5 soil; and South Ditch surface water. This is followed by a comparative analysis of the five composite alternatives.

Section 6 provides a list of references pertinent to this OU1/OU2 FS.

1.2 Background Information

The OCSS is located at 51 Eames Street in Wilmington, Massachusetts (**Figure 1.2-1**). The OCSS includes the Olin Corporation (Olin) Property (Property), an approximately 50-acre parcel, and adjoining select off-Property areas impacted by manufacturing and waste disposal activities at the Property. A chemical manufacturing facility ("facility") was located within the northern portion of the property.

Manufacturing activities were conducted at the OCSS from 1953 until 1986, when all manufacturing operations ceased. Olin purchased and operated the facility between 1980 and 1986. From 1953 onward, the facility expanded incrementally (additional buildings were constructed) as additional products and processes were added and as processes were modified. The facility produced chemical products for use in the rubber and plastics industries. Additional information regarding the history of the OCSS, including Massachusetts Contingency Plan (MCP) and CERCLA response actions, is presented in the Final OU1/ OU2 RI Report (AMEC, 2015).

The OCSS was listed on the National Priorities List (NPL) pursuant to CERCLA Section 105, 42 U.S.C. 9605 on April 19, 2006 (71 Federal Register 2006). N-nitrosodimethylamine (NDMA) was the primary substance used by USEPA to score the OCSS (USEPA, 2005) in September 2005 when it was proposed for the NPL. The primary exposure pathway scored by USEPA was potable use of groundwater. Prior to the NPL listing, the OCSS had been the subject of many years of investigations and response activities carried out by Olin, and supervised by Massachusetts Department of Environmental Protection (MassDEP) under Chapter 21E of the General Laws of Massachusetts and the MCP. Even though the Site is currently regulated under CERCLA, the OCSS has been a Priority site under the MCP since 1993, and a Tier I site since 1994.

Olin Corporation, American Biltrite Inc. (and The Biltrite Corporation), and Stepan Company, as Co-Respondents, have voluntarily entered into an Administrative Settlement Agreement and Order on Consent (AOC) with the USEPA to conduct a Remedial Investigation (RI)/ Feasibility Study (FS) for the OCSS (USEPA, 2007a) on July 3, 2007. The Scope of the RI/FS is described in the Statement of Work (SOW), prepared by the USEPA Region I – New England (USEPA, 2007b).

USEPA has subdivided the OCSS into three OUs, as defined in the AOC/SOW, and are described as follows.

OU1: Approximately 50-acre Olin Property including the former facility area, the established conservation area, the on-Property ditch system, the Calcium Sulfate Landfill, and the Slurry Wall Containment Area. The RI/FS evaluated soil (including vadose zone soil), surface water, sediment,

and potential VI into OU1 buildings. Note, soils located below the water table, consistent with USEPA approval, will be evaluated as part of the groundwater RI/FS for OU3.

OU2: Off-Property surface water and sediment areas, including the off-Property East Ditch, a small portion of the South Ditch, the off-Property West Ditch (off-PWD), portions of the Maple Meadow Brook (MMB) Wetland. Note, North Pond and Landfill Brook were investigated as part of OU2 and were found not to be part of the OCSS (AMEC, 2015, and MACTEC Engineering and Consulting, Inc. [MACTEC], 2007).

OU3: On- and off-Property groundwater areas including groundwater beneath the Olin Property, MMB aquifer, and groundwater located south and east of the Olin Property. As mentioned above, soils located below the water table will also be evaluated under OU3. A revised draft RI for OU3 groundwater is anticipate to be submitted to USEPA on June 28, 2019.

This document identifies and evaluates remedial alternatives for OU1 soil, sediment, surface water, and potential VI into potential future buildings that may be constructed on the property, and OU2 soil, sediment, and surface water. An Interim Action Feasibility Study was been developed and submitted to USEPA to address sources of contamination as well migration of groundwater downgradient of known sources and characterized by NDMA concentrations of equal to or greater than 11,000 nanograms/liter (ng/L). A separate FS will be prepared at a later date to address OU3 groundwater.

1.3 Site Description

The OCSS encompasses the Property and surrounding areas where contaminants have migrated by surface water, sediment, and/or groundwater transport. The Property is bounded on the east by the Massachusetts Bay Transit Authority tracks, on the south by the Woburn/Wilmington Town Line, on the west by an inactive Boston and Maine Railroad spur, and on the north by Eames Street (see **Figure 1.2-2**). The Property is in an industrialized area of Wilmington within a General Industrial zone. Intensive industrial land use occurs on the eastern, northern and western sides of the Property. The southern side of the property is bounded by the Woburn Sanitary Landfill, a former municipal solid waste landfill that has been closed. Residential properties are located along Main Street and Cook Avenue located to the west of the Property and along Eames Street before it intersects with Woburn Street. Site features are shown on **Figure 1.3-1**. Additional information about the Olin Property is presented in the previously approved Final OU1/OU2 RI Report (AMEC, 2015).

The former manufacturing facility was located on the northern half of the Property, which is currently unused and contains a vacated office building, a small metal butler building, a former guard shack, two vacant warehouses, paved and grassed areas, and concrete slabs from other former buildings (see **Figure 1.3-1**). In 2006, for Site maintenance and management purposes, Olin installed a forty-foot office trailer and two metal storage trailers in the northeastern portion of the Property, near the Plant B groundwater recovery/treatment system.

OU1 and OU2 contain on-Property and off-Property surface water bodies, respectively (see **Figure 1.2.-2 and Figure 1.3-1**). The on-Property surface water includes a ditch system of natural drainages (AMEC, 2015) that were modified in the early 1950s (the on-Property West Ditch [on-PWD] and the on-Property South Ditch) and a natural wetland drainage complex (Ephemeral Drainage). A surface water body, known as the Central Pond, and a large wetland area known as the Central Wetland, are located north of, and adjacent to, the Lower South Ditch. Central Pond does not discharge to South Ditch. A storm water retention basin is present between the Containment Area and South Ditch. The on-Property ditch system is connected to two other off-Property ditches (off-PWD and the East Ditch). These drainages are all part of the Aberjona River watershed. Other surface water bodies at the OCSS include the MMB, Sawmill Brook, and the associated MMB Wetland to the west, which are part of the Ipswich watershed. These two watersheds are separated by a groundwater divide, which corresponds approximately with Eames Street, then south, parallel to Main Street.

South Ditch begins at the western boundary of the Property and flows east across the center of the Property, discharging into East Ditch. South Ditch is a perennial surface water feature that receives surface flow from the off-PWD and on-PWD, as well as discharge from overburden groundwater. The flow varies, but the water depth in South Ditch is typically approximately six inches.

During seasonal high groundwater conditions, there is a constant base flow within South Ditch indicating that it is a gaining stream that receives groundwater discharge. However, during drier periods in summer months, the middle of South Ditch may go dry (flow becomes intermittent), indicating that stream reach seasonally becomes a losing stream that recharges groundwater during these periods. In August 2018 the entire length of South Ditch went dry.

In support of the BHHRA and BERA, Exposure Areas (EAs) were established to facilitate evaluation of potential risks to receptors. The BHHRA and BERA EAs are shown on **Figure 1.3-2** and **Figure 1.3-3**, respectively. These EAs are referred to in subsequent sections of this FS.

1.4 Nature and Extent of Contamination

The nature and extent of contamination across OU1 and OU2 are discussed in detail in the Final OU1/OU2 RI Report (AMEC, 2015). The RI Report concludes with a recommendation that the scope of the OU1/OU2 FS should address potential ecological risk for surface water and sediment in the South Ditch and soil in EA5 located adjacent to the off-Property portion of the South Ditch. Surface water is impacted by chromium and ammonia; sediment and off-Property soil are impacted by chromium and Bis(2-ethylhexyl)phthalate (BEHP). Based on the data presented in the Final OU1/OU2 RI Report, hexavalent chromium was not identified as a COC in surface water and sediment in South Ditch, or in EA5 soil associated with the off-Property portion of Lower South Ditch. EA5 is physically located between the Olin property boundary and the East Ditch encompassing both sides of Lower South Ditch. The results of the BHHRA are discussed in Section 1.6.

The OU1/OU2 RI Report also recommended that potential VI of TMPs from subsurface soil into future buildings at EA7, EA3, and the former Lake Poly Area (potential indoor worker exposure) and potential inhalation exposure during future excavation of soils (construction worker exposure) should be controlled via institutional and engineering controls, such as incorporating vapor mitigation features into future building designs. EA7 is physically located in the northeast corner of the property and encompasses the parking lot adjacent to the former administration building and the former Plant B production area. EA3 encompasses the former Plant B tank farm which is the current location of the Plant B groundwater extraction and treatment system. Lake Poly was one of the former unlined lagoons located on the western side of EA1.

The nature of groundwater impacts, including the area associated with Plant B, was discussed in the Draft OU3 Remedial Investigation Report (Amec Foster Wheeler, 2018b). Currently Plant B area groundwater is captured, treated, and discharged to on-PWD to South Ditch under a Remediation General Permit as part of the LNAPL recovery system. The 2008 Interim Response Steps Work Plan approved implementation of a Pump Rate Reduction Test (PRRT) to evaluate necessity of continued operation of Plant B, and Olin has recently petitioned USEPA to allow that test to move forward. If implemented, the PRRT could result in cessation of Plant B groundwater extraction. At USEPA's request, Olin has evaluated the interaction of groundwater and East Ditch surface water in this OU1/OU2 FS. The potential for Plant B groundwater to have an impact on East Ditch surface water is discussed in Section 1.4.5.

The following sections summarize the nature and extent of contamination and fate and transport for the specific media and contaminants that are being addressed by this FS.

1.4.1 OU1 Soil

Volatile organic compounds were not frequently detected in soil samples collected within OU1 with the exception of TMPs, which were detected frequently in soil samples collected from areas in the vicinity of the former Plant B and the area to the northeast (EA7), the former Plant B tank farm (EA3), and the former Lake Poly within EA1. TMPs were also detected at several locations within the Containment Area, which is not further evaluated in this OU1/OU2 FS. As previously mentioned, the proposed Interim Action for the Containment Area includes a permanent cap that includes a geomembrane that would be a sufficient barrier to TMPs vapor intrusion into future buildings. The Interim Action for the Containment Area also includes institutional controls in the form of deed covenant modifications to limit and restrict future subsurface activities in this area.

TMPs in subsurface soil are of concern because of potential vapor intrusion for future occupied buildings and potential construction worker inhalation exposure during future excavation activities. The extent of total TMP contamination in subsurface soil is presented on **Figure 1.4-1 and Figure 1.4-2**. TMPs were detected at concentrations ranging from non-detect to 1,510 milligrams per kilogram (mg/kg). Soil sample photoionization detector (PID) screening, documented in the soil boring logs, indicated substantial TMP vapors (up to 3,000 parts per million [ppm]) were associated with samples collected at and near the water table in EA7 and EA3. These observations and the high vapor pressure of the TMPs form the technical basis for identifying vapor intrusion potential for future buildings in areas where the TMPs are detected as well as for potential inhalation exposure for future construction workers involved in excavation activities.

1.4.2 OU1/OU2 Surface Water - South Ditch

Surface water impacts (especially from ammonia and chromium) are of concern due to potential risks to ecological receptors. OU1 surface water samples collected from the South Ditch include historical samples collected per the RI/FS Work Plan and quarterly samples collected under the Interim Response Steps Work Plan (IRSWP) (MACTEC, 2008). Quarterly groundwater samples are also collected under the IRSWP and reported to the USEPA in Semi-Annual Status Reports (SASRs). These data show a consistent identification of constituents and ranges of concentrations detected in the surface water samples along the entire reach of South Ditch. The headwaters of South Ditch include the off-PWD and storm run-off catchments in the immediate vicinity of Jewel Drive. The available hydrogeologic information, groundwater data, groundwater elevation measurements in the surrounding well pairs and piezometers, and surface water data indicate that solutes in surface water of the South Ditch are primarily related to solutes present in groundwater underlying the Upper South Ditch and shallow groundwater migrating to the stream. The most recent

distribution of chromium and ammonia concentrations in South Ditch surface water are presented on **Figure 1.4-3** and **Figure 1.4-4,** respectively.

Chromium was detected in South Ditch surface water during the RI (2010-2011) at concentrations ranging from 0.012 milligrams per liter (mg/L) to 2.2 mg/L. Chromium concentrations have declined by an order of magnitude over time, with chromium concentrations from samples collected in December 2018 ranging from non-detect (<0.001 mg/L) to 0.04 mg/L.

Ammonia was detected in South Ditch surface water during the RI (2010-2011) at concentrations ranging from 21 mg/L to 130 mg/L. Ammonia concentrations have declined by an order of magnitude over time, with ammonia concentrations from samples collected in December 2018 ranging from 1.2 mg/L to 14 mg/L.

The concentration of chromium and ammonia have declined well below values that were present at the time the OU1/OU2 RI and associated ecological risk assessment were competed. At the time the RI was completed, the long-term changes in concentrations for chromium and ammonia, as well as other DAPL-related solutes in South Ditch were not well understood. It was clear that groundwater was the source of these concentrations, but the underlying sources of those groundwater concentrations, particularly the changes in concentration, were not well understood. Olin has conducted a detailed review of available groundwater data, and its relationship to sources of contamination in surface water. This review is presented in **Appendix A;** a summary of review conclusions is listed below:

- Pumping of Sanmina industrial water supply wells across Jewel Drive pulled contaminated shallow and deep groundwater upgradient from above the off-PWD DAPL pool and the western edge of the on-Property DAPL pool. Construction of the Slurry Wall in December 2000 greatly reduced the flux of contamination that could be pulled upgradient to the Sanmina wells.
- From 2001 to 2004, prior to Sanmina closing (September 2004), temporary and long-term reductions in Sanmina well pumping rates are reflected in increases in concentrations in shallow and deep overburden groundwater impinging on Upper South Ditch.
- After the closure of Sanmina, the remaining contaminated groundwater that was pulled upgradient by Sanmina, flowed by ambient gradients back toward South Ditch where it ultimately discharged, causing a peak in both groundwater and surface water concentrations to pass through the area in 2005 to 2008/2009.
- Groundwater and surface water concentrations of chromium and ammonia (as well as other DAPL constituents) have continued to decline long-term since 2008/2009 as a result of 1) shutdown of the Sanmina wells, 2) the lowering of the off-PWD DAPL/Diffuse

interface from on-going DAPL extraction efforts, and 3) the installation of the Containment Area slurry wall.

1.4.3 OU1/OU2 Sediment

OU1/OU2 sediment data collected from the South Ditch include historical samples and samples collected per the RI/FS Work Plan (MACTEC, 2009). The current impacts to Lower South Ditch sediment are associated with historical releases to the ditch system and not ongoing discharge of impacted groundwater to surface water. Sediments of the Lower South Ditch are of concern due to potential risk to ecological receptors. The Upper South Ditch sediments were previously excavated and disposed of off-site. The distribution of chromium concentrations in South Ditch sediment is presented on **Figure 1.4-5**. The chromium concentrations in sediment samples from the Lower South Ditch range from 773 mg/kg to 3,000 mg/kg, while concentrations in the remediated Upper South Ditch range from 32 mg/kg to 273 mg/kg. The most recent distribution of BEHP concentrations in South Ditch sediment is presented on **Figure 1.4-6**. Concentrations of BEHP range from 210 mg/kg to 480 mg/kg in the un-remediated Lower South Ditch while BEHP concentrations in sediment samples from the remediated Upper South Ditch range from 0.27 mg/kg to 0.72 mg/kg. Current data indicate that the former sediment excavation remedies in Upper South Ditch were successful and that remaining contaminated sediment resides in the un-remediated portions of Lower South Ditch. These distributions of contaminants in sediment will be compared to PRGs in Section 2.

Olin collects annual sediment samples along South Ditch under the previously approved IRSWP. These samples are analyzed for iron, aluminum, and chromium, which are the primary components of the inert floc that can be observed periodically in South Ditch surface water, and results are reported in the SASRs. To date, this sampling has not shown an increasing pattern for these metals in sediment. The floc is an iron/aluminum/chromium precipitate that results from the discharge of groundwater into the more buffered (higher pH) surface water downstream of the weir. The floc has been studied extensively, is chemically stable, and not biologically available. Annual sediment data presented in the SASR indicates chromium recontamination is not occurring to an observable extent in the sediments.

Although USEPA has asserted that groundwater is the source of BEHP in un-remediated sediment, BEHP was not detected in shallow overburden groundwater discharging to South Ditch (OU3 RI; Figure 4.4.5-1a) and therefore, sediment in South Ditch and EA-5 soils are not being contaminated or re-contaminated by groundwater discharge of BEHP to surface water or sediment. The historical source of BEHP was overflow from Lake Poly to the former on-PWD (which was

excavated and disposed of off-site) that flowed to the South Ditch (which flooded the wetland soils adjacent to the Lower South Ditch).

1.4.4 OU2 Soil (EA5)

OU2 soil data collected from the floodplain of the off-Property portion of South Ditch contained within EA5 include historical samples and samples collected per the RI/FS Work Plan (MACTEC, 2009). Impacts to soils in EA5 (particularly from chromium and BEHP) are of concern due to potential risk to ecological receptors. The existing impacts to EA5 soil are associated with historical releases during facility operation to the ditch system with subsequent flooding and deposition (and not ongoing discharge of dissolved constituents to surface water). The distribution of contaminants in EA5 soil is related to topography and deposition. The distribution of chromium in EA5 soil is presented in **Figure 1.4-7**. The chromium concentrations in EA5 soil range from 9 mg/kg to 62,000 mg/kg. Based on the data presented in the Final OU1/OU2 RI Report, hexavalent chromium was not identified as a COC in EA5 soil associated with the off-Property portion of Lower South Ditch. The distribution of BEHP in EA5 soil is presented on **Figure 1.4-8**. The BEHP concentrations in EA5 soil ranged from 0.02 mg/kg to 216 mg/kg. These distributions of contaminants in soil will be compared to PRGs in Section 2.

As discussed in Section 1.4.3, BEHP is not detected in shallow overburden groundwater discharging to South Ditch and is not considered a source to EA5 soil. Results of the OU1/OU2 RI Report indicated that BEHP in South Ditch was only detected at ISCO-2 (0.0016 mg/L), which is located within the foot print of impacted South Ditch sediments within EA5. Other upstream surface water locations in South Ditch did not have detectable BEHP. As indicated previously, the historical source of BEHP was overflow discharge from Lake Poly to the former on-PWD, which flowed into South Ditch.

Also as discussed previously, annual sediment monitoring data for chromium does not indicate that chromium discharging from groundwater to surface water is re-contaminating sediment in the remediated portion of South Ditch, and therefore is also not a source to EA5 soil. As discussed in **Appendix A**, the source of chromium impacts to groundwater along South Ditch is the diffuse groundwater above the off-PWD DAPL pool. This is clearly indicated in **Appendix A** cross-section A-A' and in the historical groundwater monitoring data from 2000 to 2018.

1.4.5 OU2 Surface Water – East Ditch

Groundwater discharges along the eastern side of the property to East Ditch; a railroad drainage ditch bordering the Massachusetts Bay Transportation Authority (MBTA) commuter rail line. Surface water and sediment were evaluated in East Ditch under the OU1/OU2 RI program. Despite

a concerted effort to find sediment, sediment was not commonly found in the ditch due to the presence of railroad ballast associated with MBTA rail line. A sediment sample was collected at location EDSD/SW2 (OU1/OU2 RI Figure 2.2-4), the closest location downstream from Plant B. At this sample location, BEHP and ammonia were detected at 10 mg/kg and 130 mg/kg, respectively and total organic carbon (TOC) was reported at 86,000 mg/kg. The ammonia levels are characteristic of other locations in the OU2 study area with high TOC. TMPs were not detected at the sampled sediment location.

In surface water samples collected in East Ditch, immediately downstream from Plant B, low concentrations of NDMA (6.3 to 12 nanograms per Liter [ng/L]), ammonia (0.26 to 0.92 mg/L), TM1P (0.0044 to 0.0039 micrograms per liter [µg/L]), TM2P (0.0057 µg/L), and BEHP (0.0015 µg/L) were detected.

In the OU1/OU2 RI Report, groundwater/surface water interaction for the East Ditch was evaluated by considering East Ditch surface water data. The surface water data were representative of the on-going groundwater/surface water interaction along the length of East Ditch. However, the Plant B groundwater capture and treatment system was operating during the collection of the surface water data, which would be expected to result in the very low concentrations of detected constituents. An additional evaluation of groundwater/surface water interaction has been conducted in the hypothetical absence of the Plant B system to conservatively assess conditions should USEPA approve the PRRT and Plant B is ultimately shut down. In that evaluation, groundwater data associated with samples collected from the Plant B area from 2010 to 2018 has been used to conservatively estimate East Ditch surface water quality. Those data are presented in **Table B-1** in **Appendix B**. The text of **Appendix B** summarizes those data and the conclusions of the additional evaluation.

USEPA agreed in their approval of the Final OU1/OU2 RI report that the East Ditch is a low value habitat to ecological receptors and has no functional wetland value due to its existence as a man-made, engineered drainage ditch. The substrate is stone railroad ballast in which sediment is generally absent. It would not support fish habitat and no fish have been observed in the ditch. As such, potential ecological risk associated with the East Ditch was screened out in the OU1/OU2 Screening Level Ecological Risk Assessment.

East Ditch is comprised of a ditch on either side of the rail lines. In the vicinity of Plant B, groundwater on the Olin property is captured by Plant B and does not discharge to East Ditch. Outside of the influence of that system, groundwater discharges to East Ditch from both sides as groundwater head elevations on both the eastern and western side are higher than surface water in East Ditch. Based on interpreted potentiometric surfaces presented in the OU3 Groundwater

RI Report (Amec Foster Wheeler, 2018), groundwater flows toward East Ditch then along the axis of East Ditch. Given the low observed surface water flows in East Ditch, the ditch likely only captures a limited amount of the shallow groundwater flow. Farther south along East Ditch the groundwater leaving the South Ditch area passes under East Ditch. Wells along the eastern side of East Ditch and north of the confluence with South Ditch (GW-403D and GW-402D) do not show impact from the OCSS indicating that groundwater is not flowing under East Ditch to the east in this portion of the site.

An additional ecological risk screening has been conducted as documented in **Appendix B** for a future scenario in which the Plant B groundwater collection and treatment system is no longer operating and some groundwater from the area would be discharging to the East Ditch. Since surface water quality in the East Ditch is unknown for the future scenario where the Plant B groundwater collection and treatment system is no longer operating, concentrations of chemicals detected in groundwater in the vicinity of Plant B were compared to ecological screening criteria from several sources. It should be noted the ecological receptors are hypothetical given the very poor ecological habitat of the ditch. This conservative approach assumes no dilution of detected parameters in the groundwater as it flows toward the East Ditch and no dilution as the groundwater discharges to the surface water of the East Ditch. Concentrations of most of the detected parameters in groundwater samples were below ecological screening levels. Some concentrations of BEHP, ammonia, iron, and TMPs were above one or more available screening levels as detailed in Appendix B. Based on an evaluation of the East Ditch habitat, how these criteria were derived, and the overall pattern of the concentrations of these constituents, the discharge of groundwater to the East Ditch, in absence of Plant B groundwater extraction is not considered to pose a potential hazard to hypothetical ecological receptors in the East Ditch in the area of Plant B or immediately downstream if the Plant B groundwater collection and treatment system was no longer in operation.. Therefore, remedial technologies were not identified to address groundwater discharge to the East Ditch from the Plant B area and no remedial alternatives were developed for this scenario.

1.5 Contaminant Fate and Transport

For current conditions at OU1 and OU2, there are few complete migration pathways. There is no evidence of any erosional transport of impacted soils due to storm water runoff. Areas are well grassed and permanent erosion controls are in place. The volatiles (primarily TMPs) that have been reported in subsurface soils are not located at occupied structures, and therefore are not currently part of a complete VI pathway. VI is a potential concern for future buildings that may be constructed in areas where TMPs are currently present in soil, primarily within EA7. TMPs are only sparingly soluble in water and will tend to partition from water to air. Consistent with this,

their distribution in groundwater downgradient beyond EA7 is limited. TMP concentrations are highest in the water table capillary zone where they volatilize in vadose zone and migrate vertically by diffusion and advectively in response to changes in atmospheric pressure gradients.

The distribution of COCs in environmental media at OU1 and OU2 is consistent with the physical/chemical characteristics and fate and transport characteristics of those chemicals. BEHP, chromium, and TMPs are not highly water soluble and tend to get retained in soils and sediments. Ammonia is highly water soluble and is therefore highly mobile.

Chromium in the South Ditch surface water is present along with elevated concentrations of aluminum and iron, and forms a precipitate, or flocculant (floc), that includes all three of these metals when groundwater discharges to the South Ditch surface water. Based on the data presented in the Final OU1/OU2 RI Report, hexavalent chromium was not identified in South Ditch surface water at a reporting limit ranging from 0.005 to 0.001 mg/L. and it was not detected in floc. Formation of the floc material is driven by changes in aqueous pH and is stable in the surface water environment. The floc material is mobile, in that stormwater events result in the flushing of floc from the South Ditch to downstream locations. The floc material may also be incorporated in the South Ditch bottom substrate including decaying leaf material and sediment.

As discussed previously and explained in **Appendix A**, the principal source of ammonia to groundwater and therefore surface water is diffusion from DAPL (from the off-PWD DAPL pool) to diffuse groundwater and migration of diffuse groundwater by advection. Ammonia is soluble in water, but is not stable in most environments. It is easily transformed to nitrate in waters that contain oxygen and can be transformed to nitrogen gas in waters that are low in oxygen. Ammonia in surface water and sediment is also created by natural biological processes as a function of the nitrogen cycle. Organic peat deposits have the ability to fix high concentrations of ammonia. Ammonia in surface water will interchange nitrogen with aquatic plants and algae, which can convert and fix the nitrogen for growth, eventually recycling the nitrogen back into the atmosphere. The most important attenuation mechanism is likely to be sorption to organic substrates and dilution by other surface water downstream. The importance of these processes is evident from the OU1/OU2 RI Report surface water data (OU1/OU2 RI Report; Figure 4.1-31) where over a distance of approximately 1,600 feet from the confluence of South Ditch and East Ditch, the concentrations of ammonia decline from 110 to 8.7 mg/L (May 2011) and from 74 to 2.2 mg/L to sample location EDSD/SW5(EDBS11).

BEHP sorbs strongly to soil and organic sediments and has relatively low water solubility, which limits its potential to migrate in surface water at substantial concentrations or to leach from soil to groundwater or surface water.

1.6 Baseline Risk Assessment

The following subsections summarize the results of human health and ecological risk assessments completed at the OCSS.

1.6.1 Human Health Risk Assessment

The BHHRA, presented in the Final OU1/OU2 RI Report, evaluated cancer and non-cancer risks for industrial / commercial worker, construction worker exposures to OU1 surface and subsurface soil and surface soil in OU2 (EA5). The BHHRA Exposure Areas are shown on **Figure 1.3-2**. The BHHRA also evaluated cancer and non-cancer risks for potential trespasser exposures to OU1 surface soil and OU1 and OU2 surface water and sediment at all areas except Landfill Brook by agreement with USEPA. These evaluations indicate cancer risks are below or within the CERCLA acceptable risk range for all receptors evaluated, and non-cancer HI values are below or equal to 1. The BHHRA calculations indicate:

- Human health risks associated with potential direct contact (ingestion and dermal contact and inhalation of dust where applicable) exposures to surface soil, shallow subsurface soil, surface water, and sediment at OU1 indicate that the northern portion of OU1 (EA1, EA2, EA3, EA6, EA7, including the on-PWD, South Ditch, Central Pond, and the Stormwater Retention Basin) is suitable for current and future industrial/commercial use. EA4 is within the Conservation Area.
- Human health risks associated with potential trespasser, industrial/commercial worker, and construction worker exposures to OU2 surface soil at EA5 indicate the area is suitable for industrial/commercial use.
- Human health risks associated with potential trespasser exposures to OU2 surface water and sediment at the South Ditch, East Ditch, Maple Meadow Brook, off-PWD, and North Pond indicate no trespasser exposure concerns for substances associated with releases at and from the OCSS.

The BHHRA, presented in the Final OU1/OU2 RI Report, also provided a qualitative evaluation of potential future VI concerns associated with volatile compounds (primarily TMPs) in EA7 and EA3, and in a smaller area within EA1, as identified by a sample, at the former Lake Poly Area. There are no USEPA-published soil screening values which are protective of future VI exposures. As such, potential risks resulting from VI from soil to hypothetical future buildings is difficult to quantify and evaluate. Indoor air sampling and analysis in the Plant B treatment building indicated that there is not a complete VI pathway for TMPs. The office trailer construction indicates negligible potential for VI of TMPs (the trailer is an above ground structure). TMP concentrations

in bulk soil samples collected immediately north of Plant B and the PID screening of these soil samples (PID readings as high as 3,000 ppm) suggest that VI may be of concern for future buildings that might be constructed in this portion of the OCSS. In the future it is possible for redevelopment of the Property to occur in this area and new industrial/commercial buildings could be constructed that would likely require institutional and engineering controls to address or eliminate potential VI pathways. The concentrations of TMPs in subsurface soil samples from EA3, EA7, and the Lake Poly area within EA1 in conjunction with the PID screening results for soil samples collected in those areas indicate institutional and engineering controls may be required to mitigate future construction worker inhalation exposures during excavation activities.

1.6.2 Ecological Risk Assessments

The BERA characterized risk by media, exposure area and assessment/measurement endpoints, beginning with the terrestrial exposure areas and concluding with the semi-aquatic exposure areas. The BERA Exposure Areas are shown on **Figure 1.3-3**. The OU1/OU2 BERA found that adverse effects associated with releases at or from the OCSS to ecological receptors are unlikely in the following exposure areas and media:

- BERA EA2 soil;
- BERA EA4 soil;
- Central Pond surface water and sediment;
- Storm Water Retention Basin surface water and sediment;
- On-PWD/West Ditch Wetland surface water and sediment;
- Upper South Ditch sediment;
- Maple Meadow Brook surface water and sediment; and
- North Pond surface water and sediment.

The OU1/OU2 BERA also found that adverse effects associated with releases at or from the OCSS to ecological receptors may be possible in the following exposure areas and media:

- EA5 soil, due to chromium and BEHP;
- Upper South Ditch surface water, due to chromium and ammonia; and
- Lower South Ditch surface water due to chromium and ammonia and sediment due to chromium and BEHP.

Based on the data presented in the Final OU1/OU2 RI Report, the BERA and BHHRA, hexavalent chromium was not identified as a COC in surface water and sediment in South Ditch, or in EA5 soil associated with the off-Property portion of Lower South Ditch.

1.6.3 Conclusions

The nature and extent of contamination for OU1/OU2 soil, surface water, and sediment has been well characterized and defined. The data are adequate to support risk characterization and risk management decisions. The conclusions of the RI are provided below:

- Federal National Recommended Water Quality Criteria (NRWQC) are identified as chemical-specific ARARs for surface water to be used in evaluation of health effects to be protective of aquatic life and human health, as well as in the development of PRGs and remedial target levels.
- The human health risk assessment indicates the Property overall is suitable for industrial/commercial use.
- TMPs in soil in the northern portion of the property associated with EA7 and EA3 and to a lesser extent one location near former Lake Poly area in EA1 could pose potential VI risks for future building construction and occupancy and potential risks to future construction workers during excavation activities (inhalation of TMPs). These areas of the OCSS should be evaluated in an FS for potential engineering controls and requirements to mitigate potential future VI concerns and potential future construction worker exposures.
- The ecological risk assessment indicates there are no ecological risk concerns in the portions of the Property available for redevelopment.
- The BERA for OU1 and OU2 evaluated distinct EAs and found that adverse effects related to releases at or from the OCSS may be possible for Lower South Ditch sediment and EA5 soil, due to chromium and BEHP. Therefore, these areas should be evaluated in an FS to address chromium and BEHP.
- At the time the OU1/OU2 Report was prepared, surface water in Upper and Lower South Ditch showed potential adverse effects to ecological receptors primarily due to ammonia and chromium. Therefore, it was recommended that South Ditch surface water be evaluated in the OU1/OU2 FS. Since 2015 when the OU1/OU2 RI Report was finalized/approved, chromium and ammonia concentrations in South Ditch surface water have declined appreciably. The source of ammonia and chromium is groundwater adjacent to and underlying the ditch, which has also shown appreciable declines in concentrations. The reasons for these changes are discussed in **Appendix A** and indicate surface water may no longer pose potential adverse effects to ecological receptors in South Ditch.
- The BHHRA and BERA indicated no human health or ecological risk concerns for OU1 surface water and sediment of the Central Pond and the Stormwater Retention Basin and for OU2 surface water and sediment in the MMB wetland and North Pond and those water bodies do not need to be evaluated in the OU1/OU2 FS.

2.0 REMEDIAL ACTION OBJECTIVES

This OU1/OU2 FS evaluates remedial alternatives to address the following conditions at the OCSS:

- TMPs in soil (where future buildings may be constructed) – vapor intrusion and construction worker inhalation during excavation activities.
- Chromium and BEHP in Lower South Ditch sediment and EA5 soil – ecological receptor risk.
- Chromium and ammonia in South Ditch surface water – ecological receptor risk and NRWQC.

This section presents the RAOs, ARARs, COCs, and PRGs, in support of development of remedial action alternatives.

The RAOs are as follows:

<u>RAO for TMPs in soil:</u>

- Mitigate impacts to public health resulting from existing, or the potential for, soil VI into buildings and the potential for construction worker inhalation exposure during excavation activities at the OCSS.

<u>RAO for chromium and BEHP in Lower South Ditch sediment and EA5 soil:</u>

- Restore soils and sediment to levels of Site-related chemicals of concern that do not exceed Lowest Observed Adverse Effect Level (LOAEL) risk-based soil concentrations derived in the BERA, Lowest Observed Effect Concentration (LOEC) risk-based sediment concentrations derived in the BERA, and do not exceed 20% effect levels in sediment acute and chronic in-situ or laboratory toxicity tests compared to control sediment.

<u>RAO for chromium and ammonia in South Ditch surface water:</u>

- Restore surface water to achieve the NRWQC for Site-related chemicals of concern (e.g., ammonia and chromium) and eliminate acute and chronic toxicity to aquatic organisms, as measured by in-situ or laboratory toxicity tests.

RAO to Prevent Leaching of Site-related chemicals of concern into sediment and surface water:

- Prevent leaching of Site-related chemicals of concern into sediment and surface water to levels that exceed NRWQC, LOEC risk-based concentrations in surface water or sediment, or concentrations that have toxicity to aquatic organisms

USEPA requested this last RAO in its review comments on the Draft OU1/OU2 FS (Comment 9 of Appendix 6), noting "chromium appears to be leaching from the soils in the Containment Area and ammonia from soils adjacent to the Lower South Ditch at concentrations that are likely to be having adverse ecological impacts".

Olin has evaluated this requested RAO in context of what additional alternatives would be required in this OU1/OU2 FS to meet this RAO. The proposed alternative for the Containment Area in the IAFS includes a low permeability composite final cover system or cap in combination with sealing the equalization window. These actions will complete the hydraulic isolation of the soils within the Containment Area and effectively eliminate infiltration of precipitation and leaching of chromium from vadose soils located between the cap and the water table within the Containment Area.

Appendix A of this FS presents a discussion of groundwater and surface water /sediment interaction along South Ditch and an analysis of the sources of ammonia and chromium to groundwater and surface water in vicinity of South Ditch. This evaluation includes an assessment of ammonia in soil adjacent to Lower South Ditch. Ammonia concentrations in the organic rich soil adjacent to Lower South Ditch are consistent with background concentrations for soil and sediment. Ammonia at these concentrations in soil do not pose a leaching concern. Ammonia in soil at these concentration would only be expected to result in di minimis contribution to surface water or sediment. Therefore additional actions to address ammonia in soil as a source of impact to surface water and sediment appear unwarranted. The identified source of ammonia in surface water, like chromium, is upgradient groundwater originating above the off-PWD DAPL pool.

2.1 Applicable or Relevant and Appropriate Requirements

CERCLA and the NCP require that on-site Superfund remedial actions must attain federal standards, requirements, limitations, or more stringent state standards determined to be legally applicable or relevant and appropriate to the circumstances at a given site. ARARs are federal and state environmental and facility siting requirements used to: (1) evaluate the appropriate extent of site cleanup; (2) define and formulate remedial action alternatives; and (3) govern

implementation and operation of the selected action. Inherent in the interpretation of ARARs is the assumption that protection of human health and the environment is ensured.

To properly consider ARARs and to clarify their function in the remedy selection process, the NCP defines two ARAR components: (1) applicable requirements; and (2) relevant and appropriate requirements. These definitions are discussed in the following paragraphs.

Applicable Requirements. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site (40 CFR 300.400(g)). To be applicable, a requirement must directly and fully address a CERCLA activity.

Relevant and Appropriate Requirements. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the particular site (40 CFR 300.400(g)(2)).

There is another category of information that is often considered in the ARARs analysis but that are not actually ARARs. Those are non-promulgated guidance, recommendations, and other information that can be used to inform remedial decisions. These items are referred to as "To Be Considered" items.

ARARs are divided into the three categories described in the following paragraphs.

Location-specific ARARs set restrictions upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations. In determining the use of location-specific ARARs for selected remedial actions at CERCLA sites, one must investigate the jurisdictional prerequisites of each of the regulations. Basic definitions and exemptions must be analyzed on a site-specific basis to confirm the correct application of the requirements.

Chemical specific ARARs are usually health- or risk-based numerical values or methodologies that establish the acceptable amount or concentration of a chemical that may remain in, or be discharged to, the environment (USEPA, 1988a). They govern the extent of site remediation by providing either actual cleanup levels, or the basis for calculating such levels. For example, drinking water Maximum Contaminant Levels provide cleanup goals for sites with contaminated groundwater (relevant and appropriate for current and/or future potable use groundwater). If

treated groundwater is discharged to a surface water body, the treated effluent would need to meet NRWQC. Chemical-specific ARARs may also be used to indicate acceptable levels of discharge in determining treatment and disposal requirements, and to assess the effectiveness of future remedial alternatives.

Action-specific ARARs are usually technology- or activity-based requirements or limitations on remedial actions taken (USEPA, 1988a). Selection of a particular response action at a site will invoke the appropriate action-specific ARARs that may specify particular performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals.

Many regulations can fall into more than one category. For example, many location-specific ARARs are also action-specific because they are triggered if response activities affect site features. Likewise, many chemical-specific ARARs are also location-specific.

The Occupational Safety and Health Administration (OSHA) has promulgated standards for protection of workers who may be exposed to hazardous substances at Resource Conservation and Recovery Act (RCRA) or CERCLA sites. USEPA requires compliance with the OSHA standards in the NCP, not through the ARAR process. Therefore, the OSHA standards are not considered as ARARs. Although the requirements, standards, and regulations of OSHA are not ARARs, they will be complied with during response activities.

Preliminary Identification of ARARs. The location-, chemical-, and action-specific ARARs identified in support of this FS are presented by media. **Tables 2.1-1 through 2.1-3** present location-, chemical-, and action-specific ARARs for TMPs in soil. **Tables 2.1-4 through 2.1-6** present location-, chemical-, and action-specific ARARs for Lower South Ditch sediment and EA5 soil. **Tables 2.1-7 through 2.1-9** present location-, chemical-, and action-specific ARARs for South Ditch surface water.

In summary, location-specific ARARs include federal and state regulations related to wetlands and surface waters. Chemical-specific ARARs include NRWQC for aquatic life and toxicity and exposure information for construction worker exposure and vapor intrusion evaluations. Action-specific ARARs include federal and state regulations relative to: RCRA identification and listing of hazardous waste; standards applicable to generators of hazardous waste; and RCRA requirements for storage and disposal of hazardous waste.

2.2 Chemicals of Concern

The primary COCs associated with the environmental media addressed in this FS are summarized as follows:

- TMPs in soil in the northern portion of the property associated with BHHRA EA1, EA3, and EA7
- Chromium and BEHP in Lower South Ditch sediments
- Chromium and BEHP in surface soil associated with EA5
- Chromium and ammonia in surface water in Upper and Lower South Ditch

2.3 Development of Preliminary Remediation Goals

PRGs are medium-specific concentrations used during analysis and selection of remedial action alternatives and cleanup levels. PRGs should comply with ARARs and result in residual risks consistent with NCP requirements for protection of human health and the environment. Therefore, there are both ARAR-based PRGs and risk-based PRGs. Eventually, PRGs may be modified and/or potentially become the basis for final remediation levels for the selected remedy.

2.3.1 Human Health Risk-Based PRGs for Indoor Air

Based on information presented in the Final OU1/OU2 RI Report and the associated BHHRA, the location of TMPs in subsurface soils is not associated with any current buildings present at the OCSS, and therefore, there is not a complete VI pathway under current site conditions.

However, for TMPs detected in soil samples collected from EA1, EA3, and EA7, the soil analytical data and the headspace vapor field screening information indicate potential vapor intrusion for future occupied buildings and potential construction worker inhalation exposure during future construction activities in those areas. It was not possible to calculate, without orders of magnitude uncertainty, VI-related potential indoor air concentrations and associated industrial/commercial employee risks for future buildings. Human health risk-based indoor air PRGs for TMPs have been calculated and can be used to identify and evaluate potential remedial alternatives to address VI. It is not possible to predict if a future VI pathway would be complete and above a PRG without foreknowledge of a future building's design, construction methods, materials, and location.

The human health indoor air PRG for TMPs was developed based on a chronic inhalation reference concentration of 0.07175 milligrams per cubic meter (mg/m^3), considering a No Observed Adverse Effect Level and the liver as the primary target organ. The PRG was developed for a commercial/industrial indoor worker being on-site 8 hours per day for 250 days per year. The

calculated indoor air PRG for TMPs, based on target Hazard Quotients (HQs) of 1 and 0.1 are summarized below. PRGs are typically calculated for target levels of 1 and 0.1 to be able to address scenarios with multiple COCs and RAOs that call for cumulative hazard index (sum of HQs) of one or less.

Commercial/Industrial Indoor Air PRG for TMPs in Soil at BHHRA EA1, EA3, and EA7

For Target HQ = 1 Total TMPs PRG = 0.314 mg/m^3

For Target HQ = 0.1 Total TMPs PRG = 0.0314 mg/m^3

2.3.2 Ecological PRGs for Sediment, Soil, and Surface Water

Ecological PRGs were developed for chromium and BEHP in sediment and surface soil, and for chromium and ammonia in surface water.

PRGs were developed for those receptors for which risks from chromium, BEHP, and ammonia were identified in the BERA for OU1 and OU2, summarized in **Table 2.3-1**.

PRGs were developed for two target levels. The first PRG is the concentration that corresponds to an ecological HQ of 1, and the second corresponds to an HQ of 10.

In the BERA, risks to plants, soil invertebrates, benthic invertebrates, and amphibians were assessed by comparing exposure point concentrations to benchmarks. Risks to birds and mammals were assessed through food chain models. Where the assessment method consisted of a benchmark comparison, the soil/sediment/surface water concentration associated the target HQs were back-calculated from the LOEC benchmark as shown in Equation 1 and Equation 2:

PRG = LOEC Benchmark (Equation 1, PRG at HQ=1)

PRG = LOEC Benchmark * 10 (Equation 2, PRG at HQ=10)

Where the assessment method consisted of food chain modeling, the model for each respective receptor was solved to identify the soil/sediment concentration (i.e., the PRG) associated with the target HQs. PRGs derived from food chain models assumed that the surface water ingestion pathway is negligible to avoid the need to simultaneously solve for two inter-dependent variables. The food chain models demonstrated that the surface water ingestion exposure pathway was not influential to overall risk.

PRGs assumed the LOEC benchmarks and LOAEL Toxicity Reference Values when making calculations.

Maximum and average concentrations, and average background concentrations are provided where available for EA5 soil and Lower South Ditch sediment in **Table 2.3-2** and **Table 2.3-3**, respectively.

Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE) concentrations are provided for South Ditch surface water in **Table 2.3-4**.

Note that the chromium PRGs are based on trivalent chromium, as hexavalent chromium has not been identified as a COC in South Ditch surface water and sediment or EA5 soil associated with the off-Property portion of Lower South Ditch.

South Ditch is a gaining water course supported by discharge from shallow groundwater. During summer months when water table elevations decline, the middle reach of South Ditch commonly goes dry and the ditch turns into a body of disconnected stagnant pools of water. In August 2018, the entire length of South Ditch went dry. South Ditch discharges to East Ditch, which is a railroad ditch with poor ecological habitat that does not support fish. Migratory fish from farther downstream therefore cannot migrate through East Ditch and enter South Ditch. The upgradient drainages that flow into South Ditch include on-PWD (also an ephemeral ditch that is often dry) and off-PWD. The off-PWD is fed by storm water detention features that direct run-off-from around the Jewel Drive area. These ditches also are habitats not capable of supporting fish populations. South Ditch is isolated from any potential migratory fish in both upstream and downstream directions, and therefore, the ammonia PRGs appropriately assume that salmonid fish are absent. As such, these species cannot be tested to determine an appropriate criteria, because they are absent from the system.

USEPA has responded to Olin's development of surface water PRGs by indicating *"representative species are tested and used to develop the criteria; it is not acceptable to choose which species are or are not present and further adjust the criteria. The chronic concentration for ammonia is 1.9 mg/L for a pH of 7 and a temperature of 20 degrees Celsius. This criteria value is used for Halls Brook Holding Area Pond for the Industri-Plex Superfund site."* USEPA further requested Olin revise its PRG approach accordingly.

The purpose of the PRG is to protect species that are present in South Ditch or could be supported by the habitat present if the contaminants were absent. Even if ammonia and chromium were not present in surface water, South Ditch aquatic habitat could not support cold water fish species because of warm and often stagnant summer water conditions and the fact that the middle reach

of South Ditch commonly goes dry and the ditch turns into a body of disconnected stagnant pools of water. Therefore, the PRGs as proposed are appropriate for, and protective of, South Ditch.

In addition, the USEPA *Aquatic Life Ambient Water Quality Criteria For Ammonia – Freshwater 2013* contains, starting on page 42, a description of the procedure for calculating the water quality criteria for ammonia for situations where salmonid fish species are absent. The ammonia surface water PRG has been calculated using that procedure. The resultant PRG is consistent with USEPA recommendations and is therefore applicable to the South Ditch and the East Ditch upstream of the Hall's Brook Holding Area Pond. Therefore, Olin proposes adding the requested ammonia remediation goal for Halls Brook Holding Area as applicable to surface water quality leaving South Ditch.

Olin recognizes that surface water leaving South Ditch will ultimately migrate through East Ditch, and intervening waterways to Halls Brook and the Halls Brook Holding Area. Based on the surface water data for ammonia presented in the OU1/OU2 RI Report, the observed attenuation of concentrations from South Ditch to sample location EDSD/SW5 over this watercourse is at least 12.5 times. For surface water at the lower end of the South Ditch that contains ammonia at the proposed PRG, downstream ammonia concentrations at this location (EDSD/SW5) would likely be slightly in excess of 1.9 mg/L. Further, Olin notes that ammonia exiting Landfill Brook from the Woburn Sanitary Landfill (located approximately 1,200 feet down stream of EDSD/SW5) averaged 7.8 mg/L in 2010/2011. With this proposed approach, the major upstream contribution of ammonia to Halls Brook Holding Area will be from the Woburn Sanitary Landfill rather than the OCSS.

2.3.3 Volumes and Areas of Media with Concentrations Above PRGs

This subsection presents the estimated volumes of TMPs in soil, Lower South Ditch sediment and EA5 soil, and South Ditch surface water.

2.3.3.1 TMPs in Soil

The areal extent of TMP in subsurface soil associated with EA7 is estimated to be approximately 23,000 square feet. TMPs are present in soil within a 2-3 foot thickness at the groundwater surface, which is approximately 7-8 feet below ground surface. Therefore, the estimated in-place volume of TMP-impacted soil associated with EA7 is approximately 69,000 cubic feet or approximately 2,600 cubic yards.

The areal extent of TMPs in subsurface soil associated with EA3 is approximately 5,000 square feet. TMPs are present in soil within a 3-4 foot thickness at the groundwater surface. Therefore, the

estimated in-place volume of TMP-impacted soil associated with EA3 is approximately 20,000 cubic feet, or approximately 750 cubic yards.

The areal extent of TMPs in subsurface soil associated with the Lake Poly area is approximately 2,500 square feet. TMPs are present in soil within an approximate 3-foot thickness at the groundwater surface. Therefore, the estimated in-place volume of TMP-impacted soil associated with EA 3 is approximately 7,500 cubic feet, or approximately 280 cubic yards.

2.3.3.2 EA5 Surface Soil

The areal extent of surface soil in EA5 with concentrations above the ecological PRGs for chromium and BEHP based on an HQ of 1 is shown on **Figure 2.3-1**. Supporting information (figures with soil concentrations) is provided in **Appendix C**. This overall area is approximately 6,100 square feet. For simplicity, the remediation area is assumed to average one foot deep. In practice the thickness may be in excess of a foot within the organic stream channel and taper to several inches at the extremity. Therefore, the volume of surface soil at concentrations exceeding the ecological PRGs for chromium and BEHP based on an HQ of 1 is approximately 6,100 cubic feet, or approximately 230 cubic yards.

The areal extent of surface soil in EA5 with concentrations above the ecological PRGs for chromium and BEHP based on an HQ of 10 was developed for comparative purposes and is shown on **Figure 2.3-2**. Supporting information is provided in **Appendix C**. This overall area is approximately 5,100 square feet. The remediation area is again assumed to average one foot deep. Therefore, the volume of surface soil with concentrations above the ecological PRGs for chromium and BEHP based on an HQ of 10 is approximately 5,100 cubic feet, or approximately 190 cubic yards (17% smaller).

This FS conservatively assumes that the ecological PRGs will be based on an HQ of 1 for the purposes of evaluating remedial alternatives. However, an HQ of 1 may not be ultimately used in selection of a final remedial alternative.

2.3.3.3 Lower South Ditch Sediment

The areal extent of sediment to be addressed in Lower South Ditch, as shown on **Figure 2.3-3**, is identified as the area from the Delta to East Ditch. The term "Delta" refers to the downstream portion of South Ditch where the ditch flattens and widens, which coincides with where the 2000-2001 remediation ended. **Figure 2-3.3** also shows the extent of previous sediment remediation completed in South Ditch (i.e., from the Weir to the Delta). The area from the Delta to East Ditch represents the extent of sediment with concentrations above the ecological PRGs for chromium

and BEHP based on an HQ of 1. The areal extent of sediment on Lower South Ditch based on an HQ of 1 is approximately 9,700 square feet. Supporting information is provided in **Appendix C**. For estimating purposes, the proposed remediation area is assumed to be one foot deep; however, the actual remediation will be based on additional pre-design sampling that will be conducted to determine the depth and lateral extent of soil and sediment with COC concentrations above PRGs. Assuming an excavation depth of 1 foot, the volume of Lower South Ditch sediment at concentrations above the ecological PRGs for chromium and BEHP based on an HQ of 1 is approximately 9,700 cubic feet, or approximately 360 cubic yards.

The areal extent of sediment in Lower South Ditch with concentrations above the ecological PRGs for chromium based on an HQ of 10 was developed for comparative purposes and is shown on **Figure 2.3-4**. There are no concentrations of BEHP in Lower South Ditch sediment that are associated with an HQ of greater than 10. The overall area of sediment based on an HQ of 10 is the same as that for an HQ of 1. As stated in the preceding paragraph, the remediation area is assumed to be one foot deep, but the actual limits will be based on pre-design data that will be collected prior to developing an excavation plan. Therefore, the volume of Lower South Ditch sediment with concentrations above the ecological PRG for chromium based on an HQ of 10 is approximately 9,700 cubic feet or approximately 360 cubic yards.

This FS will conservatively assume that the ecological PRGs will be based on an HQ of 1 for the purposes of evaluating remedial alternatives. However, an HQ of 1 may not be ultimately used in selection of a final remedial alternative.

2.3.3.4 South Ditch Surface Water

South Ditch is a perennial surface water feature that receives surface flow from the off-PWD and on-PWD, as well as overburden groundwater, which discharges along the entire length of South Ditch. A perennial stream may have intermittent flow along portions of its length. South Ditch varies in width, but on average is approximately six feet wide. The flow varies, but the water depth in South Ditch is typically approximately six inches. During seasonal high groundwater conditions, there is constant base flow within South Ditch. However, during drier periods in summer months, the middle of South Ditch commonly goes dry and the ditch turns into a body of disconnected stagnant pools of water. During the quarterly monitoring event in August 2018, no surface water samples were collected from the South Ditch monitoring locations as these locations were all dry (i.e., these was no flowing surface water present in the ditch). A flow measurement study estimated annual flows of 1.6 million cubic feet per year for the South Ditch system (Smith, 1997), or an average of approximately 33,000 gallons per day.

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section identifies and screens remedial technologies using the process outlined in the NCP and USEPA RI/FS guidance (USEPA, 1988b). This section identifies appropriate general response actions that may be used to satisfy the RAOs identified in Section 2.0. General response actions describe categories of remedial actions that may be used to satisfy RAOs and provide the basis for identifying specific remedial technologies. Potential cleanup technologies are then identified and screened to produce a list of suitable technologies that can be assembled into remedial alternatives capable of achieving the RAOs.

3.1 General Response Actions

General response actions are categories of remedial actions that may be used to satisfy remedial action objectives by either reducing the contaminant concentration in each medium below the PRG or by preventing receptor exposure to the contaminated medium. General response actions describe categories of remedial actions that may be employed to satisfy remedial action objectives and provide the basis for identifying specific remedial technologies.

Potential general response actions for TMPs in soil are:

- No Action
- Institutional Controls
- Treatment
- Removal
- Disposal

Potential general response actions for Lower South Ditch sediment and EA5 soil are:

- No Action
- Institutional Controls
- Containment
- Treatment
- Removal
- Disposal

Potential general response actions for South Ditch surface water are:

- No Action
- Institutional Controls

- Removal
- Treatment
- Containment

3.2 Identification and Screening of Technologies and Process Options

This section identifies and screens remedial technologies using the process outlined in the NCP and USEPA RI/FS guidance (USEPA, 1988b and 1990). Technologies are first identified to attain the remedial action objectives established in Section 2.0 and to correspond to the categories of general response actions described in Subsection 3.1. Demonstrated performance of each technology for site contaminants and conditions is considered during technology identification. The result is a list of potential remedial technologies that are then screened based on their applicability to site- and waste-limiting characteristics. The purpose of the screening is to produce a list of suitable technologies that can then be assembled into remedial alternatives capable of mitigating actual or potential risks at the site. A list of potential technologies representing a range of general response actions was considered to develop the remedial alternatives.

3.2.1 Identification and Screening of Technologies

Categories of remedial technologies and specific process options were identified for each of the RAOs based on a review of literature, vendor information, performance data, and experience in developing other FSs under CERCLA. Process options considered potentially applicable to attaining the remedial response objectives were selected for screening.

The technology screening process reduces the number of potentially applicable technologies and process options by evaluating factors that may influence their effectiveness and implementability. This overall screening is consistent with guidance for performing an FS under CERCLA (USEPA, 1988b).

The screening process assesses each technology or process option for its effectiveness and implementability with regard to site-specific conditions, known and suspected contaminants, and affected environmental media. The effectiveness evaluation focuses on: (1) whether the technology is capable of handling the estimated areas or volumes of media and meeting the contaminant reduction goals identified in the remedial action objectives; (2) the effectiveness of the technology in protecting human health and the environment during the construction and implementation phase; and (3) how proven and reliable the technology is with respect to contaminants and conditions at the OCSS. Implementability encompasses both the technical and administrative feasibility of implementing a technology.

Waste-limiting characteristics primarily establish the effectiveness and performance of a technology; site-limiting characteristics affect implementability of a technology. Waste-limiting characteristics consider the suitability of a technology based on contaminant types, individual compound properties (e.g., volatility, solubility, specific gravity, adsorption potential, and biodegradability), and interactions that may occur between mixtures of compounds (e.g., chemical reactions or increased solubility). Site-limiting characteristics consider the effect of site-specific physical features on the implementability of a technology, including topography, buildings, underground utilities, available space, and proximity to sensitive operations. Technology screening based on waste- and site-limiting characteristics serves a twofold purpose of screening out technologies whose applicability is limited by site-specific waste or site considerations, while retaining as many potentially applicable technologies as possible. At this stage in the process, relative costs are considered to eliminate technologies that are substantially less cost-effective.

3.2.2 Evaluation of Technologies and Selection of Representative Technologies

The following subsections summarize the technology screening process. The retained technologies/process options may be used alone or integrated with other technologies to develop remedial alternatives.

3.2.2.1 TMPs in OU1 Soil Technology Screening Summary

USEPA requested that Olin provide a robust analysis of alternatives to address or eliminate VI pathways. **Table 3.2-1** presents the technology screening for TMPs in OU1 soil. Technologies and process options judged ineffective or not implementable were not retained. The retained technologies and process options are those considered most suitable for remediation of TMPs in soil at the OCSS.

The following paragraphs summarize the results of technology screening for TMPs in OU1 soil.

Institutional Controls. Technologies identified that may be used as components of remedial alternatives to provide institutional controls are deed covenants and environmental monitoring. If institutional controls are incorporated as part of the selected remedy, they will be written in a manner that is specific to the required actions (e.g., installation of vapor barriers or implementation of health and safety plans) and will confer rights for enforcement.

Treatment. Air sparging (AS)/soil vapor extraction (SVE) was retained as a viable in-situ treatment technology for TMPs in shallow soil. An AS/SVE system was previously and successfully implemented at the Site for remediation of TMPs at the adjacent Extractable Petroleum Hydrocarbon (EPH)/Volatile Petroleum Hydrocarbon (VPH) Area. Monitoring of the extracted soil

vapor provides a direct measure of remediation progress. Installation of subsurface vapor barriers or construction of sub-slab ventilation or depressurization systems was also retained for addressing TMPs in soils associated with future buildings at the Site that might be constructed over an area with potential VI concerns.

In-situ chemical oxidation could be effective at treating TMPs in soil; however, providing adequate contact of the reagents with the capillary fringe smear zone and control of reagent migration toward East Ditch would make this technology more difficult to implement and less certain. Ex-situ low temperature thermal desorption is viable for treating TMPs; however, unacceptable short-term exposure risks related to excavation of TMP-impacted soil and releasing volatile organic compounds resulted in this technology being eliminated from further consideration.

Removal. Mechanical excavation was eliminated as a viable technology because excavation of TMP-impacted soil would likely result in unacceptable short-term exposure risks to site workers, as well as nearby receptors. The area is immediately adjacent to Eames Street and the MBTA commuter rail line and would be subject to fugitive emissions during excavation.

Disposal. Off-site disposal was eliminated because removal of TMP-impacted soil by excavation was eliminated. Therefore, there would not be any soil generated for off-site disposal.

3.2.2.2 OU1/OU2 Sediment and EA5 Soil Technology Screening Summary

Table 3.2-2 presents the technology screening for OU1/OU2 sediment and EA5 soil. Technologies and process options judged ineffective or not implementable were not retained. The retained technologies and process options are those considered most suitable for remediation of OU1/OU2 sediment and EA5 soil.

The following paragraphs summarize the results of technology screening for OU1/OU2 sediment and EA5 soil.

Institutional Controls. Technologies identified that may be used as components of remedial alternatives to provide institutional controls are deed covenants and environmental monitoring.

Containment. Capping technologies were not retained as installation of any type of capping system would negatively affect South Ditch and would destroy the existing ecological habitat. The limited depth of stream flow (several inches) would make lining the ditch impractical.

Treatment. Solidification/stabilization was retained as a potentially viable technology to be implemented in conjunction with removal of soil and sediment by excavation. Some of the

excavated material may be characterized as hazardous waste due to chromium concentrations and therefore may require stabilization or solidification prior to disposal in order to meet the disposal facility's operating permit requirements. In-situ solidification/stabilization was not retained because it would be difficult to implement and would destroy the existing ecological habitat. In-situ treatment technologies were not retained. For example, monitored natural recovery was eliminated because of the relatively low stream flow, shallow water depth and sediment deposition rate. Enhanced bioremediation was eliminated because it is not effective for the COCs (e.g., chromium). Chemical oxidation was eliminated because it is difficult to implement in surface soil and sediment and would alter the oxidation state of chromium.

Removal. Mechanical excavation was retained as a viable technology for removal of surface soil and sediment.

Disposal. Off-site disposal was retained as a viable remedial technology. Consolidation and on-site disposal was eliminated due to limited available space for constructing a disposal area, as well as difficultly in permitting an on-site disposal facility.

3.2.2.3 South Ditch Surface Water Technology Screening Summary

Table 3.2-3 presents the technology screening for South Ditch surface water. Two general approaches were considered: (1) intercepting and treating groundwater prior to it discharging to surface water, and (2) removal of chromium and ammonia from surface water. Technologies to accomplish these general approaches were evaluated so that the analysis was comprehensive notwithstanding the current observation that concentrations of both chromium and ammonia in groundwater and in surface water are decreasing to the point where Olin's proposed PRGs for these constituents are currently being met in surface water. Technologies and process options judged ineffective or not implementable were not retained. The retained technologies and process options are those considered most suitable for remediation of South Ditch surface water.

The following paragraphs summarize the results of technology screening for South Ditch surface water.

Institutional Controls. Technologies identified that may be used as components of remedial alternatives to provide institutional controls are deed covenants and environmental monitoring.

Removal. No process options were retained under the removal general response action (e.g., removal of groundwater), because each of the identified technologies would result in eliminating the ditch, which would not be an acceptable environmental outcome.

Treatment. The In-situ Treatment general response action considered a Permeable Reactive Barrier (PRB) and Chemical Adsorption. Both technologies are considered somewhat effective, and were retained for further consideration. No process options were retained under the ex-situ treatment general response action, because each of the identified technologies would require diversion or removal of surface water, which would eliminate the ditch, resulting in an unacceptable environmental outcome.

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

In this section, alternatives are developed to meet the RAOs presented in Subsection 2.0, using the general response actions identified in Subsection 3.1 either singly or in combination. Developed remedial alternatives are typically then screened with respect to the criteria of effectiveness, implementability, and cost to meet the requirements of CERCLA and the NCP (40 CFR 300.430(e)(7)).

4.1 Alternative Screening Criteria

The objective of the alternative screening step is to eliminate impractical alternatives or higher cost alternatives (i.e., order of magnitude cost differences) that provide little or no increase in effectiveness or implementability over their lower-cost counterparts. The effectiveness, and implementability, and cost criteria used for screening the alternatives are discussed in the following paragraphs.

Effectiveness. This criterion focuses on the degree to which an alternative reduces toxicity, mobility, or volume through treatment, minimizes residual risks and affords long-term protection, complies with ARARs and minimizes short-term impacts. The NCP indicates that both short- and long-term aspects of effectiveness should be considered. Short-term is considered to be the construction and implementation period, while long-term begins once the remedial action is complete and RAOs have been met. Short-term effectiveness considerations include the effects of the alternatives during the construction and implementation period, the alternative's ability to meet RAOs, and the relative timeframe required to achieve RAOs. Long-term effectiveness considers the magnitude of the remaining residual risk because of residual contaminant sources, and the adequacy and reliability of specific technical components and control measures to maintain compliance with RAOs over the life of the remediation. Alternatives that do not meet the RAOs are eliminated from further consideration.

Implementability. Each alternative is also evaluated in terms of technical and administrative feasibility. In the assessment of short-term technical feasibility, availability of a technology for construction or mobilization and operation, as well as compliance with action-specific ARARs during the remedial action, are considered. Long-term technical feasibility considers the ease of operation and maintenance, technical reliability, the ease of undertaking additional remedial actions, and the degree of monitoring or controls for residuals and untreated wastes. Administrative feasibility for implementing a given technology addresses the ability to obtain approvals from pertinent offices and agencies for off-site activities, the availability of treatment storage and disposal services, and the commercial availability of required services and trained

specialists or operators. Alternatives that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable timeframe may be eliminated from further consideration (NCP, 40 CFR 300.430(e)(7)).

Costs. This criterion considers the costs of construction and long-term costs to operate and maintain the alternatives. As noted in USEPA guidance, the overall goal of the remedy selection process is to remediate contaminated sites to the maximum extent practicable, which requires a co-equal mandate for remedies to be cost-effective (USEPA, 1988b). Costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may also be eliminated (NCP, 40 CFR 300.430(e)(7)).

This section does not formally evaluate costs. Rather, based on knowledge of relative costs, professional judgment is used to identify the relative cost-effectiveness of each alternative. Detailed cost evaluations will be performed as part of the detailed evaluation of those alternatives passing the alternative screening process.

The No Action Alternative is not evaluated according to the screening criteria; it will pass through screening to be evaluated during the detailed analysis as a baseline for other retained alternatives (USEPA, 1988b). Actions taken to limit potential for exposure (e.g., institutional or engineering controls and monitoring) are identified as Limited Action alternatives in accordance with guidance (USEPA, 1998b page 4-7 footnote 5 and page C-6) and the NCP (USEPA, 1990).

4.2 Identification and Development of Alternatives

Based on the screening of technologies presented in Subsection 3.2 and **Tables 3.2-1 through 3.2-3**, the following is a summary of technologies and process options that have been retained for each of the RAOs for development of composite remedial alternatives.

<u>TMPs in Soil</u>

Alternative TMP-1: No Action
Alternative TMP-2: Limited Action and Vapor Barrier/Sub-Slab Depressurization System (SSDS)
Alternative TMP-3: AS/SVE

OU1/OU2 Sediment and EA5 Soil

Alternative SS-1: No Action
Alternative SS-2: Excavation, Stabilization, and Off-Site Disposal

South Ditch Surface Water

Alternative SW-1: No Action
Alternative SW-2: Limited Action
Alternative SW-3: In-situ Chemical Adsorption
Alternative SW-4: PRB Installation

4.2.1 Remedial Alternatives for Trimethylpentenes (TMPs) in Soil

This section summarizes the remedial alternatives for TMPs in soil.

4.2.1.1 Alternative TMP-1: No Action

The No Action Alternative does not include any remedial action components to reduce, control, or eliminate potential risks from exposure to contaminated soil or VI. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

4.2.1.2 Alternative TMP-2: Limited Action and Vapor Barrier/SSDS

As discussed previously, TMPs in soil are not associated with any current VI pathway, because VI dose not present a risk to occupants of existing buildings at the OCSS. However, TMPs in soil in the vicinity of Plant B could pose a potential VI risk for future building construction and occupancy.

This alternative would include modifying the existing deed covenant, which currently provides restrictions on future use and activities, to: 1) include language necessary to comply with USEPA's legal/enforcement requirements, and 2) include language to address potential VI concerns associated with future buildings that may be constructed on the Property and construction worker inhalation exposure. The limited action component would rely on effective engineering controls that are commonly employed to mitigate VI concerns and to mitigate future construction worker inhalation exposures during excavation activities (require health and safety plans). These engineering controls would include incorporating vapor barriers and/or SSDSs into the design and construction of future building foundations.

4.2.1.3 Alternative TMP-3: AS/SVE

This alternative would include installation of AS and SVE wells similar to the AS/SVE system previously installed in the vicinity of the former Plant B (EPH/VPH area) to treat vadose zone soils and soils within the capillary fringe impacted by TMPs. The AS/SVE system would be installed over the 23,000 square foot area in the vicinity of EA7 near Plant B and the 2,500 square foot area associated with Lake Poly (EA1) where elevated levels of TMPs have been detected in soil. The system would likely operate for up to five years consistent with the duration of operations at the former EPH/VPH area.

The area of TMPs in EA3 is located between the Property boundary and East Ditch within the MBTA right of way, which is not conducive to future building construction. Therefore, the EA3 TMP area is not proposed for AS/SVE.

4.2.2 Remedial Alternatives for OU1/OU2 Sediment and EA5 Soil

This section summarizes the remedial alternatives for OU1/OU2 sediment and EA5 soil.

4.2.2.1 Alternative SS-1: No Action

The No Action Alternative does not include any remedial action components to reduce, control, or eliminate potential risks from exposure to contaminated sediment or soil. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

4.2.2.2 Alternative SS-2: Excavation, Stabilization, and Off-Site Disposal

This alternative includes excavation and off-site disposal of Lower South Ditch sediment and EA5 surface soil. This is the same remediation method used during the 2000-2001 remediation of Upper South Ditch where sediments with elevated concentrations of chromium, other metals, and semi-volatile organic compounds were excavated and shipped off-site for disposal at a permitted disposal facility. The scope of the 2000-2001 remediation of Upper South Ditch is documented in the Part 2 Construction-Related Release Abatement Measure submitted to the MassDEP and subsequently approved by the MassDEP August 9, 2000. Some of the excavated material from Lower South Ditch and EA5 may contain chromium, which may require stabilization or solidification prior to disposal in order to meet the disposal facility's operating permit requirements. Excavation, stabilization as necessary, and off-site disposal are expected to take approximately two months to complete.

4.2.3 Remedial Alternatives for South Ditch Surface Water

This section summarizes the remedial alternatives for South Ditch surface water.

4.2.3.1 Alternative SW-1: No Action

The No Action Alternative does not include any remedial action components to reduce, control, or eliminate potential risks from exposure to contaminated surface water. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

4.2.3.2 Alternative SW-2: Limited Action

This alternative would include monitoring of South Ditch surface water and evaluation of the data collected. Current monitoring data indicates that the Site-specific PRGs for chromium and ammonia are currently being met. This is due in part to the combined effects of the Containment Area, and on-going extraction of DAPL in the off-PWD DAPL pool in reducing the mass flux of ammonia and chromium to overburden groundwater and geochemical transformation and precipitation of chromium. Based on the discussion of the sources of chromium and ammonia to groundwater presented in **Appendix A**, the decreasing pattern of ammonia and chromium concentrations in overburden groundwater and surface water is expected to stabilize and continue. The current data indicates potential for infrequent and sporadic fluctuations in concentrations above the site-specific PRG. Surface water monitoring would continue to demonstrate that South Ditch surface water quality continues to meet the site-specific surface water PRGs.

4.2.3.3 Alternative SW-3: In-situ Chemical Adsorption

This alternative would include construction and installation of a treatment barrier at a downstream location in South Ditch, near the Property boundary, to treat surface water such that concentrations of ammonia leaving South Ditch and entering East Ditch do not exceed the site-specific PRGs, and the ammonia remediation goal of 1.9 mg/L for the Halls Brook Holding Area (at the Holding Area). This barrier is proposed to consist of a combination of zeolite (hydrated aluminum-silicate minerals) and activated carbon to treat the elevated concentrations of ammonia and chromium in South Ditch surface water. Installation of the chemical adsorption barrier is expected to take one to two days to complete, and would likely be installed in conjunction with, and subsequent to, remediation of South Ditch sediment and EA5 soil, discussed previously. Once achievement of the Site-specific chromium PRG has been demonstrated, future renewal of the

treatment barrier would consist only of zeolite. The treatment barrier would continue to treat ammonia until such time in the future when it also can be discontinued.

4.2.3.4 Alternative SW-4: PRB Installation

This alternative would include construction of a PRB perpendicular to the direction of groundwater flow in the vicinity of the weir and along the length of South Ditch where contaminated groundwater flows laterally to and discharges to the ditch. Reactive materials for the PRB would consist of zeolites to treat ammonia and activated carbon to treat chromium. The PRB would be installed to the weathered bedrock surface and extend to ground surface.

4.3 Screening of Alternatives

During this step of the FS process, the alternatives that have been developed are screened against the effectiveness, implementability, and cost criteria as described in Subsection 4.1. The objective of the alternative screening step is to eliminate impractical or economically infeasible alternatives (i.e., order of magnitude cost differences when compared to return on investments) that provide little or no increase in effectiveness or implementability over their lower-cost counterparts. The alternatives retained during this step are then carried through a detailed evaluation.

4.3.1 Remedial Alternatives for TMPs in Soil

This section presents the screening of remedial alternatives for TMPs in soil.

4.3.1.1 Alternative TMP-1: No Action

The No Action Alternative does not include any remedial action components. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

4.3.1.2 Alternative TMP-2: Limited Action and Vapor Barrier/SSDS

This alternative consists of modifying the existing deed covenant to include language to address potential VI concerns associated with future buildings that may be constructed on the Property. This alternative also consists of engineering controls to include a vapor barrier and/or SSDS into the design and construction of future building foundations. The deed covenants would also include requirements for health & safety plans to mitigate potential inhalation exposures for construction workers during excavation activities.

This alternative would be effective by providing protection to occupants of future buildings that may be constructed in the area where elevated levels of TMPs have been detected. This alternative would also provide a reduction in the toxicity, mobility, or volume of contaminants. The components of this alternative are commonly used to address VI concerns and are readily implemented. This alternative would have a low relative cost. This alternative is retained for detailed analysis.

4.3.1.3 Alternative TMP-3: AS/SVE

This alternative includes installation and operation of an AS/SVE system installed in the approximately 23,000 square foot area in the vicinity of EA7 near Plant B and the 2,500 square foot area associated with Lake Poly (EA1) where elevated levels of TMPs have been detected in subsurface soil. As discussed in Section 4.2.1, an AS/SVE system is not proposed for EA3.

This alternative would be effective by providing a reduction in the toxicity, mobility, or volume of contaminants. The proposed AS/SVE system is similar to that previously installed in the EPH/VPH area to address soil at and near the water table impacted by TMPs. This alternative can be readily implemented and has a moderate relative cost. This alternative is retained for detailed analysis.

4.3.2 Remedial Alternatives for OU1/OU2 Sediment and EA5 Soil

This section presents the screening of remedial alternatives for OU1/OU2 sediment and EA5 soil.

4.3.2.1 Alternative SS-1: No Action

The No Action Alternative does not include any remedial action components. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

4.3.2.2 Alternative SS-2: Excavation, Stabilization, and Off-Site Disposal

This alternative includes excavation and off-site disposal of Lower South Ditch sediment and EA5 surface soil, which is the same remediation method used during the 2000-2001 remediation of impacted sediments in Upper South Ditch. Some of the excavated material may have chromium impacts and therefore may require stabilization or solidification prior to disposal in order to meet the disposal facility's operating permit requirements. The excavated sediment and soil would be dewatered and stabilized or solidified, as necessary, prior to disposal at an off-site facility. Stabilization/solidification would involve the addition of Portland cement or a similar additive/binder to immobilize the contaminants.

Excavation, dewatering, stabilization, and off-site disposal are commonly used technologies for soil and sediment remediation. This alternative would be effective at reducing risk to ecological receptors, as well as providing a reduction in toxicity, mobility, or volume of contaminants by removing the contaminated material from the OCSS. This alternative would be readily implemented and has a moderate cost. This alternative is retained for detailed analysis.

4.3.3 Remedial Alternatives for South Ditch Surface Water

This section presents the screening of remedial alternatives for South Ditch surface water.

4.3.3.1 Alternative SW-1: No Action

The No Action Alternative does not include any remedial action components. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

4.3.3.2 Alternative SW-2: Limited Action

Based on monitoring data presented in the SASRs, concentrations of ammonia and chromium in surface water have decreased over time since peak concentrations were observed in 2008/2009. This alternative includes long-term monitoring of South Ditch surface water to evaluate COC concentrations relative to the established PRGs. Monitoring would continue to demonstrate that South Ditch surface water quality continues to meet the site-specific surface water PRGs.

This alternative would be effective by continued monitoring of South Ditch surface water to verify that surface water PRGs continue to be met. This alternative can be readily implemented and has a low relative cost. This alternative is retained for detailed analysis.

4.3.3.3 Alternative SW-3: In-situ Chemical Adsorption

This alternative is similar to alternative SW-2 in that it acknowledges site-specific PRGs in South Ditch Surface water are currently being met and also includes long-term monitoring of South Ditch surface water to evaluate COC concentrations relative to the established PRGs. This alternative also eliminates South Ditch surface water as a contributing source of ammonia to the Halls Brook Holding Area, which is located downstream. This alternative would include construction and installation of a treatment barrier at a downstream location in South Ditch, near the Property boundary. This barrier is proposed to consist of a combination of zeolite and activated carbon to treat the elevated concentrations of ammonia and chromium in surface water leaving South Ditch.

This alternative would be effective by providing a reduction in the toxicity, mobility, or volume of contaminants. This alternative can be readily implemented and has a low to moderate relative cost. This alternative is retained for detailed analysis.

4.3.3.4 Alternative SW-4: PRB Installation

This alternative would include construction of a PRB perpendicular to groundwater flow in the vicinity of the weir and along the length of South Ditch where impacted groundwater discharges to the ditch. Reactive materials for the PRB would consist of zeolites (hydrated aluminum-silicate minerals) to treat ammonia and activated carbon to treat chromium.

This alternative would be effective at providing a reduction in toxicity, mobility, or volume of contaminants. This alternative would be readily implementable; however, construction of the PRB along a large, and possibly the entire, length of South Ditch would be destructive to the ecological habitat and would result in significant negative impacts to the wetlands in the vicinity of South Ditch. This alternative has a high relative cost, especially when compared to other remedial alternatives that involve treatment, such as in-situ chemical adsorption (Alternative SW-3). Therefore, this alternative is eliminated from further consideration.

4.3.4 Screening of Alternatives Conclusions

Based on the screening of remedial alternatives in Subsections 4.3.1 through 4.3.3, the following alternatives by media have been retained for detailed analysis.

<u>TMPs in Soil</u>

Alternative TMP-1: No Action
Alternative TMP-2: Limited Action and Vapor Barrier/SSDS
Alternative TMP-3: AS/SVE

<u>OU1/OU2 Sediment and EA5 Soil</u>

Alternative SS-1: No Action
Alternative SS-2: Excavation, Stabilization, and Off-Site Disposal

<u>South Ditch Surface Water</u>

Alternative SW-1: No Action
Alternative SW-2: Limited Action
Alternative SW-3: In-situ Chemical Adsorption

5.0 DETAILED ANALYSIS OF ALTERNATIVES

This section identifies the composite remedial alternatives and presents the detailed analysis of those composite remedial alternatives, followed by a comparative analysis of the alternatives.

Based on the media-specific alternatives that have been retained as described above, the following composite remedial alternatives have been developed for detailed analysis to address the scope of this FS which addresses: TMPs in OU1 soil; OU1/OU2 sediment and EA5 soil; and South Ditch surface water.

Alternative 1: No Action

Alternative 2: Limited Action and Vapor Barrier/SSDS for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and Limited Action for South Ditch Surface Water

Alternative 3: Limited Action and Vapor Barrier/SSDS for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and In-situ Chemical Adsorption for South Ditch Surface Water

Alternative 4: AS/SVE for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and Limited Action for South Ditch Surface Water

Alternative 5: AS/SVE for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and In-situ Chemical Adsorption for South Ditch Surface Water

The composite remedial alternatives are evaluated below with respect to nine CERCLA criteria:

1. Overall protection of human health and the environment
2. Compliance with ARARs
3. Short-term effectiveness
4. Long term effectiveness and permanence
5. Reduction of toxicity, mobility, or volume through treatment
6. Implementability
7. Cost
8. State acceptance
9. Community acceptance

The composite remedial alternatives were evaluated for the first seven criteria and then compared with one another to identify their respective strengths and weaknesses. Two criteria, state and community acceptance, were not evaluated because they will be based on comments received and addressed by USEPA during the Record of Decision process, which includes the public comment period for the Proposed Plan.

Cost estimates for the composite remedial alternatives were prepared using USEPA RI/FS guidance (USEPA, 1988b) and FS cost estimating guidance (USEPA, 2000). The cost estimates include capital costs (where appropriate) and operation and maintenance (O&M) costs. Both total cost and present worth costs are provided. An annual discount rate of 2.7 % was applied to calculate present worth.

5.1 Alternative 1: No Action

The No Action alternative does not include remedial action components to reduce, control, or eliminate potential risks from exposure to contaminants in soil, sediment, and surface water. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

5.1.1 Overall Protection of Human Health and the Environment

The No Action Alternative is not protective of human health or the environment because the existing restrictions on future use and activities would not be maintained, and monitoring would not be conducted to evaluate potential future impacts to human health and the environment.

5.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

The No Action Alternative does not comply with ARARs because without monitoring, achievement of RAOs will not be known.

5.1.3 Short-term Effectiveness

The No Action Alternative is not considered effective in the short-term because no actions are included to address potential risks to human health and the environment.

5.1.4 Long-term Effectiveness and Permanence

The No Action Alternative is not considered effective in the long term because no actions are included to address potential risks to human health and the environment, and no monitoring would be conducted to evaluate achievement of RAOs.

5.1.5 Reduction of Toxicity, Mobility, or Volume through Treatment

The No Action Alternative does not include any actions to treat or remove contamination in site media, and no monitoring would be conducted to evaluate any changes in contaminant toxicity, mobility, or volume.

5.1.6 Implementability

No measures are implemented as part of the No Action Alternative.

5.1.7 Cost

The No Action Alternative has no capital or maintenance costs.

5.2 Alternative 2: Limited Action and Vapor Barrier/SSDS for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and Limited Action for South Ditch Surface Water

The major components of Alternative 2 are as follows:

- Deed covenant modifications
- Vapor barrier/SSDS
- Pre-design investigations
- Temporary storm water control and diversion
- Excavation, stabilization, and off-site disposal
- Backfill and re-grading of soil and sediment remediation areas
- Wetland Restoration
- Environmental monitoring
- Five-year reviews

Deed covenant modifications. Deed covenants are currently in effect to provide restrictions on future activities and future use of the Property. As part of the limited action component of the alternative, the existing deed covenants would be modified to include language to address potential VI concerns associated with future buildings that may be constructed on the Property at locations where VI is a concern and confer rights for enforcement of such restrictions. This limited action component of the alternative would rely on effective engineering controls that are commonly employed to mitigate VI concerns. These engineering controls would include incorporating vapor barriers and/or SSDSs into the design and construction of future building

foundations. The deed covenants would also include requirements for health & safety plans to mitigate potential inhalation exposures for construction workers during excavation activities.

Vapor barrier/SSDS. As part of the deed covenant modifications, engineering controls in the form of vapor barriers and/or SSDSs would be required to be incorporated into the design and construction of future building foundations in the vicinity of EA7, EA3, and the Lake Poly area where elevated levels of TMPs have been detected in subsurface soil.

Final design requirements will depend on the size and type of the building to be constructed and will need to be determined if/when a building is proposed for the area. However, for the purpose of this FS, it is conservatively assumed that both a vapor barrier and an active SSDS would be necessary. It is also assumed that the footprint of the building would be equal to the full extent of EA7 – approximately 23,000 square feet. The extent of the vapor barrier and/or SSDS associated with EA3 and the Lake Poly area is approximately 5,000 square feet and 2,500 square feet, respectively, or a total area of approximately 30,500 square feet. Although the area of TMPs in EA3 is located between the Property boundary and East Ditch, and is not conducive to future building construction, this area is included for a vapor barrier and/or SSDS as a conservative approach in the context of this FS.

For the purposes of providing FS-level costing for this alternative we have assumed that the venting system will consist of collection piping or a collection geotextile laid into a layer of gravel. The collection vents are laid out in a grid over the surface area of the building foundation and connected to header pipes that vent the gasses outside the building footprint. A fabric or cushion layer would then be placed over the gravel/vent system to protect the vapor barrier from puncture. The vapor barrier would be laid next and can be applied as a sheet with seams sealed or as a spray-applied membrane. Another fabric or cushion layer would usually be placed on top of the barrier to protect it from puncture during foundation construction, and then the concrete foundation is installed on top of the system.

Pre-design investigations. Pre-design studies would consist of pre-excavation sampling in Lower South Ditch and EA5 to further refine the extent of COCs at concentrations above PRGs. The results of the study would be used to determine the excavation limits. By conducting the pre-excavation sampling, confirmation sampling would be eliminated.

At the same time, a pre-excavation wetland survey would be conducted to document the existing forested wetland characteristics, values, and functions. This would include documenting the type, age, density, and structure of vegetation present. Discussions will be held during this survey with the remediation contractor to determine what can reasonably be done to minimize impacts during

excavation. A restoration plan would subsequently be written and submitted to USEPA for approval.

Temporary storm water control and diversions. Temporary stormwater control measures, as needed, would be taken to temporarily divert surface water flow around sections of Lower South Ditch during sediment and soil remediation. The water in South Ditch would be temporarily diverted to facilitate sediment and soil removal in relatively dry conditions. Water diversion would be accomplished by using a temporary dam(s) to control the surface water flow, and temporary piping to divert the water flow around the proposed excavation area and discharge it just downstream of the proposed excavation area (a distance of approximately 400 feet). The temporary diversion structure(s) and piping would be removed at the completion of the remedial action and stream flow would resume in Lower South Ditch.

Excavation, stabilization, and off-site disposal of contaminated Lower South Ditch sediment and EA5 surface soil. This is the same remediation method used during the 2000-2001 remediation of sediments in the Upper South Ditch, on-PWD, on-PWD Wetland, and Central Pond.

As discussed in Section 2.3.3, the volume of South Ditch sediment and EA5 surface soil at concentrations exceeding the ecological PRGs for chromium and BEHP (HQ of 1) is approximately 15,800 cubic feet, or approximately 590 cubic yards.

The proposed remediation area includes the portion of Lower South Ditch from where the 2000 – 2001 sediment remediation ended, and continues downstream to the confluence with the Ephemeral Drainage and eventually to East Ditch, limited in distance by a buffer for the MBTA right of way. Access to the contaminated sediments in Lower South Ditch will be via the existing access road entrance near GW-79S, and will follow the original haul road access that was constructed and used during the 2000 – 2001 sediment remediation project, and continue downstream to the Property boundary and eventually close to East Ditch.

The contaminated sediment and soil will be excavated using low ground pressure soft terrain earthmoving equipment and loaded directly into trucks and transported to a staging area in the former plant site. The staging area will include a temporary containment berm for dewatering of the sediment if necessary for transportation or disposal purposes, as well as stabilization of the sediment if needed due to physical characteristics or if pre-design investigation results indicate the excavated material is characterized as a hazardous waste. Stabilization would be accomplished by the addition of Portland cement or other suitable binding agent. The stabilized sediment and soil will be loaded to containers for shipment from the site to a permitted disposal facility that Olin has approved as part of its Waste Management Unit policies and procedures. The

excavated soil and sediment are anticipated to exhibit elevated concentrations of chromium and BEHP. Based on chromium concentrations detected in soil and sediment in the areas proposed to be remediated, a portion of the excavated soil might be classified as a characteristic hazardous waste (e.g., chromium concentrations exceeding regulatory criteria based on the toxicity characteristic leaching procedure). Excavated soils will be segregated appropriately to minimize the amount of hazardous waste to be disposed of.

As discussed previously, pre-excavation sampling and analysis would be conducted to refine the extent of the remediation area. The excavation would then be completed to these limits. Because the excavation area would be pre-characterized, confirmation sampling would not be conducted in the completed excavation area.

Backfill and re-grading of the Lower South Ditch and EA5 soil remediation areas and wetland restoration. The excavation areas would be backfilled with off-site borrow material that is verified to be non-contaminated at concentrations that exceed Regional Screening Levels by off-site analytical results. The excavation areas would be backfilled to generally match pre-excavation conditions, using granular soil material within the stream channel, and dressed with an organic top soil and an erosion control mix in adjacent forested wetland area. Temporary erosion controls best management practices will be instituted until such time as natural systems recover which should be within a season or two given the small area involved and the minimal disturbance in the surrounding ecological system. Re-vegetation of the excavated area would be performed in accordance with the wetland restoration plan. Best management practices to control erosion and sedimentation would be maintained until permanent erosion control is reestablished. Post-remediation monitoring will be conducted to evaluate the recovery of the ecological environment associated with these remediation areas as part of the environmental monitoring and site inspection component of the alternative, discussed below.

Environmental monitoring and site inspections. As part of the limited action component of the alternative, monitoring of South Ditch surface water would be conducted on a semi-annual basis to verify that concentrations of chromium and ammonia remain below the site-specific surface water PRGs. Toxicity testing of South Ditch surface water would also be conducted to demonstrate achievement of the surface water RAO. The monitoring results and evaluation of the data will be documented in SASRs that are submitted to the USEPA. For cost estimating purposes to support this FS, semi-annual surface water monitoring of South Ditch has been assumed for 30 years.

As discussed previously, pre-excavation sampling and analysis would be conducted to refine the extent of the remediation area. The excavation would then be completed to these limits. Because

the excavation area would be pre-characterized, confirmation sampling would not be conducted in the completed excavation area. Post-excavation toxicity testing of South Ditch sediment and EA5 soil would be conducted to demonstrate achievement of the RAO.

Periodic inspections would be conducted throughout the remediation area of Lower South Ditch and EA5 to monitor and evaluate the recovery of the ecological environment associated with these areas of the OCSS. It is assumed that these inspections would be conducted monthly for the first six months, and semi-annual thereafter until recovery has been established (1-2 years). These periodic inspections would be documented in routine reporting submitted to the USEPA. For cost estimating purposes to support this FS, periodic inspections would then occur every five years consistent with the five-year review cycle and have been assumed for 30 years.

Five-year reviews. CERCLA requires that any remedial action that results in contaminants remaining on-site at concentrations above those allowing unlimited exposure and unrestricted use must be reviewed at least every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. For cost estimating purposes to support this FS, five-year site reviews have been assumed for 30 years.

5.2.1 Overall Protection of Human Health and the Environment

This alternative would be protective of human health and the environment by removing EA5 surface soil and Lower South Ditch sediment with chromium and BEHP concentrations above the site-specific PRGs and conducting post-excavation toxicity testing to demonstrate achievement of the RAO. Surface water monitoring in South Ditch would continue to provide data to evaluate and verify that surface water concentrations remain below the established site-specific ecological PRGs. Toxicity testing would be conducted to demonstrate achievement of the surface water RAO. TMPs in soil are not associated with any current VI pathway, because VI does not present a risk to occupants of existing buildings. Modifying the existing deed covenant to include language to address potential VI concerns associated with future buildings that may be constructed on the Property and incorporating engineering controls, such as vapor barriers and/or SSDSs, into the design and construction of future building foundations would be protective of potential future building occupants, as well as addressing construction worker health and safety plan requirements. Language would be provided such that these provisions are enforceable.

5.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

This alternative would comply with ARARs that are identified in **Tables 5.2-1 through 5.2-3**.

This alternative would be designed and implemented to minimize potential impacts to adjacent floodplain or wetland areas. Restoration activities would be implemented to comply with the identified location-specific ARARs.

Site-specific PRGs have been developed to comply with the identified chemical-specific ARARs, including NRWQC for South Ditch surface water. This alternative would remove EA5 surface soil and Lower South Ditch sediment to achieve the site-specific PRGs that have been developed and meet the toxicity testing requirements of the RAO. South Ditch surface water would continue to be monitored to verify compliance with site-specific PRGs and meet the toxicity testing requirements of the RAO.

Engineering controls to address potential VI concerns in future buildings that may be constructed at the Site would be designed and constructed to comply with the identified action-specific ARARs, such as USEPA's *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*. Engineering controls would also be employed to comply with RCRA standards applicable to generation, transportation, and storage of hazardous waste, as well as federal and state solid waste disposal regulations.

5.2.3 Short-term Effectiveness

This alternative includes limited action for TMPs in soil, excavation and off-site disposal of EA5 surface soil and Lower South Ditch sediment, and continued monitoring of South Ditch surface water. This alternative would be protective of human health and the environment upon completion of the active, construction-related activities associated with this remedy. Potential short-term risks to on-site workers involved in the remedial activities would be minimized by conducting the work in accordance with a site-specific health and safety plan.

5.2.4 Long-term Effectiveness and Permanence

This alternative provides long-term effectiveness by permanently removing EA5 surface soil and Lower South Ditch sediment with COC concentrations above the site-specific PRGs and continued monitoring of South Ditch surface water to verify surface water concentrations remain below PRGs. Toxicity testing would also be conducted for sediment and surface water associated with South Ditch to demonstrate achievement of the RAOs. Long-term effectiveness is also provided by modifying the deed covenants to include language to address potential VI concerns associated

with future buildings that may be constructed on the Property and incorporating engineering controls, such as vapor barriers and/or SSDSs, into the design and construction of future building foundations. Language would be provided such that these provisions are enforceable.

5.2.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Removal of EA5 surface soil and Lower South Ditch sediment to achieve PRGs would reduce the toxicity and mobility of contaminants at the OCSS. Excavated soil and sediment that may be characterized as hazardous waste would be treated by stabilization prior to off-site disposal.

Engineering controls, such as vapor barriers and/or SSDSs, would reduce the toxicity, mobility, or volume of TMPs in the vicinity of Plant B where elevated levels of TMPs have been detected in subsurface soil.

5.2.6 Implementability

The major components of this alternative are deed covenant modifications and engineering controls to address potential VI concerns associated with future buildings that may be constructed, excavation and off-site disposal of soil and sediment, and continued monitoring of South Ditch surface water. The technologies used for this alternative are available and sufficiently demonstrated for use at the site. The necessary equipment and materials are readily available.

5.2.7 Cost

The cost estimate for this alternative is presented in **Table 5.2-4** and includes:

- Deed covenant modifications
- Vapor barrier/SSDS
- Pre-design investigations
- Temporary storm water control and diversion
- Excavation, stabilization, and off-site disposal
- Backfill and re-grading of soil and sediment remediation areas
- Wetland restoration
- Environmental monitoring
- Five-year reviews

Assuming remedial activities can be conducted simultaneously as much as possible, the overall estimated duration to complete this alternative is approximately 3 months.

Unit cost estimates for storm water diversion, excavation, off-site disposal, backfill, and regrading were provided by environmental remediation contractors. Cost estimates for environmental monitoring, inspections, and reporting are based on costs for similar projects.

The capital costs for Alternative 2 are estimated to be approximately $1,021,425. The total cost for Alternative 2 is estimated to be $1,431,000. The total present worth for Alternative 2 is $1,295,000.

5.3 Alternative 3: Limited Action and Vapor Barrier/SSDS for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and In-situ Chemical Adsorption for South Ditch Surface Water

The major components of Alternative 3 are as follows:

- Deed covenant modifications
- Vapor barrier/SSDS
- Pre-design investigations
- Temporary storm water control and diversion
- Excavation, stabilization, and off-site disposal
- Backfill and re-grading of soil and sediment remediation areas
- Wetland Restoration
- In-situ chemical adsorption for South Ditch surface water
- Environmental monitoring
- Long-term O&M
- Five-year reviews

Deed covenant modifications. Modifications to the existing Deed covenants would be made as described for Alternative 2 to address potential VI concerns associated with future buildings that may be constructed on the Property. The deed covenants would also include requirements for health & safety plans to mitigate potential inhalation exposures for construction workers during excavation activities.

Vapor barrier/SSDS. As part of the deed covenant modifications, engineering controls in the form of vapor barriers and/or SSDSs would be required to be incorporated into the design and construction of future building foundations in the vicinity of EA7, EA3, and Lake Poly area where elevated levels of TMPs have been detected in subsurface soil. Details of this component of the alternative are the same as described for Alternative 2.

Pre-design investigations. Pre-design studies would consist of pre-excavation sampling in Lower South Ditch and EA5 to further refine the extent of COCs at concentrations above PRGs. A pre-excavation wetland survey would be conducted to document the existing forested wetland characteristics, values, and functions in support of development of a restoration plan to be written and submitted to USEPA for approval.

Temporary storm water control and diversions. Temporary stormwater control measures will be necessary to temporarily divert surface water flow in around sections of Lower South Ditch during remediation. Details of this component of the alternative are the same as described for Alternative 2.

Excavation, stabilization, and off-site disposal of contaminated Lower South Ditch sediment and EA5 surface soil. The excavation, stabilization, and off-site disposal components of the alternative are the same as described for Alternative 2.

Backfill and re-grading of the Lower South Ditch and EA5 soil remediation areas and wetland restoration. The backfilling, re-grading, and re-vegetation components of this alternative are the same as described for Alternative 2.

Installation of chemical adsorption barrier in South Ditch. A treatment barrier would be constructed and installed at a downstream location in South Ditch, near the Property boundary, to treat surface water such that concentrations of chromium and ammonia exiting South Ditch and entering East Ditch do not exceed the site-specific PRGs. This should have a positive effect on surface water quality exiting South Ditch and entering the East Ditch and help support, by improving East Ditch water quality, USEPA's objective of achieving a surface water cleanup criterion of 1.9 mg/L for ammonia (at pH of 7 and temperature of 20 degrees Celsius) at the Halls Brook Holding Area Pond for the Industri-Plex Superfund Site, which is located downstream of the OCSS and downstream of the confluence of Landfill Brook.

The proposed treatment barrier consists of gabion basket-type units filled with a combination of zeolite and activated carbon to treat the current concentrations of ammonia and chromium in South Ditch surface water. Installation of the chemical adsorption barriers would be completed in conjunction with, and following, the sediment remediation component of the alternative. The adsorbent material would require periodic replacement, and the spent adsorbent materials would be shipped off-site to a facility permitted to accept this type of waste material. A shallow concrete structure would be installed across the stream bed of South Ditch at the location as a "cradle" to hold the treatment gabions. This would allow periodic replacement of the treatment baskets with

very little disturbance to the ecological habitat during replacement and O&M activities, which are discussed below.

Environmental monitoring and site inspections. The environmental monitoring and site inspection components of this alternative are the same as for Alternative 2.

Long-term O&M. This alternative would include long-term O&M of the gabion basket treatment barrier in Lower South Ditch. For cost estimating purposes for this FS, the gabion baskets with treatment media would be replaced every five years.

Five-year reviews. CERCLA five-year reviews would be conducted as described for Alternative 2.

5.3.1 Overall Protection of Human Health and the Environment

This alternative would be protective of human health and the environment by removing EA5 surface soil and Lower South Ditch sediment with chromium and BEHP concentrations above the site-specific PRGs and conducting post-excavation toxicity testing to demonstrate achievement of the RAO. TMPs in soil are not associated with any current VI pathway, because VI dose not present a risk to occupants of existing buildings. Modifying the existing deed covenant to include language to address potential VI concerns associated with future buildings that may be constructed on the Property and incorporating engineering controls, such as vapor barriers and/or SSDSs, into the design and construction of future building foundations would be protective of potential future building occupants, as well as addressing construction worker health and safety plan requirements. Language would be provided such that these provisions are enforceable.

Concentrations of chromium and ammonia in South Ditch surface water are currently below the site-specific ecological PRGs. Installation of a chemical adsorption barrier at a downstream location in South Ditch, near the Property boundary, would treat surface water such that concentrations of chromium and ammonia entering East Ditch do not exceed the site-specific PRGs. This should have a positive effect on surface water quality exiting South Ditch and entering the East Ditch and help support, by improving East Ditch water quality, USEPA's objective of achieving a surface water cleanup criterion of 1.9 mg/L for ammonia (at pH of 7 and temperature of 20 degrees Celsius) at the Halls Brook Holding Area Pond for the Industri-Plex Superfund Site, which is located downstream of the OCSS and downstream of the confluence of Landfill Brook.

5.3.2 Compliance with Applicable or Relevant and Appropriate Requirements

This alternative would comply with ARARs that are identified in **Tables 5.3-1 through 5.3-3**.

This alternative would be designed and implemented to minimize potential impacts to adjacent floodplain or wetland areas. Restoration activities would be implemented to comply with the identified location-specific ARARs.

Site-specific PRGs have been developed to comply with the identified chemical-specific ARARs, including NRWQC for South Ditch surface water. This alternative would remove EA5 surface soil and Lower South Ditch sediment to achieve the site-specific PRGs that have been developed and meet the toxicity testing requirements in the RAO. South Ditch surface water would continue to be monitored to verify compliance with site-specific PRGs and meet the toxicity testing requirements of the RAO.

Engineering controls to address potential VI concerns in future buildings that may be constructed at the Site would be designed and constructed to comply with the identified action-specific ARARs, such as USEPA's *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*. Engineering controls would also be employed to comply with RCRA standards applicable to generation, transportation, and storage of hazardous waste, as well as federal and state solid waste disposal regulations.

5.3.3 Short-term Effectiveness

This alternative includes limited action for TMPs in soil, excavation and off-site disposal of EA5 surface soil and Lower South Ditch sediment, and installation of a chemical adsorption barrier in Lower South Ditch to treat surface water prior to discharge to East Ditch. This alternative would be protective of human health and the environment upon completion of the active, construction-related activities associated with this remedy. Potential short-term risks to on-site workers involved in the remedial activities would be minimized by conducting the work in accordance with a site-specific health and safety plan.

5.3.4 Long-term Effectiveness and Permanence

This alternative provides long-term effectiveness by permanently removing EA5 surface soil and Lower South Ditch sediment with COC concentrations above the site-specific PRGs and treating Lower South Ditch surface water to continue to achieve PRGs in surface water prior to discharge to East Ditch. Toxicity testing would also be conducted for sediment and surface water associated with South Ditch to demonstrate achievement of the RAOs. Long-term effectiveness is also provided by modifying the deed covenants to include language to address potential VI concerns associated with future buildings that may be constructed on the Property and incorporating engineering controls, such as vapor barriers and/or SSDSs, into the design and construction of

future building foundations as well as addressing construction worker health and safety plan requirements. These provisions would be enforceable.

5.3.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Removal of EA5 surface soil and Lower South Ditch sediment to achieve PRGs would reduce the toxicity and mobility of contaminants at the OCSS. Excavated soil and sediment that may be characterized as hazardous waste would be treated by stabilization prior to off-site disposal.

Engineering controls, such as vapor barriers and/or SSDSs, would reduce the toxicity, mobility, or volume of TMPs in the vicinity of Plant B where elevated levels of TMPs have been detected in subsurface soil.

Treatment of Lower South Ditch surface water would reduce the toxicity, mobility, or volume of Site-related COCs in surface water, and help support USEPA's objective of achieving a surface water cleanup criterion of 1.9 mg/L for ammonia (at pH of 7 and temperature of 20 degrees Celsius) at the Halls Brook Holding Area Pond for the Industri-Plex Superfund Site, which is located downgradient of the OCSS and downgradient of the confluence of Landfill Brook.

5.3.6 Implementability

The major components of this alternative are deed covenant modifications and engineering controls to address potential VI concerns associated with future buildings that may be constructed, excavation and off-site disposal of soil and sediment, and installation of a chemical adsorption barrier to treat surface water in Lower South Ditch. The technologies used for this alternative are available and sufficiently demonstrated for use at the site. The necessary equipment and materials are readily available.

5.3.7 Cost

The cost estimate for this alternative is presented in **Table 5.3-4** and includes:

- Deed covenant modifications
- Vapor barrier/SSDS
- Pre-design investigations
- Temporary storm water control and diversion
- Excavation, stabilization, and off-site disposal
- Backfill and re-grading of soil and sediment remediation areas
- Wetland restoration

- In-situ chemical adsorption for South Ditch surface water
- Environmental monitoring
- Long-term O&M
- Five-year reviews

Assuming remedial activities can be conducted simultaneously as much as possible, the overall estimated duration to complete this alternative is approximately 3 months.

Unit cost estimates for storm water diversion, excavation, off-site disposal, backfill, and regrading were provided by environmental remediation contractors. Cost estimates for environmental monitoring, inspections, and reporting are based on costs for similar projects.

The capital costs for Alternative 3 are estimated to be approximately $1,028,405. The total cost for Alternative 3 is estimated to be $1,455,000. The total present worth for Alternative 3 is $1,312,000.

5.4 Alternative 4: AS/SVE for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and Limited Action for South Ditch Surface Water

The major components of Alternative 4 are as follows:

- Installation of AS/SVE system
- Pre-design investigations
- Temporary storm water control and diversion
- Excavation, stabilization, and off-site disposal
- Backfill and re-grading of soil and sediment remediation areas
- Wetland Restoration
- Environmental monitoring
- Long-term O&M
- Five-year reviews

Installation of AS/SVE system. An AS/SVE system would be installed in the former Plant B area and to the northeast (EA7) where elevated levels of TMPs have been detected in subsurface soil. It is assumed that some of the previous AS/SVE equipment used at the site could be repurposed. The AS/SVE system would cover an area of approximately 23,000 square feet at EA7 and 2,500 square feet at Lake Poly (EA1). Twenty AS wells and 40 SVE wells would be installed at EA7 and two AS and four SVE wells would be installed at Lake Poly (EA1). Some system components would

be upgraded, and new piping and instrumentation would be installed. The AS/SVE system would operate for up to 5 years.

Pre-design investigations. Pre-design studies would consist of pre-excavation sampling in Lower South Ditch and EA5 to further refine the extent of COCs at concentrations above PRGs. The results of the study would be used to determine the excavation limits. A pre-excavation wetland survey would be conducted to document the existing forested wetland characteristics, values, and functions in support of development of a restoration plan.

Temporary storm water control and diversions. Temporary stormwater control measures will be necessary to temporarily divert surface water flow in around sections of Lower South Ditch during remediation. Details of this component of the alternative are the same as described for Alternative 2.

Excavation, stabilization, and off-site disposal of contaminated Lower South Ditch sediment and EA5 surface soil. The excavation, stabilization, and off-site disposal components of the alternative are the same as described for Alternative 2.

Backfill and re-grading of the Lower South Ditch and EA5 soil remediation areas and wetland restoration. The backfilling, re-grading, and re-vegetation components of this alternative are the same as described for Alternative 2.

Environmental monitoring and site inspections. The environmental monitoring and site inspection components of this alternative are the same as for Alternative 2.

Long-term O&M. This alternative would include long-term O&M of the AS/SVE system, which is anticipated to continue for up to five years. O&M is assumed to consist of one operator at a rate of 8 hours per week.

Five-year reviews. CERCLA five-year reviews would be conducted as described for Alternative 2.

5.4.1 Overall Protection of Human Health and the Environment

This alternative would be protective of human health and the environment by installing an AS/SVE system to treat TMPs in subsurface soil to prevent potential VI concerns associated with future buildings that may be constructed in the vicinity of EA7 and Lake Poly (EA1), as well as addressing construction worker health and safety plan requirements. This alternative would also be protective of human health and the environment by removing EA5 surface soil and Lower South Ditch sediment with chromium and BEHP concentrations above the site-specific PRGs and conducting

post-excavation toxicity testing to demonstrate achievement of the RAO. Surface water monitoring in South Ditch would continue to provide data to evaluate and verify that surface water concentrations remain below the established site-specific ecological PRGs and the toxicity testing requirements of the RAO.

5.4.2 Compliance with Applicable or Relevant and Appropriate Requirements

This alternative would comply with ARARs that are identified in **Tables 5.4-1 through 5.4-3**.

This alternative would be designed and implemented to minimize potential impacts to adjacent floodplain or wetland areas. Restoration activities would be implemented to comply with the identified location-specific ARARs.

Site-specific PRGs have been developed to comply with the identified chemical-specific ARARs, including NRWQC for South Ditch surface water. This alternative would remove EA5 surface soil and Lower South Ditch sediment to achieve the site-specific risk-based PRGs that have been developed and meet the toxicity testing requirements of the RAO. South Ditch surface water would continue to be monitored to verify compliance with site-specific PRGs and the risk-based toxicity testing requirements of the RAO.

The AS/SVE system to address potential VI concerns in future buildings that may be constructed at the Site would be designed and constructed to comply with the identified action-specific ARARs, such as USEPA's *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*. The system would also be designed to eliminate or mitigate the potential construction worker inhalation exposure to TMPs during future excavation activities. Engineering controls would be employed to comply with RCRA standards applicable to generation, transportation, and storage of hazardous waste, as well as federal and state solid waste disposal regulations.

5.4.3 Short-term Effectiveness

This alternative includes installation of an AS/SVE system for TMPs in soil, excavation and off-site disposal of EA5 surface soil and Lower South Ditch sediment, and continued monitoring of South Ditch surface water. This alternative would be protective of human health and the environment upon completion of the active, construction-related activities associated with this remedy. Potential short-term risks to on-site workers involved in the remedial activities would be minimized by conducting the work in accordance with a site-specific health and safety plan.

5.4.4 Long-term Effectiveness and Permanence

This alternative provides long-term effectiveness by permanently removing EA5 surface soil and Lower South Ditch sediment with COC concentrations above the site-specific PRGs and meeting toxicity testing requirements for sediment and continued monitoring of South Ditch surface water to verify surface water concentrations remain below PRGs and that toxicity testing requirements are met. Long-term effectiveness is also provided by installation and operation of an AS/SVE system to address potential VI concerns associated with future buildings that may be constructed on the Property as well as construction worker inhalation exposure.

5.4.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Removal of EA5 surface soil and Lower South Ditch sediment to achieve PRGs would reduce the toxicity and mobility of contaminants at the OCSS. Excavated soil and sediment that may be characterized as hazardous waste would be treated by stabilization prior to off-site disposal.

Installation and operation of an AS/SVE system would reduce the toxicity, mobility, or volume of TMPs in the vicinity of EA7 and Lake Poly (EA1) where elevated levels of TMPs have been detected in subsurface soil.

5.4.6 Implementability

The major components of this alternative are installation and operation of an AS/SVE system to address potential VI concerns associated with future buildings that may be constructed, excavation and off-site disposal of soil and sediment, and continued monitoring of South Ditch surface water. The technologies used for this alternative are available and sufficiently demonstrated for use at the site. The necessary equipment and materials are readily available.

5.4.7 Cost

The cost estimate for this alternative is presented in **Table 5.4-4** and includes:

- Installation of AS/SVE system
- Pre-design investigations
- Temporary storm water control and diversion
- Excavation, stabilization, and off-site disposal
- Backfill and re-grading of soil and sediment remediation areas
- Wetland restoration
- Environmental monitoring

- Long-term O&M
- Five-year reviews

Assuming remedial activities can be conducted simultaneously as much as possible, the overall estimated duration to complete this alternative is approximately 6 months.

Unit cost estimates for storm water diversion, excavation, off-site disposal, backfill, and regrading were provided by environmental remediation contractors. Cost estimates for environmental monitoring, inspections, and reporting are based on costs for similar projects.

The capital costs for Alternative 4 are estimated to be approximately $1,454,908. The total cost for Alternative 4 is estimated to be $2,040,000. The total present worth for Alternative 4 is $1,889,000.

5.5 Alternative 5: AS/SVE for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and In-situ Chemical Adsorption for South Ditch Surface Water

The major components of Alternative 5 are as follows:

- Installation of AS/SVE system
- Pre-design investigations
- Temporary storm water control and diversion
- Excavation, stabilization, and off-site disposal
- Backfill and re-grading of soil and sediment remediation areas
- Wetland restoration
- In-situ chemical adsorption for South Ditch surface water
- Environmental monitoring
- Long-term O&M
- Five-year reviews

Installation of AS/SVE system. An AS/SVE system would be installed in EA7 and Lake Poly (EA1) to address elevated levels of TMPs in subsurface soil as described for Alternative 4.

Pre-design investigations. Pre-design studies would consist of pre-excavation sampling in Lower South Ditch and EA5 to further refine the extent of COCs at concentrations above PRGs. The results of the study would be used to determine the excavation limits. A pre-excavation wetland survey would be conducted to document the existing forested wetland characteristics, values, and functions in support of development of a restoration plan.

Temporary storm water control and diversions. Temporary stormwater control measures will be necessary to temporarily divert surface water flow in around sections of Lower South Ditch during remediation. Details of this component of the alternative are the same as described for Alternative 2.

Excavation, stabilization, and off-site disposal of contaminated Lower South Ditch sediment and EA5 surface soil. The excavation, stabilization, and off-site disposal components of the alternative are the same as described for Alternative 2.

Backfill and re-grading of the Lower South Ditch and EA5 soil remediation areas and wetland restoration. The backfilling, re-grading, and re-vegetation components of this alternative are the same as described for Alternative 2.

Installation of chemical adsorption barrier in South Ditch. A treatment barrier would be constructed and installed at a downstream location in South Ditch, near the Property boundary, to treat surface water such that concentrations of chromium and ammonia entering East Ditch do not exceed the site-specific PRGs. This component of the alternative is the same as described for Alternative 3.

Environmental monitoring and site inspections. The environmental monitoring and site inspection components of this alternative are the same as for Alternative 2.

Long-term O&M. This alternative would include long-term O&M of the gabion basket treatment barrier in Lower South Ditch as described for Alternative 3 and O&M of the AS/SVE system as described for Alternative 4.

Five-year reviews. CERCLA five-year reviews would be conducted as described for Alternative 2.

5.5.1 Overall Protection of Human Health and the Environment

This alternative would be protective of human health and the environment by installing an AS/SVE system to treat TMPs in subsurface soil to prevent potential VI concerns associated with future buildings that may be constructed in the vicinity of EA7 and Lake Poly EA1) and to eliminate or mitigate future construction worker inhalation exposure to TMPs during excavation activities. This alternative would also be protective of human health and the environment by removing EA5 surface soil and Lower South Ditch sediment with chromium and BEHP concentrations above the site-specific PRGs and meeting toxicity testing requirements for sediment specified in the RAO. Concentrations of chromium and ammonia in South Ditch are currently below the site-specific ecological PRGs. Installation of a chemical adsorption barrier at a downstream location in South

Ditch, near the Property boundary, would treat surface water such that concentrations of chromium and ammonia entering East Ditch do not exceed the site-specific PRGs and the toxicity testing requirements of the RAO. This should have a positive effect on surface water quality exiting South Ditch and entering the East Ditch and help support, by improving East Ditch water quality, USEPA's objective of achieving a surface water cleanup criterion of 1.9 mg/L for ammonia (at pH of 7 and temperature of 20 degrees Celsius) at the Halls Brook Holding Area Pond for the Industri-Plex Superfund Site, which is located downstream of the OCSS and downstream of the confluence of Landfill Brook.

5.5.2 Compliance with Applicable or Relevant and Appropriate Requirements

This alternative would comply with ARARs that are identified in **Tables 5.5-1 through 5.5-3**.

This alternative would be designed and implemented to minimize potential impacts to adjacent floodplain or wetland areas. Restoration activities would be implemented to comply with the identified location-specific ARARs.

Site-specific PRGs have been developed to comply with the identified chemical-specific ARARs, including NRWQC for South Ditch surface water. This alternative would remove EA5 surface soil and Lower South Ditch sediment to achieve the site-specific risk-based PRGs that have been developed as well as the toxicity testing requirement of the RAO. South Ditch surface water would be monitored to verify compliance with site-specific ARARs-based PRGs and meet the toxicity testing requirements of the RAO.

The AS/SVE system to address potential VI concerns in future buildings that may be constructed at the Site would be designed and constructed to comply with the identified action-specific ARARs, such as USEPA's *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*. The system would also be designed to eliminate or mitigate the potential construction worker inhalation exposure to TMPs during future excavation activities. Engineering controls would be employed to comply with RCRA standards applicable to generation, transportation, and storage of hazardous waste, as well as federal and state solid waste disposal regulations.

5.5.3 Short-term Effectiveness

This alternative includes installation of an AS/SVE system for TMPs in soil, excavation and off-site disposal of EA5 surface soil and Lower South Ditch sediment, and installation of a chemical adsorption barrier in Lower South Ditch to treat surface water prior to discharge to East Ditch. This alternative would be protective of human health and the environment upon completion of

the active, construction-related activities associated with this remedy. Potential short-term risks to on-site workers involved in the remedial activities would be minimized by conducting the work in accordance with a site-specific health and safety plan.

5.5.4 Long-term Effectiveness and Permanence

This alternative provides long-term effectiveness by permanently removing EA5 surface soil and Lower South Ditch sediment with COC concentrations above the site-specific PRGs and treating Lower South Ditch surface water to continue to achieve PRGs in surface water prior to discharge to East Ditch, as well as conducting toxicity testing to demonstrate achievement of sediment and surface water RAOs. Long-term effectiveness is also provided by installation and operation of an AS/SVE system to address potential VI concerns associated with future buildings that may be constructed on the Property as well as potential future construction worker inhalation exposure to TMPs during excavation activities.

5.5.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Installation and operation of an AS/SVE system would reduce the toxicity, mobility, or volume of TMPs in the vicinity EA7 and Lake Poly (EA1) where elevated levels of TMPs have been detected in subsurface soil.

Removal of EA5 surface soil and Lower South Ditch sediment to achieve PRGs would reduce the toxicity and mobility of contaminants at the OCSS. Excavated soil and sediment that may be characterized as hazardous waste would be treated by stabilization prior to off-site disposal.

Treatment of Lower South Ditch surface water would reduce the toxicity, mobility, or volume of Site-related COCs in surface water, and help support USEPA's objective of achieving a surface water cleanup criterion of 1.9 mg/L for ammonia (at pH of 7 and temperature of 20 degrees Celsius) at the Halls Brook Holding Area Pond for the Industri-Plex Superfund Site, which is located downstream of the OCSS and downstream of the confluence of Landfill Brook.

5.5.6 Implementability

The major components of this alternative are installation and operation of an AS/SVE system to address potential VI concerns associated with future buildings that may be constructed, excavation and off-site disposal of soil and sediment, and installation of a chemical adsorption barrier to treat surface water in Lower South Ditch. The technologies used for this alternative are available and sufficiently demonstrated for use at the site. The necessary equipment and materials are readily available.

5.5.7 Cost

The cost estimate for this alternative is presented in **Table 5.5-4** and includes:

- Installation of AS/SVE system
- Pre-design investigations
- Temporary storm water control and diversion
- Excavation, stabilization, and off-site disposal
- Backfill and re-grading of soil and sediment remediation areas
- Wetland Restoration
- In-situ chemical adsorption for South Ditch surface water
- Environmental monitoring
- Long-term O&M
- Five-year reviews

Assuming remedial activities can be conducted simultaneously as much as possible, the overall estimated duration to complete this alternative is approximately 6 months.

Unit cost estimates for storm water diversion, excavation, off-site disposal, backfill, and regrading were provided by environmental remediation contractors. Cost estimates for environmental monitoring, inspections, and reporting are based on costs for similar projects.

The capital costs for Alternative 5 are estimated to be approximately $1,465,788. The total cost for Alternative 5 is estimated to be $2,067,000. The total present worth for Alternative 5 is $1,911,000.

5.6 Comparative Analysis of Alternatives

Table 5.6-1 summarizes the comparative analysis of remedial alternatives. The alternatives are compared to one another by the evaluation criteria in the subsections presented in the following subsections.

5.6.1 Overall Protection of Human Health and the Environment

Alternative 1, No Action, is not protective of human health and the environment because it leaves contaminated soil and sediment in place without controls to prevent exposure. Alternative 1 is also not protective because it does not provide any monitoring or treatment of South Ditch surface water, nor does it include any actions to minimize or reduce potential VI concerns for

occupants of potential future buildings that may be constructed at the Site or future construction workers.

Alternatives 2 through 5 are equally protective of human health and the environment. These four alternatives remove soil and sediment with COC concentrations above PRGs. Alternatives 2 and 4 monitor surface water in South Ditch to continue to provide data to evaluate and verify that surface water concentrations remain below the established site-specific ecological PRGs. Whereas Alternatives 3 and 5 include installation of a chemical adsorption barrier at a downstream location in South Ditch, near the Property boundary. This added treatment of South Ditch surface water should have a positive effect on surface water quality exiting South Ditch and entering East Ditch and help support, by improving East Ditch water quality, USEPA's objective of achieving a surface water cleanup criterion of 1.9 mg/L for ammonia (at pH of 7 and temperature of 20 degrees Celsius) at the Halls Brook Holding Area Pond for the Industri-Plex Superfund Site, which is located downgradient of the OCSS and downgradient of the confluence of Landfill Brook. Protection of human health and the environment is also provided by conducting toxicity testing to demonstrate achievement of the sediment and surface water RAOs.

TMPs in soil are not associated with any current VI pathway, because VI dose not present a risk to occupants of existing buildings. Alternatives 2 and 3 include modifying the existing deed covenant to include language to address potential VI concerns associated with future buildings that may be constructed on the Property and incorporating engineering controls, such as vapor barriers and/or SSDSs, into the design and construction of future building foundations would be protective of potential future building occupants as well as addressing construction worker health and safety plan requirements Whereas Alternatives 4 and 5 include installing an AS/SVE system to treat TMPs in subsurface soil to prevent potential VI concerns associated with future buildings that may be constructed in the vicinity of EA7 and Lake Poly (EA1) as well as addressing construction worker health and safety plan requirements.

5.6.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative 1, No Action, does not comply with ARARs. Alternatives 2 through 5 would be designed, constructed, and maintained to comply equally with ARARs.

The remedial alternatives would be designed and implemented to minimize potential impacts to adjacent floodplain or wetland areas. Restoration activities would be implemented to comply with the identified location-specific ARARs.

The remedial alternatives would be designed and implemented to comply with chemical-specific ARARs and site-specific PRGs.

Alternatives 2 through 5 would be designed and implemented to comply with the identified action-specific ARARs, such as USEPA's *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*. Engineering controls would be employed to comply with RCRA standards applicable to generation, transportation, and storage of hazardous waste, as well as federal and state solid waste disposal regulations.

5.6.3 Short-term Effectiveness

Alternative 1, No Action, is not effective in the short term. Alternatives 2 through 5 are equally effective in the short term. RAOs would be achieved upon completion of the active, construction-related activities of the remedies. Potential short-term risks to on-site workers involved in the remedial activities would be minimized by conducting the work in accordance with a site-specific health and safety plan.

5.6.4 Long-term Effectiveness and Permanence

Alternative 1, No Action, is not effective in the long term. Alternatives 2 through 5 are equally effective in the long term. RAOs would be achieved upon completion of the active, construction-related activities of the remedies. Additionally, these alternatives include long-term monitoring to verify compliance with RAOs and PRGs.

5.6.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1, No Action, does not reduce toxicity, mobility, or volume. Alternatives 2 through 5 reduce mobility and volume equally by removing and disposing of soil and sediment to achieve PRGs. Excavated soil and sediment that may be characterized as hazardous waste would be treated by stabilization prior to off-site disposal.

TMPs in soil are not associated with any current VI pathway, because VI dose not present a risk to occupants of existing buildings. Alternatives 2 and 3 reduce the toxicity and mobility of TMPs in soil by incorporating engineering controls (i.e., vapor barriers and/or SSDSs) into the design and construction of future building foundations would be protective of potential future building occupants. Alternatives 4 and 5 include installation of an AS/SVE system, which would provide a reduction in toxicity and mobility of TMPs, as well as a reduction in volume of TMPs through treatment.

South Ditch surface water is currently in compliance with site-specific ecological PRGs. Alternatives 2 and 4 include additional treatment of South Ditch surface water prior to that water flowing into East Ditch, which should help support USEPA's objective of achieving a surface water

cleanup criterion of 1.9 mg/L for ammonia (at pH of 7 and temperature of 20 degrees Celsius) at the Halls Brook Holding Area Pond for the Industri-Plex Superfund Site, which is located downgradient of the OCSS and downgradient of the confluence of Landfill Brook.

5.6.6 Implementability

Alternative 1, No Action, requires no implementation. Alternatives 2 through 5 are straightforward to implement. The technologies for these four alternatives are available and sufficiently demonstrated for use at the site. The necessary equipment and materials are readily available.

5.6.7 Cost

The comparative costs for the four alternatives are shown below:

Alternative Description	Capital Costs	Total Cost	Total Present Worth
1: No Action	$0	$0	$0
2: Limited Action and Vapor Barrier/SSDS for TMPs, Excavation/Stabilization/Disposal of Soil/Sediment, Limited Action for South Ditch Surface Water	$1,021,425	$1,431,000	$1,295,000
3: Limited Action and Vapor Barrier/SSDS for TMPs, Excavation/Stabilization/Disposal of Soil/Sediment, In-situ Chemical Adsorption for South Ditch Surface Water	$1,028,405	$1,455,000	$1,312,000
4: AS/SVE for TMPs, Excavation/Stabilization/Disposal of Soil/Sediment, Limited Action for South Ditch Surface Water	$1,454,908	$2,040,000	$1,889,000
5: AS/SVE for TMPs, Excavation/Stabilization/Disposal of Soil/Sediment, In-situ Chemical Adsorption for South Ditch Surface Water	$1,465,788	$2,067,000	$1,911,000

Alternative 2 has the lowest capital costs, total costs, and total present worth of the four active alternatives.

5.6.8 Recommended Alternative

The preferred alternative is Alternative 3: Limited Action and Vapor Barrier/SSDS for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and In-situ Chemical Adsorption for South Ditch Surface Water.

Alternative 3 is protective of human health and the environment, and would be designed and implemented to comply with ARARs. Alternative 3 provides short-term and long-term effectiveness by:

- providing a vapor barrier and/or SSDS for potential future buildings in the vicinity of EA7 near the former Plant B, EA3, and the Lake Poly area where TMPs have been detected in subsurface soil and by requiring health and safety plans to address construction worker inhalation exposure to TMPs during excavation activities;
- removing Lower South Ditch sediment and EA5 soil to achieve the established PRGs and sediment toxicity testing requirements and stabilizing the excavated material and disposing of the material at on off-site disposal facility; and
- installing an in-situ chemical adsorption barrier to treat surface water exiting South Ditch and entering East Ditch, meeting NRWQC in the South Ditch surface water, and meeting surface water toxicity testing requirements.

Alternative 3 will achieve the site-specific PRGs presented in this FS that are based on the identified ARARs as well as the risk-based PRGs for soil and sediment. This alternative should also have a positive effect on surface water quality exiting South Ditch and entering the East Ditch and help support, by improving East Ditch water quality, USEPA's objective of achieving a surface water cleanup criterion of 1.9 mg/L for ammonia (at pH of 7 and temperature of 20 degrees Celsius) at the Halls Brook Holding Area Pond for the Industri-Plex Superfund Site, which is located downstream of the OCSS and downstream of the confluence of Landfill Brook and the East Ditch. Toxicity testing would also be conducted for sediment and surface water associated with South Ditch to demonstrate achievement of the RAOs.

Alternative 3 provides a reduction in toxicity, mobility, or volume of contaminants by:

- installing vapor barriers and/or SSDSs to address potential VI concerns related to potential future buildings that may be constructed at the Site;
- removing soil and sediment to achieve PRGs and treating the excavated material via stabilization as necessary prior to off-site disposal; and
- treating surface water exiting South Ditch and entering East Ditch.

Alternative 3 is readily implemented at a reasonable cost, as compared to the other alternatives evaluated. Considering that Alternative 3 also provides treatment of surface water exiting South Ditch and achieves all the RAOs, it has been identified as the preferred alternative.

6.0 REFERENCES

AMEC, 2015. Final Remedial Investigation Report Operable Unit 1 & Operable Unit 2, Olin Chemical Superfund Site; Wilmington, Massachusetts; July 24, 2015.

Amec Foster Wheeler, 2018a. Draft Operable Unit 1 and Operable Unit 2 Feasibility Study; Olin Chemical Superfund Site; Wilmington, Massachusetts; March 30, 2018.

Amec Foster Wheeler, 2018b. Draft Remedial Investigation Report - Operable Unit 3; Olin Chemical Superfund Site; Wilmington, Massachusetts; March 30, 2018.

MACTEC, 2007. Draft Focused Remedial Investigation Report; Olin Chemical Superfund Site; Wilmington, Massachusetts; October 2007.

MACTEC, 2008. Final Interim Response Steps Work Plan; Olin Chemical Superfund Site; Wilmington, Massachusetts; August 8, 2008.

MACTEC, 2009. Final Remedial Investigation/Feasibility Study Work Plan, Olin Chemical Superfund Site, Wilmington, Massachusetts. August 14, 2009.

Smith, 1997. Supplemental Phase II Report; Olin Corporation; Wilmington Massachusetts; MassDEP RTN: 3-0471; Smith Technology Corporation; PTI Environmental Services; ABB Environmental Services, Inc.; June 1997.

USEPA, 1988a. CERCLA Compliance With Other Laws Manual; Interim Final, USEPA Office of Emergency and Remedial Response, Washington, D.C.; EPA/540/G 89/006, August.

USEPA, 1988b. USEPA Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final. Office of Emergency and Remedial Response. EPA/540/G-89/004. OSWER Directive 9355.3-01. October.

USEPA, 1990. National Oil and Hazardous Substances Pollution Contingency Plan, Code of Federal Regulations, Title 40, Part 300; March 8, 1990; Final Rule: Federal Register; Vol. 55, No. 46; pp. 8666 et seq.

USEPA, 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, Office of Solid Waste and Emergency Response; Washington, D.C.; OSWER Directive 9355.0-75, EPA 540/R-00-002; July.

USEPA, 2001. Comprehensive Five-Year Review Guidance, Office of Solid Waste and Emergency Response; Washington, D.C.; OSWER Directive 9355.7-03B-P, EPA 540/R-01-007; June.

USEPA, 2005. Hazard Ranking System Documentation Record, Olin Chemical, EPA ID No. MAD001403104.

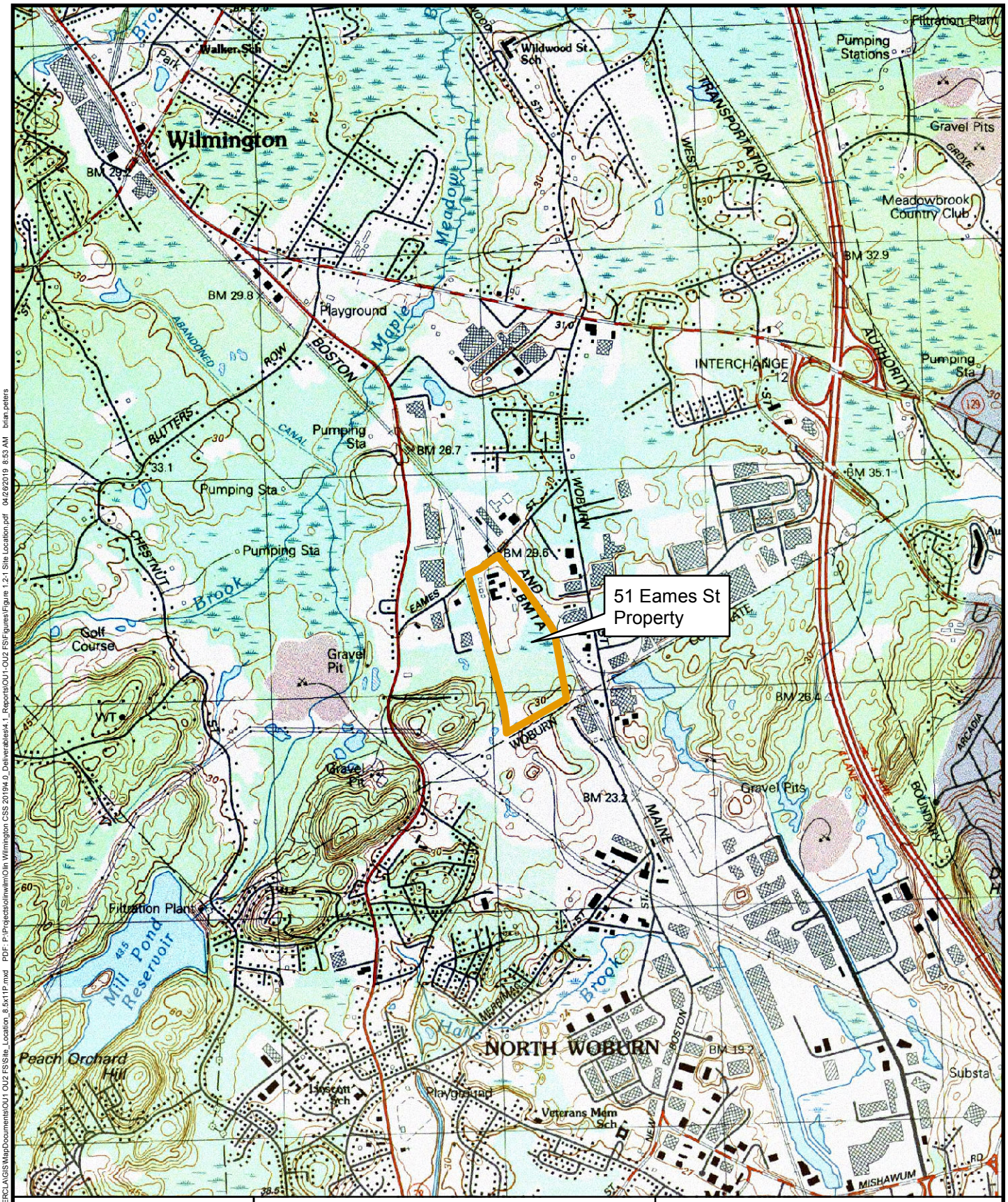
USEPA, 2007a. Administrative Settlement Agreement and Order on Consent For Remedial Investigation/Feasibility Study; Olin Chemical Superfund Site; Wilmington, Massachusetts.

USEPA, 2007b. Statement of Work, Remedial Investigation and Feasibility Study; Olin Chemical Superfund Site; June.

USEPA, 2015. Review and Conditional Approval Draft Final Remedial Investigation Report, Operable Units 1 and 2, MACTEC, April 10, 2014 and related Documents. July, 2, 2015

Wood, 2019. Draft Interim Action Feasibility Study; Olin Chemical Superfund Site; Wilmington, Massachusetts; April 2019.

FIGURES



Massachusetts

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

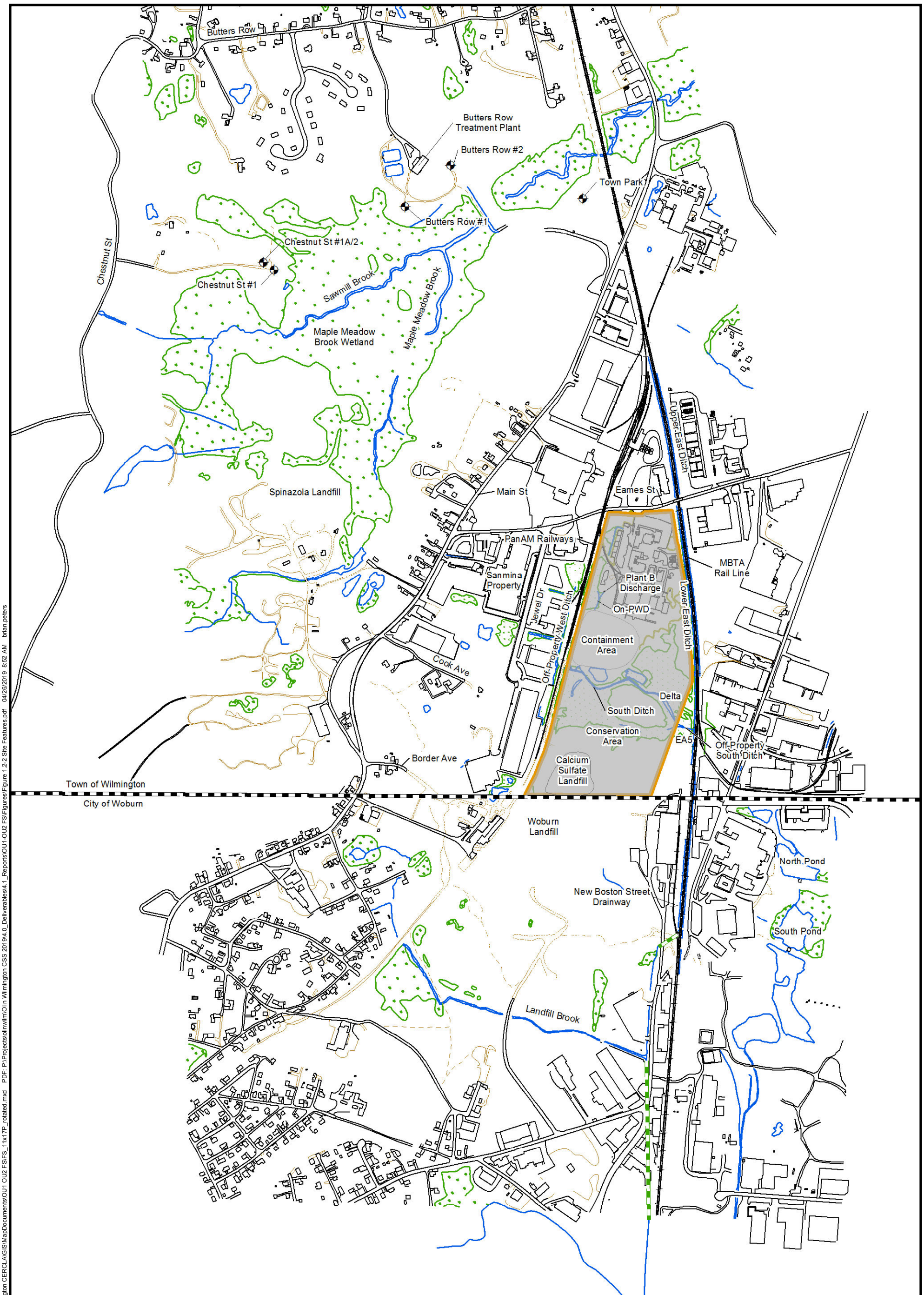
0 1,000 2,000 4,000 Feet

Figure 1.2-1
Site Location

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/26/19 | Checked/Date: APP 04/26/19

Document: P:\Projects\olinwlm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\Site_Location_8.5x11P.mxd PDF: P:\Projects\olinwlm\Olin Wilmington CSS 201994.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure 1.2-1 Site Location.pdf 04/26/2019 8:53 AM brian.peters



Legend

- Operable Unit 1
- 51 Eames St. Property Boundary
- Town Wells
- Town Line
- Paved Road
- Unpaved Road
- Sidewalks
- Structure
- Surface Water
- Trails
- Wooded Areas
- Wetland Boundary
- Culvert

*Operable Unit 2 is portion shown outside of OU1.

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

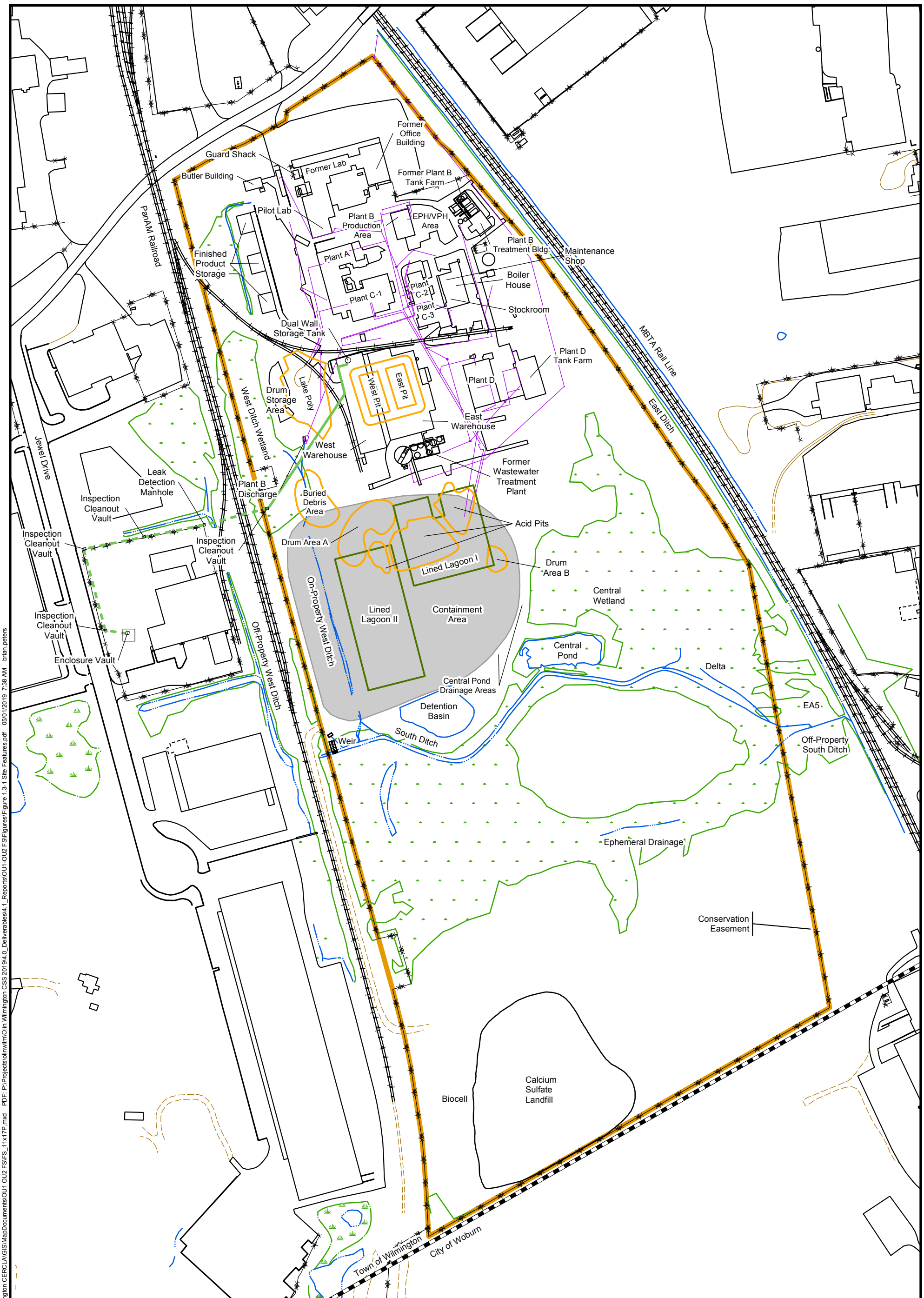
0 370 740 1,480 Feet

Figure 1.2-2
Site Features

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/26/19 | Checked/Date: APP 04/26/19

Document: P:\Projects\olinwilm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1-OU2 FS\Figures\Figure 1.2-2 Site Features.pdf 04/26/2019 8:52 AM brian.peters
PDF: P:\Projects\olinwilm\Olin Wilmington CSS 2019\4.0_Deliverables\4.1_Reports\OU1-OU2 FS\FS_11x17P_rotated.mxd



Legend

- 51 Eames St. Property Boundary
- Containment Structure
- Historical Disposal Area
- Aboveground Conveyance Piping
- Underground Conveyance Piping
- Structure
- Paved Road
- Unpaved Road
- Railroad
- Town Line
- Fence
- Trail
- Drain/Sewer Line
- Surface Water
- Wetland Boundary

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

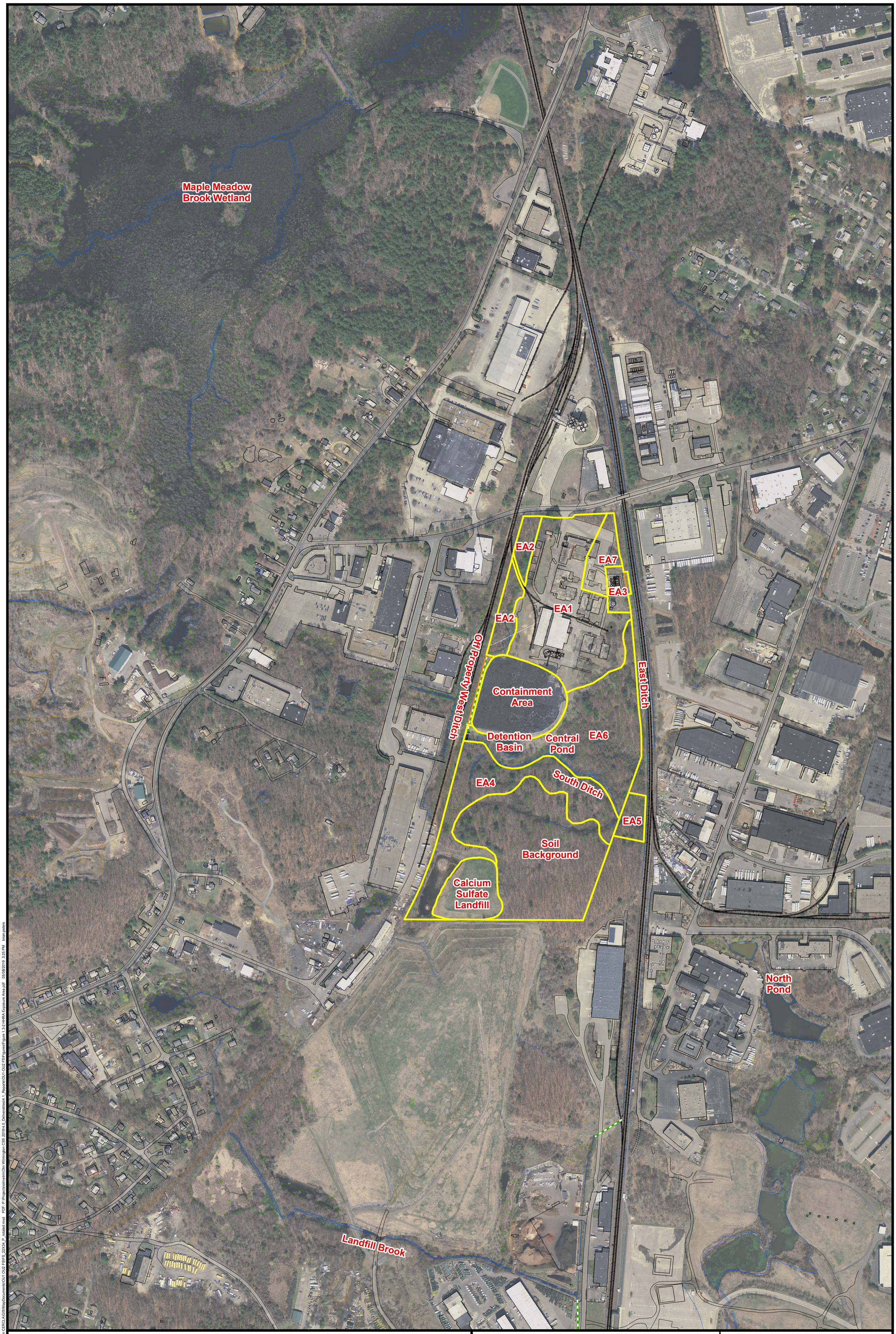
0 100 200 400 Feet

Figure 1.3-1
Site Features (Current and Historic)

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 05/01/19 | Checked/Date: APP 05/01/19

Document: P:\Projects\olinwilm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\FS_11x17P.mxd PDF: P:\Projects\olinwilm\Olin Wilmington CSS 2019\4.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure 1.3-1 Site Features.pdf 05/01/2019 7:38 AM brian.peters



Legend

- Exposure Area
- Culvert
- 51 Eames St. Property Boundary
- Paved Road
- Unpaved Road
- Railroad
- Surface Water
- Wetland Boundary

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

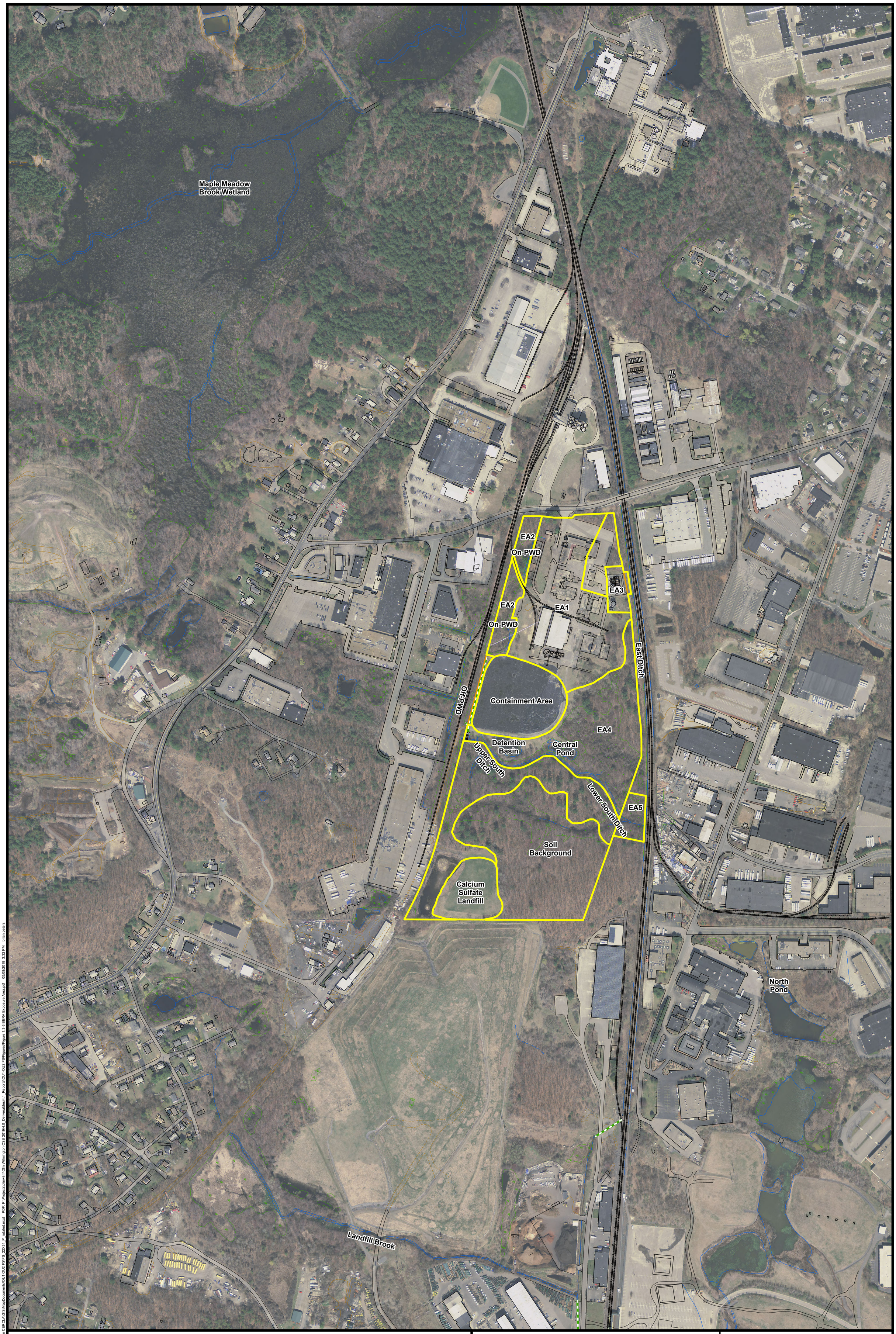
0 250 500 Feet

Figure 1.3-2
HHRA Exposure Areas

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 05/08/19 | Checked/Date: APP 05/08/19

Document: P:\Projects\olinwilm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\FS_22X34_P_rotated.mxd PDF: P:\Projects\olinwilm\Olin Wilmington CSS 2019\4.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure 1.3-2 HHRA Exposure Area.pdf 05/08/2019 3:25 PM brian.peters



Legend

- Exposure Area
- Culvert
- 51 Eames St. Property Boundary
- Paved Road
- Unpaved Road
- Railroad
- Surface Water
- Wetland Boundary

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

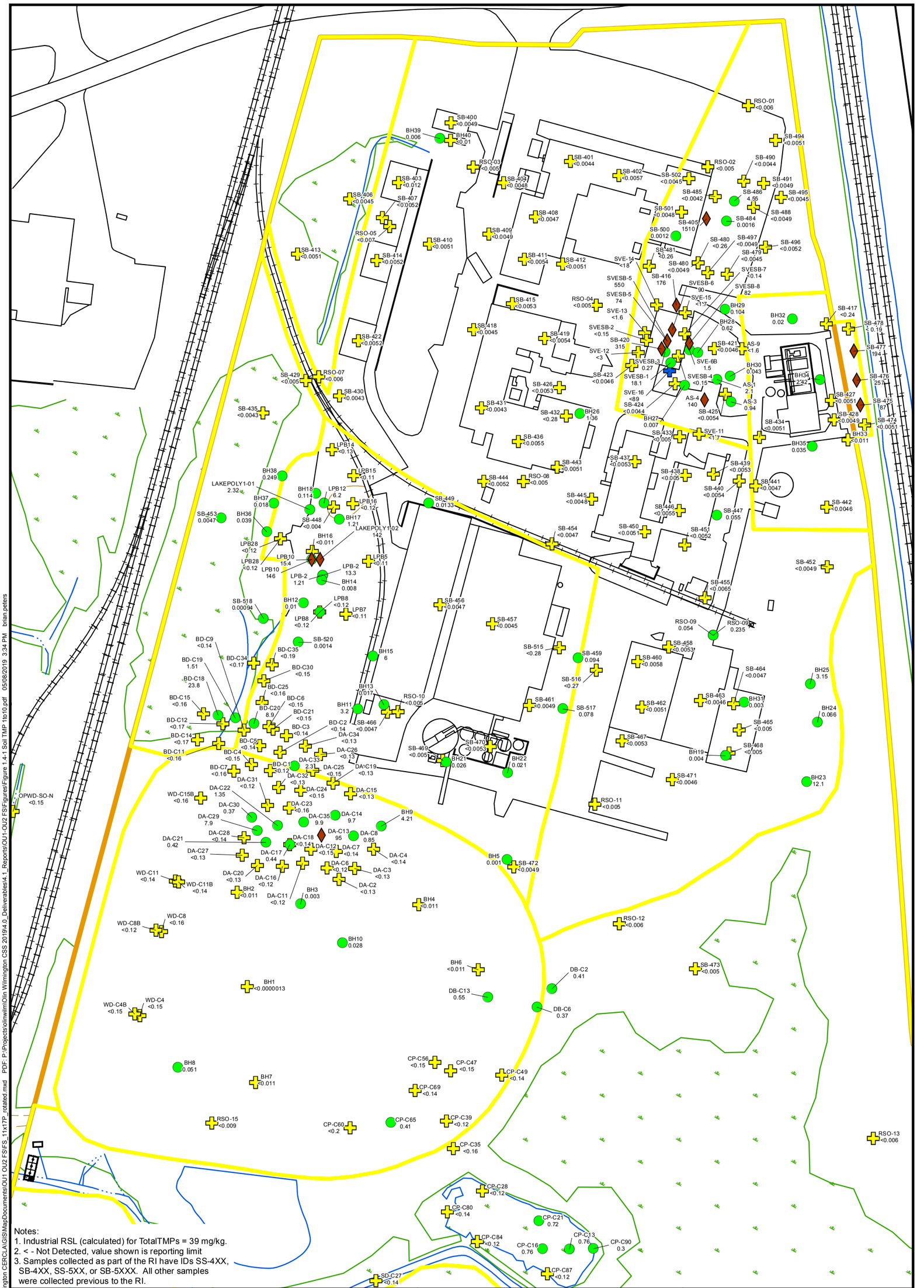
0 250 500 Feet

Figure 1.3-3
BERA Exposure Areas

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 05/08/19 | Checked/Date: APP 05/08/19

Document: P:\Projects\olinwilm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\FS_22X34_P_rotated.mxd PDF: P:\Projects\olinwilm\Olin Wilmington CSS 2019\4.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure 1.3-3 BERA Exposure Area.pdf 05/08/2019 3:32 PM brian.peters



Notes:
1. Industrial RSL (calculated) for TotalTMPs = 39 mg/kg.
2. < - Not Detected, value shown is reporting limit
3. Samples collected as part of the RI have IDs SS-4XX, SB-4XX, SS-5XX, or SB-5XXX. All other samples were collected previous to the RI.

Legend

- Analyte Detected Below Industrial RSL
- Analyte Detected Above Industrial RSL
- 2.5 Detected Analyte Concentration (mg/kg)
- Analyte not detected
- 51 Eames St. Property Boundary
- Railroad
- Paved Road
- Unpaved Road
- Sidewalks
- Structure
- Surface Water
- Wetland Boundary

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

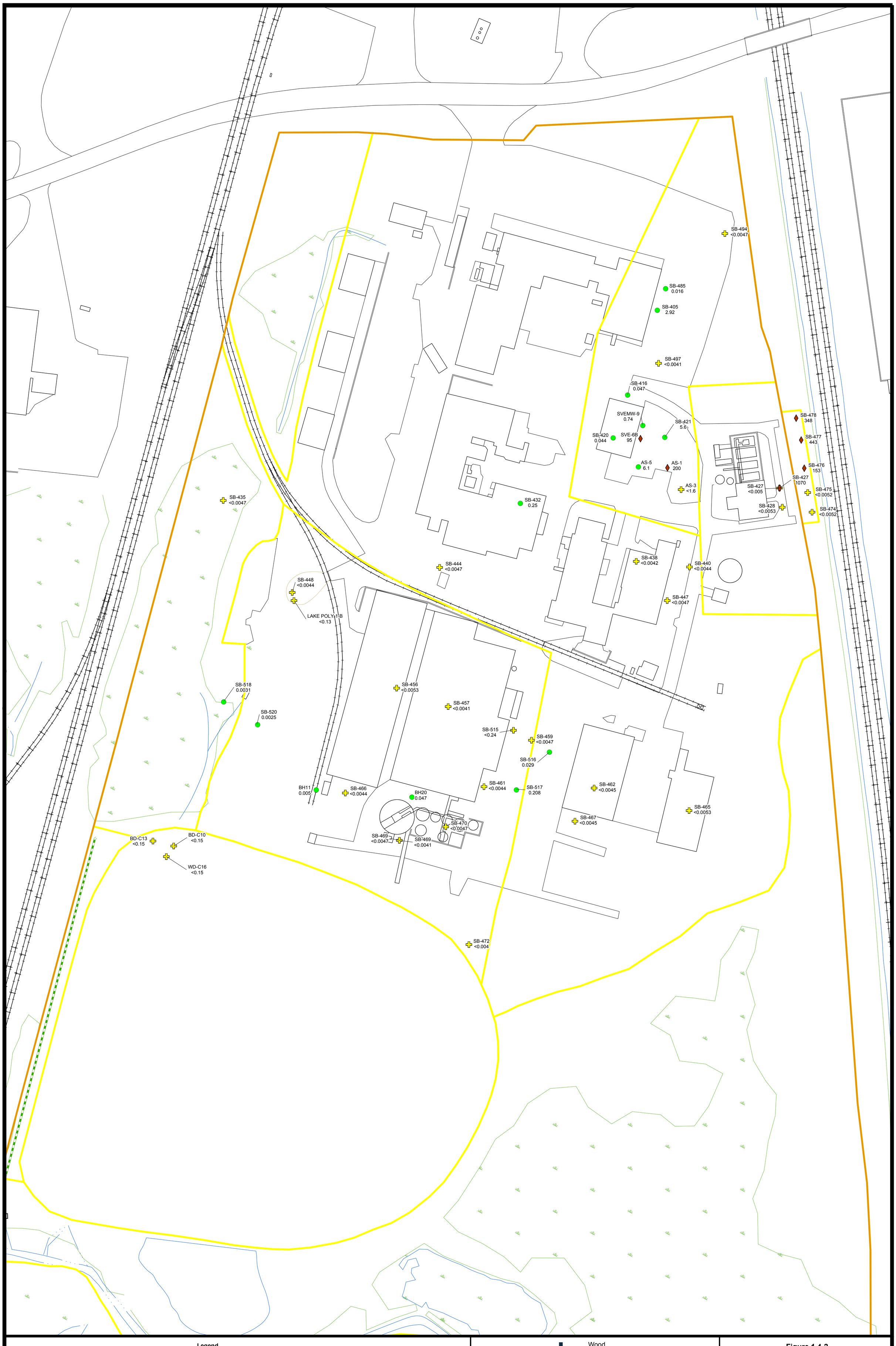
N

0 50 100 200 Feet

Figure 1.4-1
Distribution of Soil (1 to 10 ft) Concentrations for Total Trimethylpentenes
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 05/08/19 | Checked/Date: APP 05/08/19

Document: P:\Projects\olinwilm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\FS_11x17P_rotated.mxd PDF: P:\Projects\olinwilm\Olin Wilmington CSS 20194.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure 1.4-1 Soil TMP 1to10.pdf 05/08/2019 3:34 PM brian.peters



Legend

- Analyte Detected Below Industrial RSL
- Analyte Detected Above Industrial RSL
- Analyte not detected - Reporting Limit Below Industrial RSL
- 2.5 Detected Analyte Concentration (mg/kg)
- 51 Eames St. Property Boundary
- Exposure Area Boundaries
- Water
- Railroad
- Paved Road
- Unpaved Road
- Wetland Boundary

Notes:
1. Industrial RSL (calculated) for TotalTMPs = 39 mg/kg.
2. < - Not Detected, value shown is reporting limit
3. Samples collected as part of the RI have IDs SS-4XX, SB-4XX, SS-5XX, or SB-5XXX. All other samples were collected previous to the RI.

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

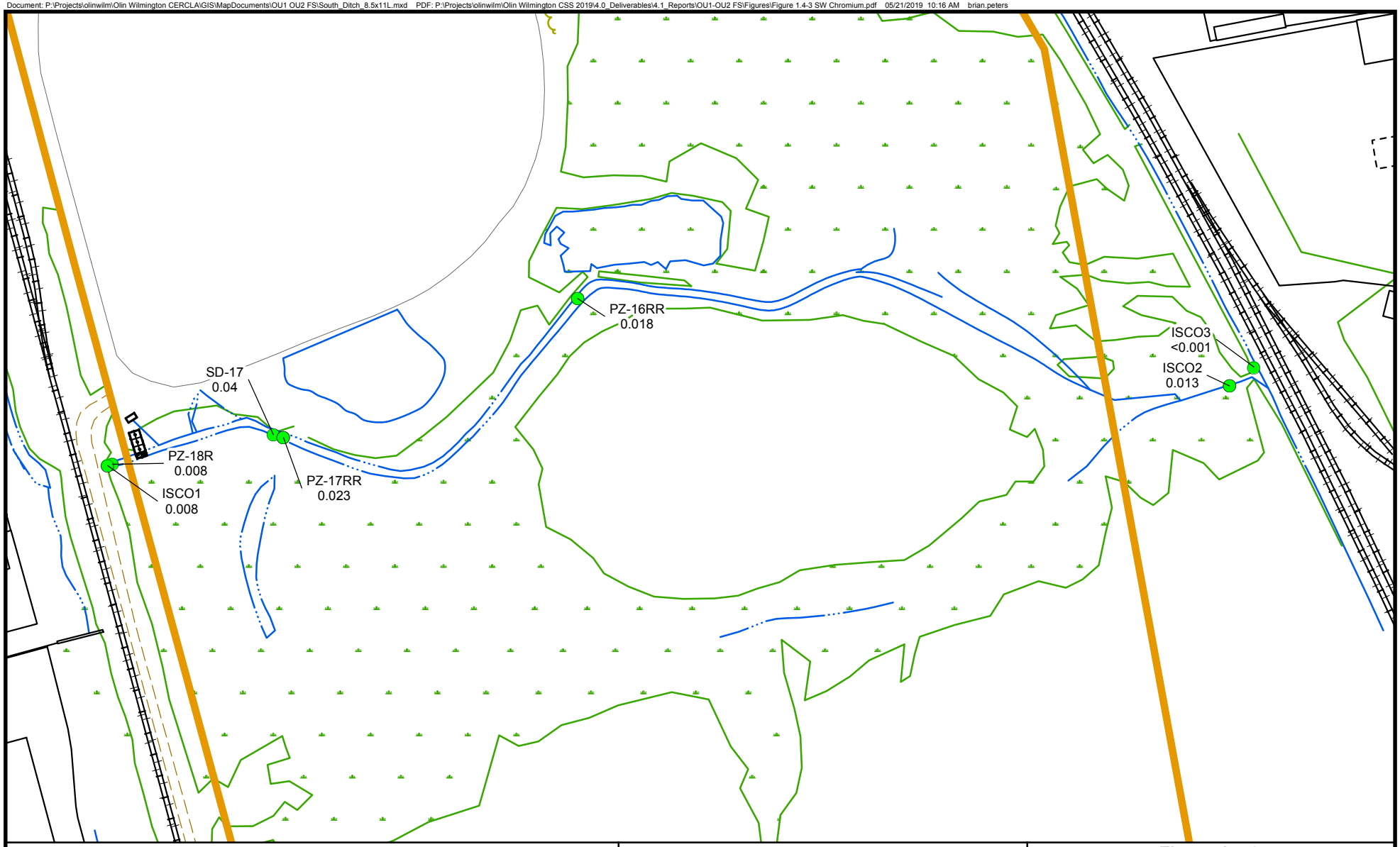
N

0 50 100 Feet

Figure 1.4-2
Distribution of Soil (Greater Than 10 ft) Concentrations for Total Trimethylpentenes
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 05/01/19 | Checked/Date: APP 05/01/19

Document: P:\Projects\olinwilm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\SoilDistributions_22X34P_rotated.mxd PDF: P:\Projects\olinwilm\Olin Wilmington CSS 2019\4.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure 1.4-2 Soil TMP gt10.pdf 05/01/2019 8:31 AM brian.peters



Legend

- ISCO1 Location ID
- 0.05 Analyte Concentration (mg/L)
- 51 Eames St. Property Boundary
- Paved Road
- Unpaved Road
- Railroad
- Structure
- Surface Water
- Wetland Boundary

Note:
Data shown is from 12/4/18
Chromium Ecological PRG = 0.46 mg/L

wood.

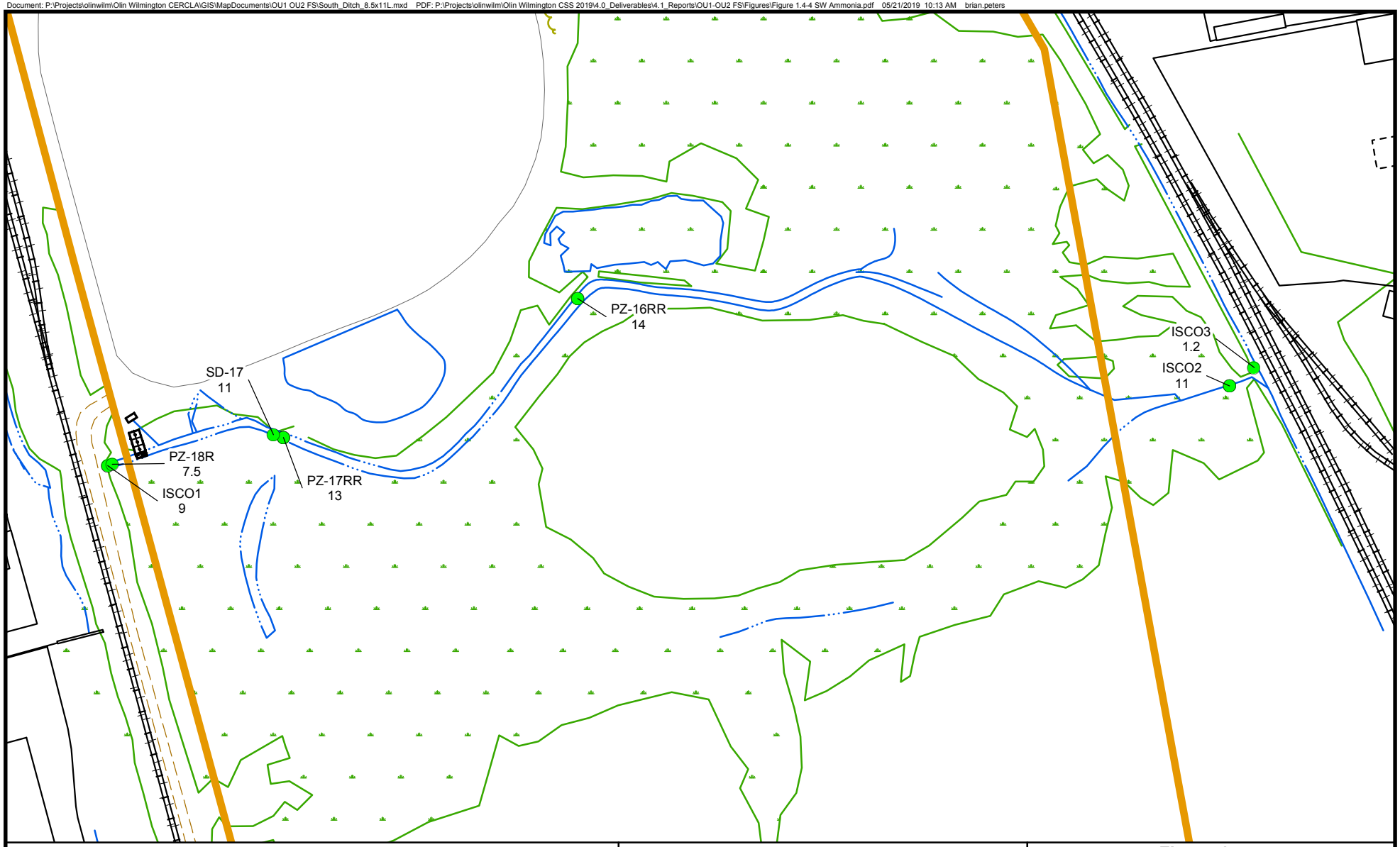
Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 70 140 280 Feet

Figure 1.4-3
Distribution of Surface Water Concentrations for Chromium in South Ditch
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 05/21/19 | Checked/Date: APP 05/21/19



Legend

- ISCO1 Location ID
- 0.05 Analyte Concentration (mg/L)
- 51 Eames St. Property Boundary
- Paved Road
- Unpaved Road
- Railroad
- Structure
- Surface Water
- Wetland Boundary

Note:
Data shown is from 12/4/18
Ammonia Ecological PRG = 36 mg/L

wood.

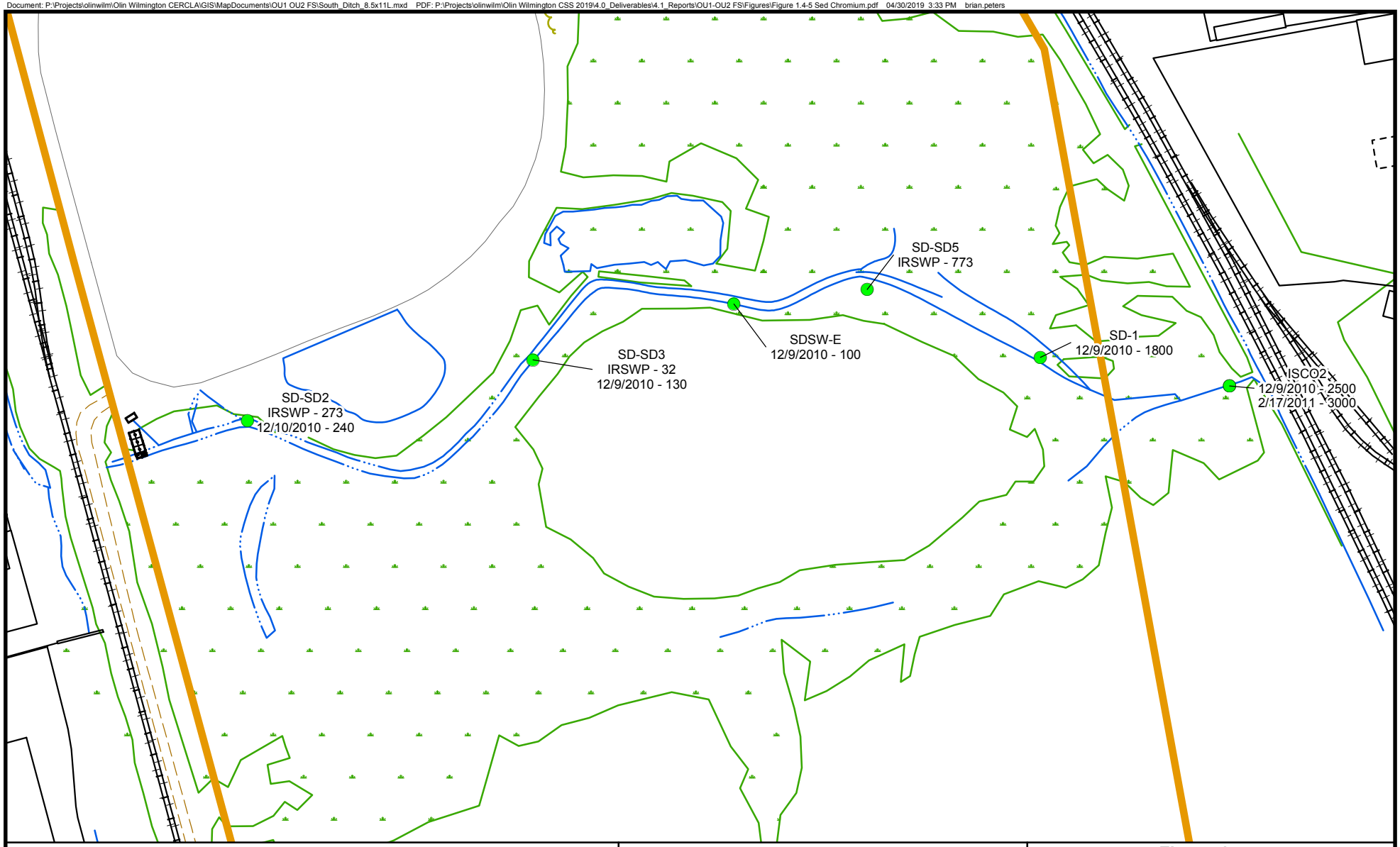
Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 70 140 280 Feet

Figure 1.4-4
Distribution of Surface Water Concentrations for Ammonia in South Ditch
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 05/21/19 | Checked/Date: APP 05/21/19



Legend

- SDC1 Location ID
- 10 Analyte Concentration (mg/kg)
- 51 Eames St. Property Boundary
- Paved Road
- Unpaved Road
- Railroad
- Structure
- Surface Water
- Wetland Boundary

Note:
IRSWP - Annual sediment sample location. Value shown is arithmetic mean for samples collected Oct 2010 to Jan 2013.

wood.

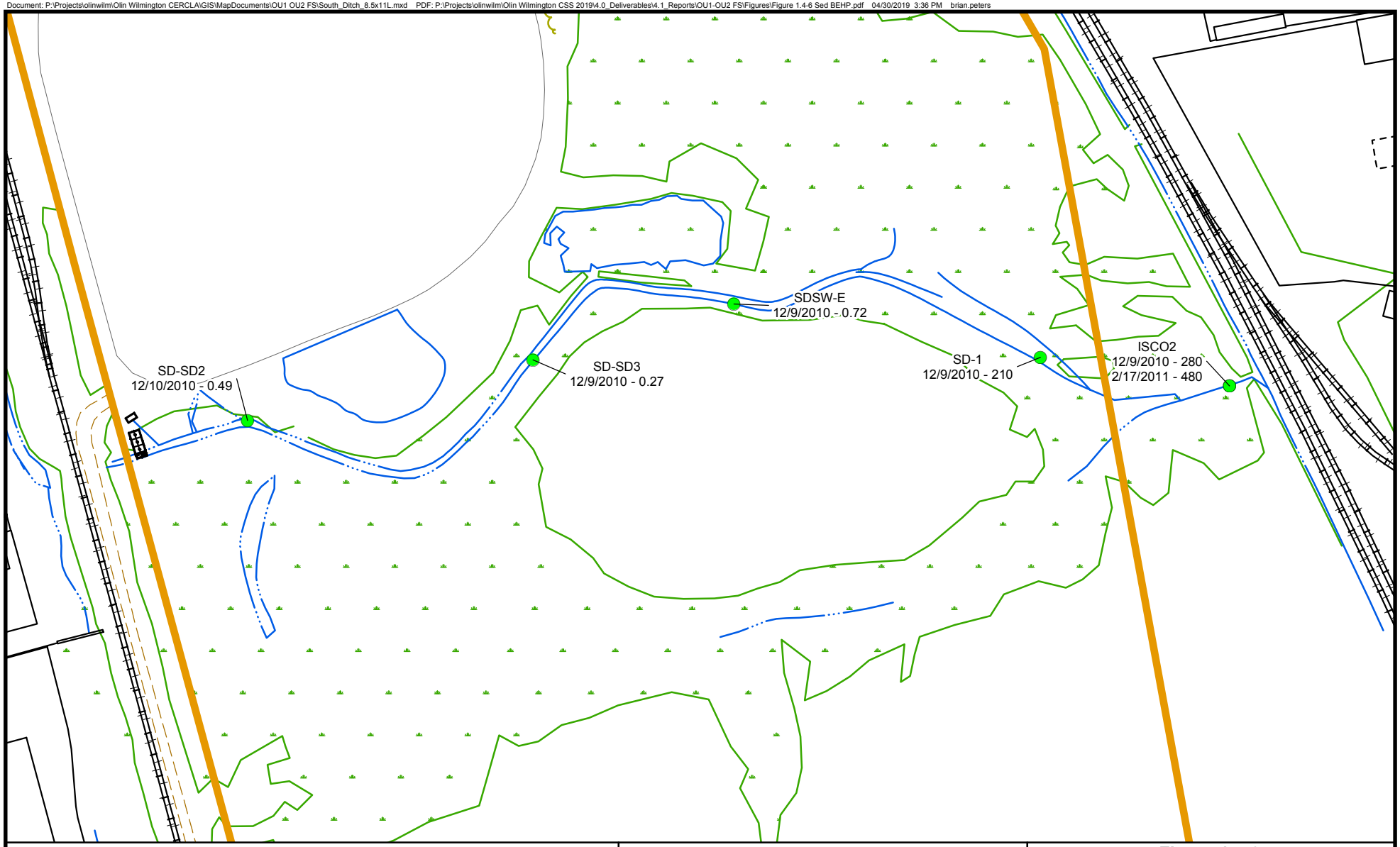
Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 70 140 280 Feet

Figure 1.4-5
Distribution of Sediment Concentrations for Chromium in South Ditch
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/30/19 | Checked/Date: APP 04/30/19



Legend

- SDC1 Location ID
- 10 Analyte Concentration (mg/kg)
- 51 Eames St. Property Boundary
- Paved Road
- Unpaved Road
- Railroad
- Structure
- Surface Water
- Wetland Boundary

wood.

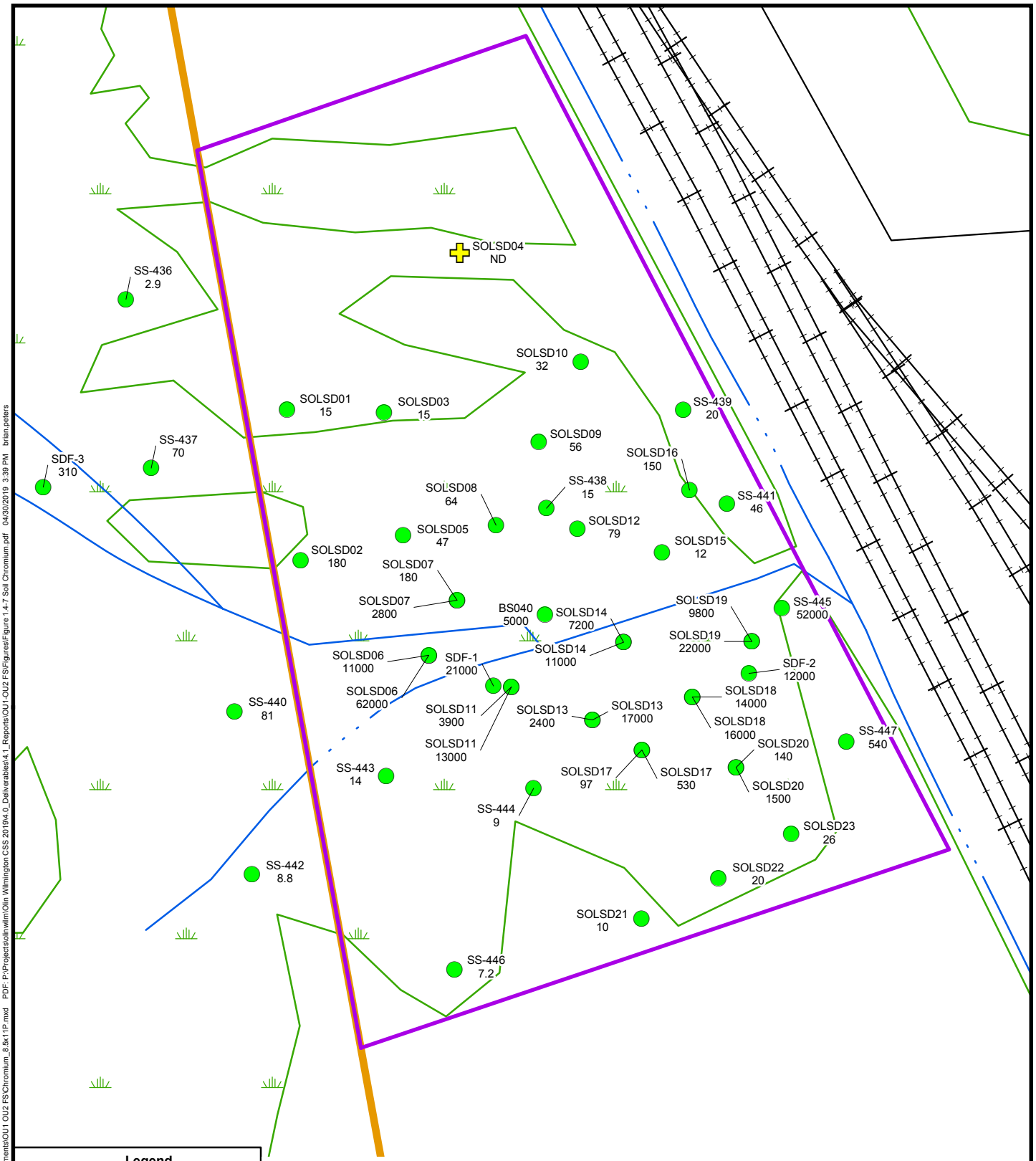
Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 70 140 280 Feet

Figure 1.4-6
Distribution of Sediment Concentrations for Bis(2-Ethylhexyl)phthalate in South Ditch
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/30/19 | Checked/Date: APP 04/30/19



Legend

- Analyte Detected Below Industrial RSL
- Analyte Detected Above Industrial RSL
- 2.5 Detected Analyte Concentration (mg/kg)
- Analyte not detected
- Exposure Area 5
- 51 Eames St. Property Boundary
- Railroad
- Structure
- Surface Water
- Wetland Boundary

Notes:
1. Industrial RSL (USEPA) for Chromium = 1,500,000 mg/kg.
2. < - Not Detected, value shown is reporting limit
3. Samples collected as part of the RI have IDs SS-4XX, SB-4XX, SS-5XX, or SB-5XXX. All other samples were collected previous to the RI.

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

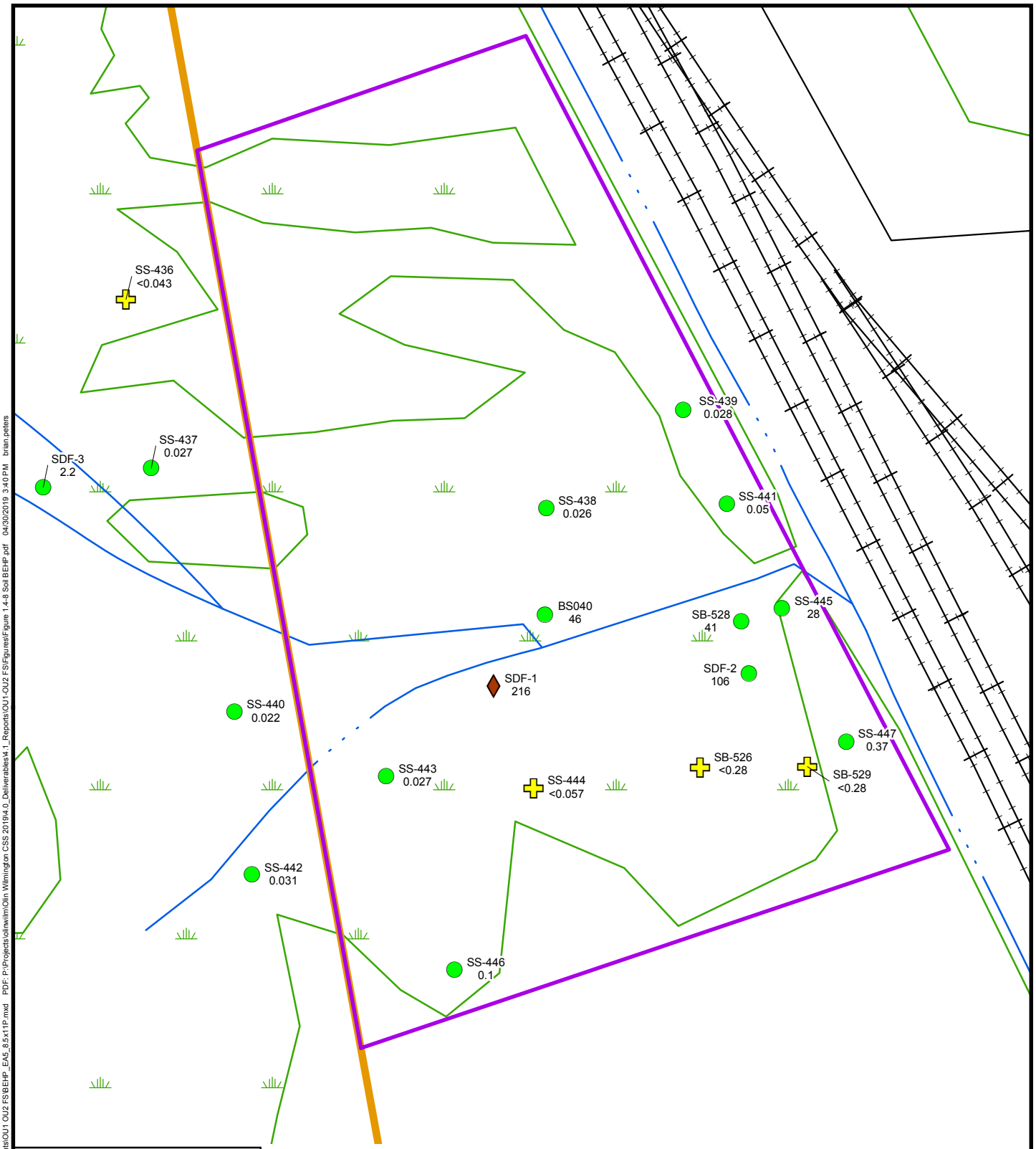
0 20 40 80 Feet

Figure 1.4-7
Distribution of Surface Soil Concentrations for Chromium - EA5

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/30/19 | Checked/Date: APP 04/30/19

Document: P:\Projects\olinwlm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\Chromium_8.5x11P.mxd PDF: P:\Projects\olinwlm\Olin Wilmington CSS 2019\4.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure 1.4-7 Soil Chromium.pdf 04/30/2019 3:39 PM brian.peters



Legend

- Analyte Detected Below Industrial RSL
- Analyte Detected Above Industrial RSL
- 2.5 Detected Analyte Concentration (mg/kg)
- Analyte not detected
- Exposure Area 5
- 51 Eames St. Property Boundary
- Railroad
- Structure
- Surface Water
- Wetland Boundary

Notes:
1. Industrial RSL (USEPA) for BEHP = 120 mg/kg.
2. < - Not Detected, value shown is reporting limit
3. Samples collected as part of the RI have IDs SS-4XX, SB-4XX, SS-5XX, or SB-5XXX. All other samples were collected previous to the RI.
4. BEHP = Bis(2-ethylhexyl)phthalate

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

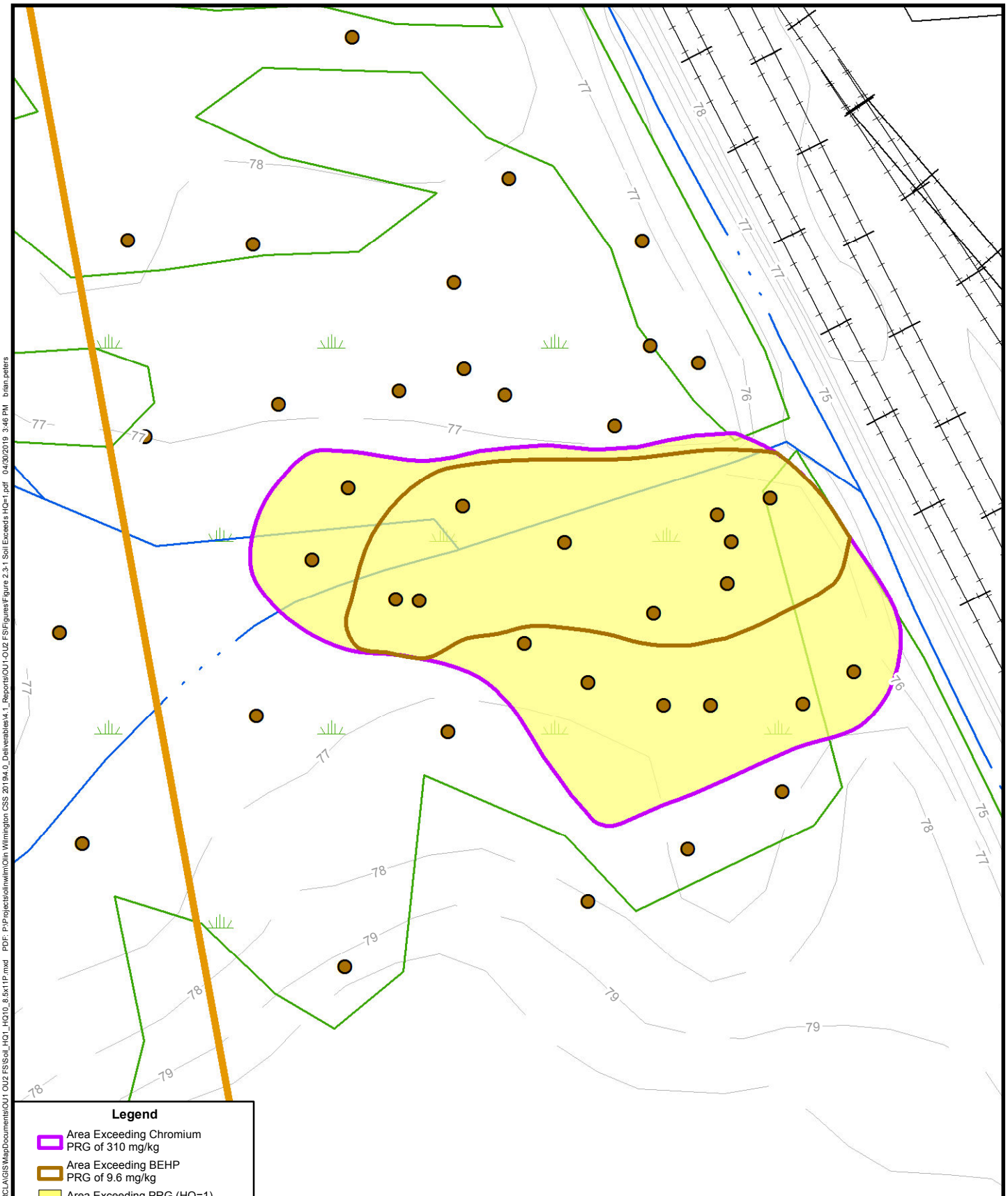
0 20 40 80 Feet

Figure 1.4-8
Distribution of Surface Soil Concentrations for BEHP - EA5

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/30/19 | Checked/Date: APP 04/30/19

Document: P:\Projects\olinwlm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\BEHP_EA5_8.5x11P.mxd PDF: P:\Projects\olinwlm\Olin Wilmington CSS 2019\4.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure 1.4-8 Soil BEHP.pdf 04/30/2019 3:40 PM brian.peters



Legend

- Area Exceeding Chromium PRG of 310 mg/kg
- Area Exceeding BEHP PRG of 9.6 mg/kg
- Area Exceeding PRG (HQ=1)
- Surface Soil Sample
- 51 Eames St. Property Boundary
- Railroad
- Structure
- Surface Water
- Wetland Boundary
- Elevation Contours (MSL ft)

Note:
BEHP = Bis(2-thylhexyl)phthalate

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

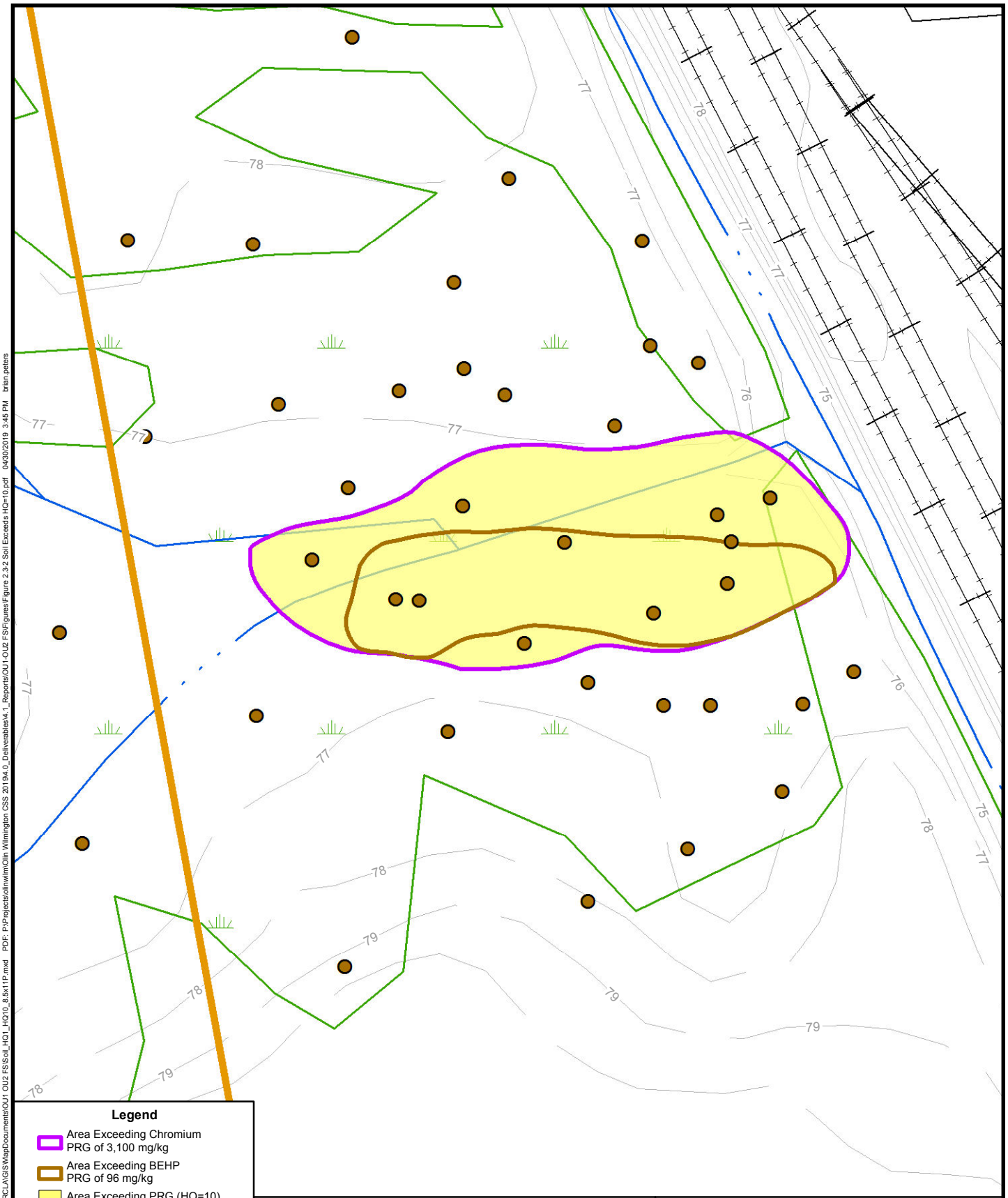
0 15 30 60 Feet

Figure 2.3-1
Areas Exceeding Soil PRGs for Chromium and BEHP at HQ=1

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/30/19 | Checked/Date: APP 04/30/19

Document: P:\Projects\olinwlm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\Soil_HQ1_HQ10_8.5x11P.mxd PDF: P:\Projects\olinwlm\Olin Wilmington CSS 201394.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure 2.3-1 Soil Exceeds HQ=1.pdf 04/30/2019 3:46 PM brian.peters



Legend

- Area Exceeding Chromium PRG of 3,100 mg/kg
- Area Exceeding BEHP PRG of 96 mg/kg
- Area Exceeding PRG (HQ=10)
- Surface Soil Sample
- 51 Eames St. Property Boundary
- Railroad
- Structure
- Surface Water
- Wetland Boundary
- Elevation Contours (MSL ft)

Note:
BEHP = Bis(2-thylhexyl)phthalate

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

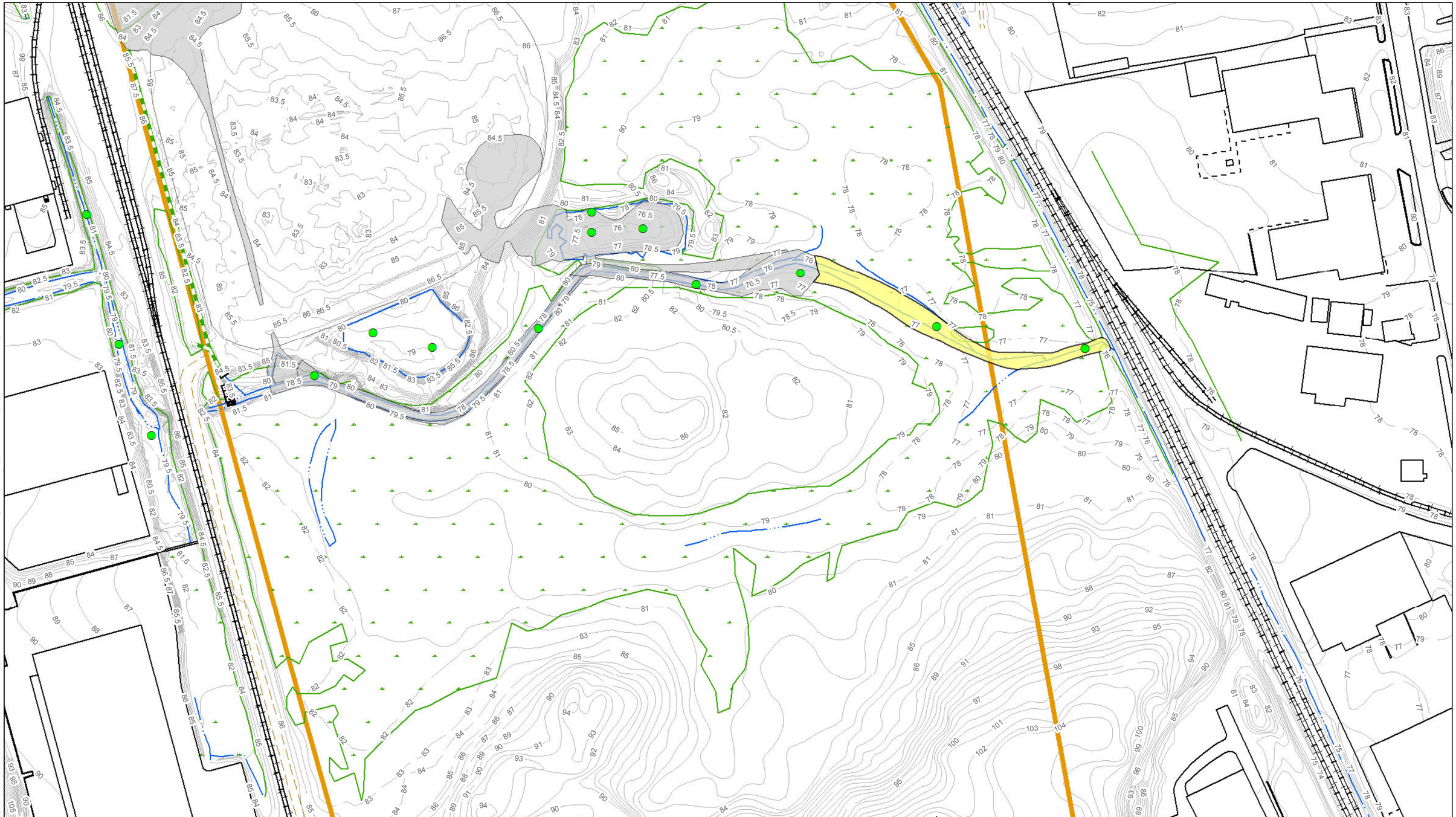
0 15 30 60 Feet

Figure 2.3-2
Areas Exceeding Soil PRGs for Chromium and BEHP at HQ=10

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/30/19 | Checked/Date: APP 04/30/19

Document: P:\Projects\olinwlm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\Soil_HQ1_HQ10_8.5x11P.mxd PDF: P:\Projects\olinwlm\Olin Wilmington CSS 201394.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure 2.3-2 Soil Exceeds HQ=10.pdf 04/30/2019 3:45 PM brian.peters



Legend

- Sediment Sample Location
- Inferred Area Exceeding Sediment PRGs (HQ=1)
- Previous Sediment Excavation Areas
- 51 Eames St. Property Boundary
- Culvert
- Railroad
- Elevation Contour (MSL ft)
- Paved Road
- Unpaved Road
- Structures
- Surface Water
- Wetland Boundary

Note:
BEHP = Bis(2-ethylhexyl)phthalate

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

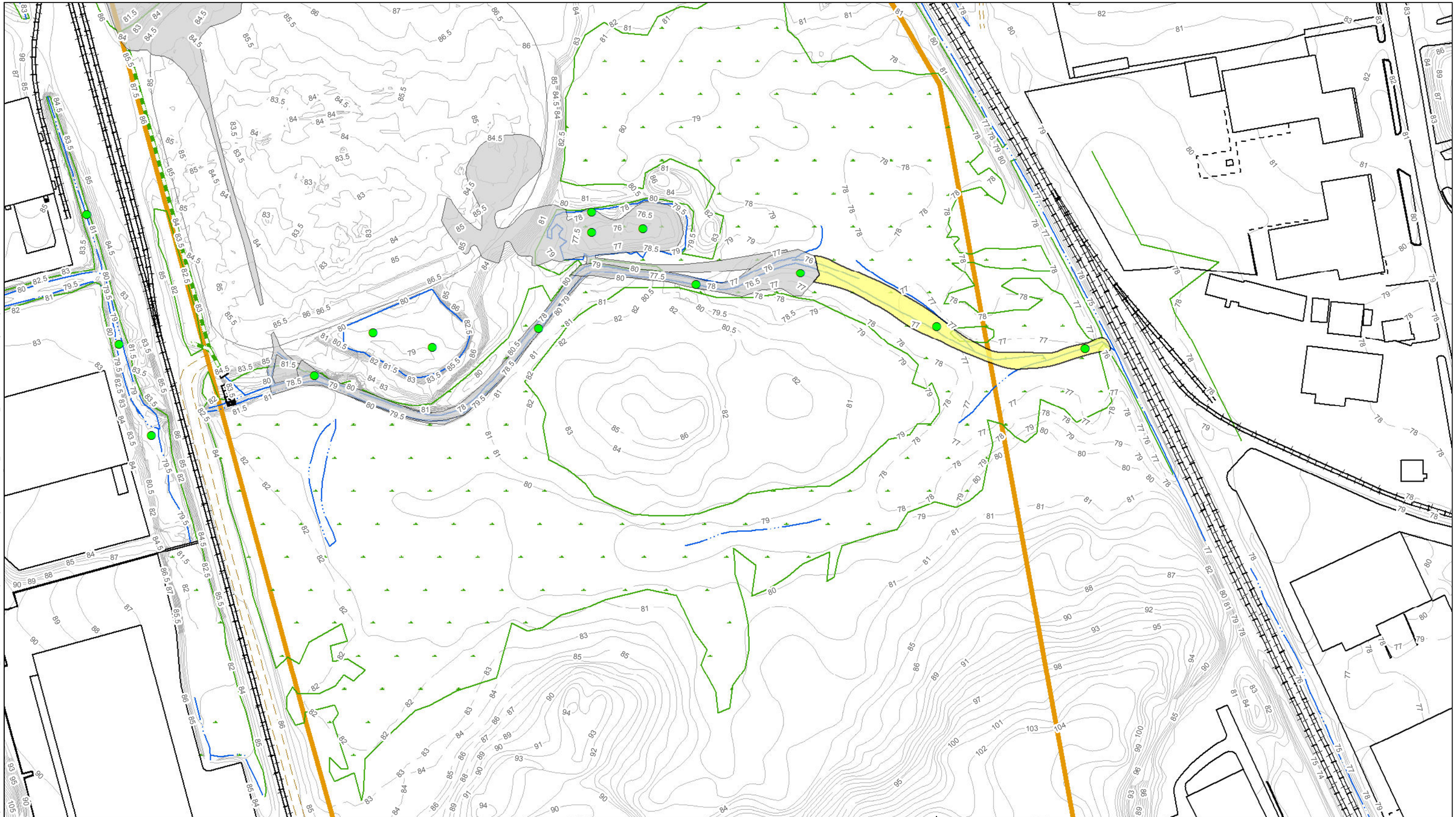
N

0 60 120 240 Feet

Figure 2.3-3
Areas Exceeding Sediment PRGs for Chromium and BEHP at HQ=1
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 05/01/19 | Checked/Date: APP 05/01/19

Document: P:\Projects\olinwlm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\FS_11x17L.mxd PDF: P:\Projects\olinwlm\Olin Wilmington CSS 201994.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure 2.3-3 Sediment Exceeds HQ=1.pdf 05/01/2019 7:32 AM brian.peters



Legend

- Sediment Sample Location
- Inferred Area Exceeding Sediment PRGs (HQ=10)
- Previous Sediment Excavation Areas
- 51 Eames St. Property Boundary
- Culvert
- Railroad
- Elevation Contour (MSL ft)
- Paved Road
- Unpaved Road
- Structures
- Surface Water
- Wetland Boundary

Notes:
1. No BEHP sediment PRG Exceedances at HQ=10.
2. BEHP = Bis(2-ethylhexyl)phthalate

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 60 120 240 Feet

Figure 2.3-4
Areas Exceeding Sediment PRGs for Chromium and BEHP at HQ=10
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 05/01/19 | Checked/Date: APP 05/01/19

Document: P:\Projects\olinwlm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\FS_11x17L.mxd PDF: P:\Projects\olinwlm\Olin Wilmington CSS 201944.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure 2.3-4 Sediment Exceeds HQ=10.pdf 05/01/2019 7:31 AM brian.peters

TABLES

Table 2.1-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
TMPs in Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards					
Floodplains and Wetlands	Floodplain Management and Protection of Wetlands	44 CFR Part 9 (implementing Executive Orders 11988 and 11990)	Applicable	Federal Emergency Management Agency (FEMA) regulations set forth the policy, procedure, and responsibilities to implement and enforce Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). These regulations prohibit activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. These regulations require the avoidance of impacts associated with the occupancy and modification of federally-designated 100-year and 500-year floodplains and require the avoidance of development within a floodplain wherever there is a practicable alternative. An assessment of impacts to the 500-year floodplain is required for critical actions, which includes siting waste facilities in a floodplain. These regulations require public notice when proposing any action in or affecting floodplains or wetlands.	If there is no practical alternative method of work in federal jurisdictional wetlands, or 100-year or 500-year floodplains, then all practical measures will be taken to minimize and mitigate any adverse impacts. Erosion and sediment control measures will be adopted during remedial activities to protect these wetlands and floodplains. After completion of work, there will be no significant net loss of flood storage capacity and no significant net increase in flood stage or velocities. Floodplain habitat will be restored to the extent practicable. Public comment will be solicited as part of the Proposed Plan concerning any proposed alteration to wetlands and floodplains.
Floodplains	RCRA Floodplain Restrictions for Hazardous Waste Facilities	42 USC § 6901 et seq.; 40 CFR § 264.18(b)	Applicable	A hazardous waste treatment, storage, or disposal facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout or to result in no adverse effects on human health or the environment if washout were to occur.	Any hazardous waste generated during remedial activities will be managed so that it will not impact floodplain resources.
Floodplains	RCRA Floodplain Restrictions for Solid Waste Disposal Facilities and Practices	40 CFR § 257.3-1	Applicable	Solid waste practices must not restrict the flow of a 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources.	Any solid waste generated from remedial activities involving excavation activities will be managed so that it will not impact floodplain resources.

Table 2.1-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
TMPs in Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Wetlands, Aquatic Ecosystem	Clean Water Act (CWA) Section 404 and regulations	33 USC § 1344; 40 CFR Parts 230 & 231; and 33 CFR Parts 320-323	Applicable	For discharge of dredged or fill material into water bodies or wetlands, there must be no practicable alternative with less adverse impact on aquatic ecosystem; discharge cannot cause or contribute to violation of state water quality standards or toxic effluent standards or jeopardize threatened or endangered species; discharge cannot significantly degrade waters of U.S.; practicable steps must be taken to minimize and mitigate adverse impacts; and impacts on flood level, flood velocity, and flood storage capacity must be evaluated. Sets standards for restoration and mitigation required as a result of unavoidable impacts to aquatic resources. USEPA must determine which alternative is the "Least Environmentally Damaging Practicable Alternative" (LEDPA) to protect wetland and aquatic resources.	Remedial alternatives will be developed and designed to comply with these regulations. Compensatory wetlands mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives.
Wetlands	U.S. Army Corps of Engineers, New England District Compensatory Mitigation Guidance (09-07-2016)	New England District Compensatory Mitigation Guidance (09-07-2016)	To Be Considered	This Guidance is to be considered when compensatory mitigation to address impacts to federal jurisdiction wetlands is appropriate for a particular remedial activity.	Activities affecting federal jurisdictional wetlands will be conducted in accordance with these guidance standards for mitigation and restoration.
Surface Waters, Wetland/Waterway Habitat for Endangered Species, Migratory Species	Fish and Wildlife Coordination Act	16 USC §§ 662-663; 40 CFR Part 6	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss to the maximum extent practicable.	To the extent necessary, actions will be taken to develop measures to prevent, mitigate, or compensate for project-related impacts to habitat and wildlife. The USFWS, acting as a review agency for the USEPA, will be kept informed of proposed remedial activities.
Endangered Species	Endangered Species Act	50 CFR §§ 17.11-17.12; 50 CFR Part 402	Applicable, if endangered species are encountered	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	Protection of endangered species and their habitat will be considered during development and design of remedial alternatives.

Table 2.1-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
TMPs in Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Historical/ Archeological Resources	National Historic Preservation Act	16 USC § 469 et seq.; 36 CFR Part 65	Applicable, if subject historical resources are present	When a federal agency finds, or is notified, that its activities in connection with a federal construction project may cause irreparable loss or destruction of significant scientific, pre-historical, historical, or archeological data, the substantive standards under the Act will be met.	Any undisturbed areas altered by the remedial activities will be assessed to ensure no protected resource areas are present. If present, federal and state preservation officials will be consulted to address measures to avoid, minimize, and/or mitigate any impacts to protected resource areas.
Atlantic Flyway	Migratory Bird Treaty Act	16 USC § 703 et seq.	Applicable, if subject protected species are present	Protects migratory birds, their nests and eggs. A depredation permit issued by the U.S. Fish and Wildlife Service is required to take, possess, or transport migratory birds or disturb their nests, eggs, or young.	Remedial activities will be evaluated to protect migratory birds, their nests and eggs. If migratory bird protected areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.
State Standards					
Floodplains, Wetlands, Surface Waters	Massachusetts Wetland Protection Act and Regulations	MGL c. 131, § 40; 310 CMR 10.00	Applicable	These regulations restrict dredging, filling, altering, or polluting inland wetland resource areas (defined as areas within the 100-year floodplain) and impose performance standards for work in such areas. Protected resource areas include: 10.54 (Bank); 10.55 (Bordering Vegetated Wetlands); 10.56 (Land under Water Bodies and Waterways); 10.57 (Land Subject to Flooding); and 10.58 (Riverfront Area).	Any remedial activity conducted within a state regulated wetland resource area will comply with the substantive requirements of these regulations. Mitigation of impacts on state wetland resource areas will be addressed.
Floodplains	Massachusetts Hazardous Waste regulations, Location Standards for Land Subject to Flooding	310 CMR 30.701	Applicable	Any new or expanded hazardous waste storage or treatment facility (which only receives hazardous waste from on-site sources), the active portion of which is located within the boundary of land subject to flooding from the statistical 100-year frequency storm, shall be flood-proofed. Flood-proofing shall be designed, constructed, operated and maintained to prevent floodwaters from coming into contact with hazardous waste.	To the extent any hazardous waste is generated during the remedial activities, the wastes will be managed so that it will not impact floodplain resources.

Table 2.1-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
TMPs in Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Wetlands, Aquatic Ecosystem	Massachusetts Water Quality Certification for Discharge of Dredged or Fill Material	MGL c. 21, §§ 26-53; 314 CMR 9.00	Applicable	For discharges of dredged or fill material, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; appropriate and practicable steps must be taken to avoid and minimize potential adverse impacts to wetlands and land under water; stormwater discharges must be controlled with BMPs; and there must not be substantial adverse impacts to the physical, chemical, or biological integrity of surface waters. For dredging and dredged material management, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; and if avoidance is not possible, then minimize, or if neither avoidance or minimization are possible, then mitigate potential adverse impacts.	The remedial alternatives' effects on the aquatic ecosystem will be evaluated and avoided, and/or minimized. Compensatory mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives. Any required removal of soil/sediment from wetland or surface water areas will be designated for eventual restoration. Excavation and filling activities to be performed impacting the aquatic ecosystem will be in accordance with the substantive requirements of these regulations.
Endangered Species	Massachusetts Endangered Species Regulations	321 CMR 10.00	Applicable, if endangered species are encountered	Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural Heritage Program.	The protection of state listed endangered species will be considered during the development and design of remedial alternatives.
Historical/ Archeological Resources	Protection of Properties Included in the State Register of Historic Places	MGL c. 9, §§ 26-27C; 950 CMR 71.00	Applicable, if subject historical resources are present	Projects must eliminate, limit, or mitigate adverse effects to properties listed in the State Register of Historic Places (historic and archaeological properties). Establishes coordination with the National Historic Preservation Act.	If protected resource areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials.

Table 2.1-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
TMPs in Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Area of Critical Environmental Concern	Massachusetts Areas of Critical Environmental Concern (ACECs) Regulations	310 CMR 12.00	Applicable, if ACEC is identified	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical interrelationships among a number of components. An eligible area must contain features from four or more of the following groups: (1) fisheries, (2) coastal features, (3) estuarine wetlands, (4) inland wetlands, (5) inland surface waters, (6) water supply areas (e.g., aquifer recharge area); (7) natural hazard areas (e.g., floodplain); (8) agricultural areas; (9) historical/archeological resources; (10) habitat resources (e.g., for endangered wildlife); or (11) special use areas. After an area is designated as an ACEC, the aim is to preserve and restore these areas.	If ACEC is identified in the site area, activities will be controlled to minimize impacts to affected species.

Prepared By / Date: APP 04/24/2019
Checked By / Date: MJM 05/08/2019

Notes:
ACEC = Areas of Critical Environmental Concern
ARAR = Applicable or Relevant and Appropriate Requirement
BMP = Best Management Practice
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
CWA = Clean Water Act
DAPL = Dense Aqueous Phase Liquid
FEMA = Federal Emergency Management Agency
LEDPA = Least Environmentally Damaging Practicable Alternative
MGL = Massachusetts General Law
RCRA = Resource Conservation and Recovery Act
USEPA = United States Environmental Protection Agency
USFWS = United States Fish and Wildlife Service
USC = United States Code

Table 2.1-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
TMPs in Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards				
USEPA Risk Reference Doses (RfDs)	USEPA RfDs	To Be Considered	RfDs are estimates of daily exposure levels that are likely to cause significant adverse non-carcinogenic health effects over a lifetime.	RfDs will be considered during development of PRGs.
USEPA Carcinogenic Assessment Group, Cancer Slope Factors (CSFs)	USEPA CSFs	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to site contaminants and represent the most up-to-date information on cancer risk from USEPA's Carcinogenic Assessment Group.	CSFs will be considered during development of PRGs.
Guidelines for Carcinogenic Risk Assessment	EPA/630/P-03/001F, March 2005	To Be Considered	These guidance values are to be used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	These guidelines will be considered during development of PRGs.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F, March 2005	To Be Considered	These Guidance values are to be used to evaluate the potential carcinogenic hazard to children caused by exposure to contaminants.	These guidelines will be considered during development of PRGs.
Regional Screening Levels for Chemical Contaminants at Superfund Sites		To Be Considered	Regional Screening Levels (RSLs) are risk-based tools for screening contaminants at Superfund sites. RSLs are not intended to be cleanup standards.	RSLs will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.
Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites	OSWER 9355.4-24 (2002)	To Be Considered	EPA guidance for evaluating soil contamination. Used to develop risk-based cleanup standards, including based on the leaching of soil contaminants to groundwater.	This guidance will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.

Table 2.1-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
TMPs in Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Soil Screening Guidance: Technical Background Document	EPA/540/R95/ 128 (1996)	To Be Considered	EPA guidance for evaluating soil contamination. Used to develop risk-based cleanup standards.	This guidance will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.

Prepared By / Date: APP 04/24/2019
Checked By / Date: MJM 05/08/2019

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CSF = cancer slope factor
OSWER = Office of Solid Waste and Emergency Response
PRGs = Preliminary Remediation Goals
RfD = reference dose
RSL = Regional Screening Level
USEPA = United States Environmental Protection Agency

Table 2.1-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
TMPs in Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards					
Hazardous Waste Treatment, Storage, Disposal	Resource Conservation and Recovery Act (RCRA) Subtitle C; Hazardous Waste Identification; Generator and Handler Requirements; Tracking Requirements; Storage, Treatment and Disposal Requirements; Groundwater Monitoring Requirements; Closure and Post Closure Requirements; Land Disposal Restriction Requirements	42 USC § 6901 et seq.; 40 CFR Parts 260-262, Part 264/(including Subparts B, C, D, E, F, G, I, J, K, L, M, N, W, X) and Part 268	Potentially Applicable or Relevant and Appropriate	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. These provisions have been adopted by the Commonwealth.	Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous waste. Non-hazardous wastes will be disposed of appropriately. Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.

Table 2.1-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
TMPs in Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Air Emissions	RCRA, Air Emission Standards for Process Vents, Equipment Leaks, Tanks, Surface Impoundments, and Containers	40 CFR Part 264, Subparts AA, BB, and CC	Applicable, if hazardous waste with volatile organic concentrations of at least 10 parts per million by weight (ppmw) (Subpart AA), with organic concentrations of at least 10 % by weight (Subpart BB), will be treated, stored, or disposed of in tanks, surface impoundments, or containers, and thresholds are met (Subpart CC). Relevant and Appropriate, if less than thresholds.	RCRA emissions standards not delegated to the State. Standards for process vents for systems that manage hazardous wastes that have organic concentrations of at least 10 ppmw. Standards for air equipment leaks for systems that manage hazardous wastes with organic concentrations of at least 10% by weight. Standards for certain tanks, surface impoundments, containers that treat, store, or dispose of hazardous wastes.	Any hazardous wastes generated during remedial activities that meet these rules' threshold requirements will be managed in accordance with these regulations.
Air Emissions	Clean Air Act (CAA), Hazardous Air Pollutants; National Emission Standards for Hazardous Air Pollutants (NESHAPs)	42 USC § 112(b)(1); 40 CFR Part 61	Potentially Applicable	These regulations establish emissions standards for 189 hazardous air pollutants.	No air emissions from remedial activities, such as soil excavation, will cause air quality standards to be exceeded. Dust standards will be complied with during remedial activities.
Investigation-Derived waste (IDW)	Guide to Management of Investigation-Derived Wastes	USEPA OSWER Publication 9345.3-03FS, January 1992	To Be Considered	Guidance on management of IDW in a manner that ensures protection of human health and the environment.	IDW generated during remedial activities and monitoring comply with this guidance

Table 2.1-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
TMPs in Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Vapor Intrusion	OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air.	OSWER 9200.2-154 (June 2015)	To Be Considered	EPA guidance for addressing vapor intrusion issues at CERCLA sites.	This guidance will be considered during development and implementation of remedial alternatives related to vapor intrusion.
State Standards					
Hazardous Waste Identification	Massachusetts Hazardous Waste Management Rules for Identification and Listing of Hazardous Wastes	310 CMR 30.100	Applicable	Massachusetts is delegated to administer RCRA through its state regulations. These regulations establish requirements for determining whether wastes are either listed or characteristic hazardous waste.	These Massachusetts regulations supplement federal RCRA requirements. Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous wastes. Non-hazardous wastes will be disposed of appropriately.
Hazardous Waste - Generator Standards	Massachusetts Hazardous Waste Rules – Requirements for Generators	310 CMR 30.300	Applicable for listed wastes that still display characteristics, or for hazardous wastes generated as part of a cleanup; Relevant and Appropriate for non-listed hazardous waste left in-place	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.

Table 2.1-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
TMPs in Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Management Facility Standards	Massachusetts Hazardous Waste Rules – Management Standards for All Hazardous Waste Facilities	310 CMR 30.500	Applicable for listed wastes that still display characteristics, or for hazardous wastes generated as part of a cleanup; Relevant and Appropriate for non-listed hazardous waste left in-place	General facility requirements for waste analysis, security measures, inspections, and training requirements. Section 30.580 addresses closure and, Section 30.590 addresses post-closure of hazardous waste facilities.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.
Hazardous Waste - Containers	Massachusetts Hazardous Waste Rules – Use and Management of Containers	310 CMR 30.680	Potentially Applicable	310 CMR 30.681 through 30.689 prescribe requirements for the use of containers, such as drums, to store hazardous waste. Provides specifications for *inter alia* labelling and marking, management of containers, inspections, and closure.	Establishes requirements for the management of containers, such as drums, that are used to store hazardous wastes. Alternatives handling containers of hazardous waste will comply with this ARAR.
Hazardous Waste - Tanks	Massachusetts Hazardous Waste Rules – Storage and Treatment in Tanks	310 CMR 30.690	Potentially Applicable	310 CMR 30.691 through 30.699 prescribe requirements for the use of tanks to store and treat hazardous waste. Provides specifications for *inter alia* design and installation, containment and detection of leaks, general operating requirements, inspections, and closure and post-closure care.	Alternatives utilizing tanks for storage or treatment of hazardous waste will comply with this ARAR.
Air Emissions	Massachusetts Ambient Air Quality Standards	310 CMR 6.00	Applicable	These regulations establish primary and secondary standards for emissions of sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead.	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.

Table 2.1-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
TMPs in Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Air Emissions	Massachusetts Air Pollution Control Regulations	310 CMR 7.00	Applicable	These regulations set emission limits necessary to attain ambient air quality standards, including standards for visible emissions (7.06); dust, odor, construction and demolition (7.09); noise (7.10); and volatile organic compounds (7.18).	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.
Institutional Controls	Massachusetts Contingency Plan, Implementation of Activity and Use Limitations	310 CMR 40.1070(4)	Relevant and Appropriate	Establish standards for the use of Notice of Activity and Use Limitations, a form of institutional controls, at CERCLA sites in Massachusetts.	Institutional controls will be established consistent with state standards for enforceable restrictions on contaminated property to prevent human contact with contamination and to protect remedial infrastructure.
Sediment/Erosion Control; Stormwater Management	Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas	Prepared for Massachusetts Executive Office of Environmental Affairs (original print March 1997; reprint May 2003)	To Be Considered	Guidance on preventing erosion and sedimentation.	Remedial activities will be managed to control erosion and sedimentation.

Prepared By / Date: APP 04/24/2019
Checked By / Date: MJM 05/08/2019

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
IDW = Investigation Derived Waste
NESHAP = National Emission Standards for Hazardous Air Pollutant
OSWER = Office of Solid Waste and Emergency Response
ppmw = parts per million by weight
RCRA = Resource Conservation and Recovery Act
USC = United States Code
USEPA = United States Environmental Protection Agency

Table 2.1-4
Location-Specific ARARs, Criteria, Advisories, and Guidance
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards					
Floodplains and Wetlands	Floodplain Management and Protection of Wetlands	44 CFR Part 9 (implementing Executive Orders 11988 and 11990)	Applicable	Federal Emergency Management Agency (FEMA) regulations set forth the policy, procedure, and responsibilities to implement and enforce Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). These regulations prohibit activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. These regulations require the avoidance of impacts associated with the occupancy and modification of federally-designated 100-year and 500-year floodplains and require the avoidance of development within a floodplain wherever there is a practicable alternative. An assessment of impacts to the 500-year floodplain is required for critical actions, which includes siting waste facilities in a floodplain. These regulations require public notice when proposing any action in or affecting floodplains or wetlands.	If there is no practical alternative method of work in federal jurisdictional wetlands, or 100-year or 500-year floodplains, then all practical measures will be taken to minimize and mitigate any adverse impacts. Erosion and sediment control measures will be adopted during remedial activities to protect these wetlands and floodplains. After completion of work, there will be no significant net loss of flood storage capacity and no significant net increase in flood stage or velocities. Floodplain habitat will be restored to the extent practicable. Public comment will be solicited as part of the Proposed Plan concerning any proposed alteration to wetlands and floodplains.
Floodplains	RCRA Floodplain Restrictions for Hazardous Waste Facilities	42 USC § 6901 et seq.; 40 CFR § 264.18(b)	Applicable	A hazardous waste treatment, storage, or disposal facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout or to result in no adverse effects on human health or the environment if washout were to occur.	Any hazardous waste generated during remedial activities will be managed so that it will not impact floodplain resources.
Floodplains	RCRA Floodplain Restrictions for Solid Waste Disposal Facilities and Practices	40 CFR § 257.3-1	Applicable	Solid waste practices must not restrict the flow of a 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources.	Any solid waste generated from remedial activities involving excavation activities will be managed so that it will not impact floodplain resources.

Table 2.1-4
Location-Specific ARARs, Criteria, Advisories, and Guidance
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Wetlands, Aquatic Ecosystem	Clean Water Act (CWA) Section 404 and regulations	33 USC § 1344; 40 CFR Parts 230 & 231; and 33 CFR Parts 320-323	Applicable	For discharge of dredged or fill material into water bodies or wetlands, there must be no practicable alternative with less adverse impact on aquatic ecosystem; discharge cannot cause or contribute to violation of state water quality standards or toxic effluent standards or jeopardize threatened or endangered species; discharge cannot significantly degrade waters of U.S.; practicable steps must be taken to minimize and mitigate adverse impacts; and impacts on flood level, flood velocity, and flood storage capacity must be evaluated. Sets standards for restoration and mitigation required as a result of unavoidable impacts to aquatic resources. USEPA must determine which alternative is the "Least Environmentally Damaging Practicable Alternative" (LEDPA) to protect wetland and aquatic resources.	Remedial alternatives will be developed and designed to comply with these regulations. Compensatory wetlands mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives.
Wetlands	U.S. Army Corps of Engineers, New England District Compensatory Mitigation Guidance (09-07-2016)	New England District Compensatory Mitigation Guidance (09-07-2016)	To Be Considered	This Guidance is to be considered when compensatory mitigation to address impacts to federal jurisdiction wetlands is appropriate for a particular remedial activity.	Activities affecting federal jurisdictional wetlands will be conducted in accordance with these guidance standards for mitigation and restoration.
Surface Waters, Wetland/Waterway Habitat for Endangered Species, Migratory Species	Fish and Wildlife Coordination Act	16 USC §§ 662-663; 40 CFR Part 6	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss to the maximum extent practicable.	To the extent necessary, actions will be taken to develop measures to prevent, mitigate, or compensate for project-related impacts to habitat and wildlife. The USFWS, acting as a review agency for the USEPA, will be kept informed of proposed remedial activities.
Endangered Species	Endangered Species Act	50 CFR §§ 17.11-17.12; 50 CFR Part 402	Applicable, if endangered species are encountered	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	Protection of endangered species and their habitat will be considered during development and design of remedial alternatives.

Table 2.1-4
Location-Specific ARARs, Criteria, Advisories, and Guidance
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Historical/ Archeological Resources	National Historic Preservation Act	16 USC § 469 et seq.; 36 CFR Part 65	Applicable, if subject historical resources are present	When a federal agency finds, or is notified, that its activities in connection with a federal construction project may cause irreparable loss or destruction of significant scientific, pre-historical, historical, or archeological data, the substantive standards under the Act will be met.	Any undisturbed areas altered by the remedial activities will be assessed to ensure no protected resource areas are present. If present, federal and state preservation officials will be consulted to address measures to avoid, minimize, and/or mitigate any impacts to protected resource areas.
Atlantic Flyway	Migratory Bird Treaty Act	16 USC § 703 et seq.	Applicable, if subject protected species are present	Protects migratory birds, their nests and eggs. A depredation permit issued by the U.S. Fish and Wildlife Service is required to take, possess, or transport migratory birds or disturb their nests, eggs, or young.	Remedial activities will be evaluated to protect migratory birds, their nests and eggs. If migratory bird protected areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.
State Standards					
Floodplains, Wetlands, Surface Waters	Massachusetts Wetland Protection Act and Regulations	MGL c. 131, § 40; 310 CMR 10.00	Applicable	These regulations restrict dredging, filling, altering, or polluting inland wetland resource areas (defined as areas within the 100-year floodplain) and impose performance standards for work in such areas. Protected resource areas include: 10.54 (Bank); 10.55 (Bordering Vegetated Wetlands); 10.56 (Land under Water Bodies and Waterways); 10.57 (Land Subject to Flooding); and 10.58 (Riverfront Area).	Any remedial activity conducted within a state regulated wetland resource area will comply with the substantive requirements of these regulations. Mitigation of impacts on state wetland resource areas will be addressed.
Floodplains	Massachusetts Hazardous Waste regulations, Location Standards for Land Subject to Flooding	310 CMR 30.701	Applicable	Any new or expanded hazardous waste storage or treatment facility (which only receives hazardous waste from on-site sources), the active portion of which is located within the boundary of land subject to flooding from the statistical 100-year frequency storm, shall be flood-proofed. Flood-proofing shall be designed, constructed, operated and maintained to prevent floodwaters from coming into contact with hazardous waste.	To the extent any hazardous waste is generated during the remedial activities, the wastes will be managed so that it will not impact floodplain resources.

Table 2.1-4
Location-Specific ARARs, Criteria, Advisories, and Guidance
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Wetlands, Aquatic Ecosystem	Massachusetts Water Quality Certification for Discharge of Dredged or Fill Material	MGL c. 21, §§ 26-53; 314 CMR 9.00	Applicable	For discharges of dredged or fill material, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; appropriate and practicable steps must be taken to avoid and minimize potential adverse impacts to wetlands and land under water; stormwater discharges must be controlled with BMPs; and there must not be substantial adverse impacts to the physical, chemical, or biological integrity of surface waters. For dredging and dredged material management, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; and if avoidance is not possible, then minimize, or if neither avoidance or minimization are possible, then mitigate potential adverse impacts.	The remedial alternatives' effects on the aquatic ecosystem will be evaluated and avoided, and/or minimized. Compensatory mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives. Any required removal of soil/sediment from wetland or surface water areas will be designated for eventual restoration. Excavation and filling activities to be performed impacting the aquatic ecosystem will be in accordance with the substantive requirements of these regulations.
Endangered Species	Massachusetts Endangered Species Regulations	321 CMR 10.00	Applicable, if endangered species are encountered	Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural Heritage Program.	The protection of state listed endangered species will be considered during the development and design of remedial alternatives.
Historical/ Archeological Resources	Protection of Properties Included in the State Register of Historic Places	MGL c. 9, §§ 26-27C; 950 CMR 71.00	Applicable, if subject historical resources are present	Projects must eliminate, limit, or mitigate adverse effects to properties listed in the State Register of Historic Places (historic and archaeological properties). Establishes coordination with the National Historic Preservation Act.	If protected resource areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials.

Table 2.1-4
Location-Specific ARARs, Criteria, Advisories, and Guidance
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Area of Critical Environmental Concern	Massachusetts Areas of Critical Environmental Concern (ACECs) Regulations	310 CMR 12.00	Applicable, if ACEC is identified	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical interrelationships among a number of components. An eligible area must contain features from four or more of the following groups: (1) fisheries, (2) coastal features, (3) estuarine wetlands, (4) inland wetlands, (5) inland surface waters, (6) water supply areas (e.g., aquifer recharge area); (7) natural hazard areas (e.g., floodplain); (8) agricultural areas; (9) historical/archeological resources; (10) habitat resources (e.g., for endangered wildlife); or (11) special use areas. After an area is designated as an ACEC, the aim is to preserve and restore these areas.	If ACEC is identified in the site area, activities will be controlled to minimize impacts to affected species.

Prepared By / Date: APP 04/11/2019
Checked By / Date: MJM 05/08/2019

Notes:
ACEC = Areas of Critical Environmental Concern
ARAR = Applicable or Relevant and Appropriate Requirement
BMP = Best Management Practice
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
CWA = Clean Water Act
DAPL = Dense Aqueous Phase Liquid
FEMA = Federal Emergency Management Agency
LEDPA = Least Environmentally Damaging Practicable Alternative
MGL = Massachusetts General Law
RCRA = Resource Conservation and Recovery Act
USEPA = United States Environmental Protection Agency
USFWS = United States Fish and Wildlife Service
USC = United States Code

Table 2.1-5
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards				
Ontario Ministry of Environment and Energy (OMEE) Severe Effect Levels (SELs) for Freshwater Sediments	(Persaud et al., 1993)	To Be Considered	The SEL value is the concentration at which the majority of the sediment-dwelling organisms are affected. Used to develop risk-based cleanup standards.	SELs will be used to assess ecological risks due to exposure to chemicals in sediment and to develop sediment PRGs.
Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Probable Effects Concentrations (PECs)	(MacDonald et al., 2000)	To Be Considered	The SEL value is the concentration at which the majority of the sediment-dwelling organisms are affected. Used to develop risk-based cleanup standards.	PECs will be used to assess ecological risks due to exposure to chemicals in sediment and to develop sediment PRGs.

Prepared By / Date: APP 04/11/2019
Checked By / Date: MJM 05/08/2019

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
OMEG = Ontario Ministry of Environment and Energy
PEC = Probable Effects Concentration
PRGs = Preliminary Remediation Goals
SEL - Severe Effect Level

Table 2.1-6
Action-Specific ARARs, Criteria, Advisories, and Guidance
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards					
Hazardous Waste Treatment, Storage, Disposal	Resource Conservation and Recovery Act (RCRA) Subtitle C; Hazardous Waste Identification; Generator and Handler Requirements; Tracking Requirements; Storage, Treatment and Disposal Requirements; Groundwater Monitoring Requirements; Closure and Post Closure Requirements; Land Disposal Restriction Requirements	42 USC § 6901 et seq.; 40 CFR Parts 260-262, Part 264/(including Subparts B, C, D, E, F, G, I, J, K, L, M, N, W, X) and Part 268	Potentially Applicable or Relevant and Appropriate	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. These provisions have been adopted by the Commonwealth.	Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous waste. Non-hazardous wastes will be disposed of appropriately. Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.

Table 2.1-6
Action-Specific ARARs, Criteria, Advisories, and Guidance
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Air Emissions	RCRA, Air Emission Standards for Process Vents, Equipment Leaks, Tanks, Surface Impoundments, and Containers	40 CFR Part 264, Subparts AA, BB, and CC	Applicable, if hazardous waste with volatile organic concentrations of at least 10 parts per million by weight (ppmw) (Subpart AA), with organic concentrations of at least 10 % by weight (Subpart BB), will be treated, stored, or disposed of in tanks, surface impoundments, or containers, and thresholds are met (Subpart CC). Relevant and Appropriate, if less than thresholds.	RCRA emissions standards not delegated to the State. Standards for process vents for systems that manage hazardous wastes that have organic concentrations of at least 10 ppmw. Standards for air equipment leaks for systems that manage hazardous wastes with organic concentrations of at least 10% by weight. Standards for certain tanks, surface impoundments, containers that treat, store, or dispose of hazardous wastes.	Any hazardous wastes generated during remedial activities that meet these rules' threshold requirements will be managed in accordance with these regulations.
Discharges to Surface Water; Storm Water Controls	Clean Water Act National Pollutant Discharge Elimination System (NPDES)	40 CFR Parts 122 and 125	Applicable	The NPDES permit program specifies the permissible concentration or level of contaminants in the discharge from any point source to waters of the United States. Also, includes storm water standards for activities disturbing more than one acre.	Any discharges to surface waters related to excavation and dewatering activities will need to have the discharges meet the substantive discharge standards (the Massachusetts Surface Water Discharge Permit Program [314 CMR 3.00] has similar requirements).
Discharges to Surface Water	Clean Water Act; Toxic Pollutant Effluent Standards	40 CFR Part 129	Applicable	Regulates surface water discharges of specific toxic pollutants, specifically certain pesticides and PCBs.	Any discharge of water contaminated with the specific toxic pollutants generated during remedial activities will be treated to meet applicable toxic pollutant discharge standards if the water is to be discharged to surface waters.

Table 2.1-6
Action-Specific ARARs, Criteria, Advisories, and Guidance
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Discharge to a Publicly Owned Treatment Works (POTW)	General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR Part 403	Applicable	Establishes responsibilities of federal, state, and local government, industry and the public to implement National Pretreatment Standards to control pollutants which pass through or interfere with treatment processes in POTWs or which may contaminate sewage sludge.	If remedial actions, such as excavation and dewatering activities, result in liquid waste streams that are discharged to a POTW, pretreatment of such waste streams will be evaluated for compliance with applicable requirements of the regulation.
Air Emissions	Clean Air Act (CAA), Hazardous Air Pollutants; National Emission Standards for Hazardous Air Pollutants (NESHAPs)	42 USC § 112(b)(1); 40 CFR Part 61	Potentially Applicable	These regulations establish emissions standards for 189 hazardous air pollutants.	No air emissions from remedial activities, such as soil excavation, will cause air quality standards to be exceeded. Dust standards will be complied with during remedial activities.
Sediment Remediation	Contaminated Sediment Remediation Guidance for Hazardous Waste Sites	EPA-540-R-05-012; OSWER 9355.0-85 (December 2005)	To Be Considered	Guidance for making remedy decisions for contaminated sediment sites. Some of the relevant sections of the guidance address Remedial Investigations (Ch. 2), FS Considerations (Ch. 3), Monitored Natural Recovery (Ch. 4), In-Situ Capping (Ch. 5), and Dredging and Excavation (Ch. 6).	Remedial alternatives will be developed and implemented with consideration of this guidance.
Investigation-Derived waste (IDW)	Guide to Management of Investigation-Derived Wastes	USEPA OSWER Publication 9345.3-03FS, January 1992	To Be Considered	Guidance on management of IDW in a manner that ensures protection of human health and the environment.	IDW generated during remedial activities and monitoring comply with this guidance
State Standards					
Hazardous Waste Identification	Massachusetts Hazardous Waste Management Rules for Identification and Listing of Hazardous Wastes	310 CMR 30.100	Applicable	Massachusetts is delegated to administer RCRA through its state regulations. These regulations establish requirements for determining whether wastes are either listed or characteristic hazardous waste.	These Massachusetts regulations supplement federal RCRA requirements. Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous wastes. Non-hazardous wastes will be disposed of appropriately.

Table 2.1-6
Action-Specific ARARs, Criteria, Advisories, and Guidance
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Generator Standards	Massachusetts Hazardous Waste Rules – Requirements for Generators	310 CMR 30.300	Applicable for listed wastes that still display characteristics, or for hazardous wastes generated as part of a cleanup; Relevant and Appropriate for non-listed hazardous waste left in-place	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.
Hazardous Waste - Management Facility Standards	Massachusetts Hazardous Waste Rules – Management Standards for All Hazardous Waste Facilities	310 CMR 30.500	Applicable for listed wastes that still display characteristics, or for hazardous wastes generated as part of a cleanup; Relevant and Appropriate for non-listed hazardous waste left in-place	General facility requirements for waste analysis, security measures, inspections, and training requirements. Section 30.580 addresses closure and, Section 30.590 addresses post-closure of hazardous waste facilities.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.
Hazardous Waste - Groundwater	Massachusetts Hazardous Waste Rules – Groundwater Protection	310 CMR 30.660	Applicable	310 CMR 30.661 through 30.673 prescribe requirements for regulated units that receive hazardous waste, except for certain waste piles, to protect groundwater.	Any hazardous waste generated by remedial alternatives that involve excavation of soil/sediment will be managed to prevent contaminant migration to groundwater.

Table 2.1-6
Action-Specific ARARs, Criteria, Advisories, and Guidance
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Containers	Massachusetts Hazardous Waste Rules – Use and Management of Containers	310 CMR 30.680	Potentially Applicable	310 CMR 30.681 through 30.689 prescribe requirements for the use of containers, such as drums, to store hazardous waste. Provides specifications for *inter alia* labelling and marking, management of containers, inspections, and closure.	Establishes requirements for the management of containers, such as drums, that are used to store hazardous wastes. Alternatives handling containers of hazardous waste will comply with this ARAR.
Hazardous Waste - Tanks	Massachusetts Hazardous Waste Rules – Storage and Treatment in Tanks	310 CMR 30.690	Potentially Applicable	310 CMR 30.691 through 30.699 prescribe requirements for the use of tanks to store and treat hazardous waste. Provides specifications for *inter alia* design and installation, containment and detection of leaks, general operating requirements, inspections, and closure and post-closure care.	Alternatives utilizing tanks for storage or treatment of hazardous waste will comply with this ARAR.
Discharges to Surface Waters	Massachusetts Clean Water Act; Surface Water Discharge Permit Regulations	MGL c. 21, §§ 26-53; 314 CMR 3.00	Applicable, if surface water discharge occurs	These regulations provide that discharges to waters of the Commonwealth shall not result in exceedances of Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00).	Any discharges to surface waters related to excavation and dewatering activities will need to have the discharges meet the substantive discharge standards of the Massachusetts Surface Water Discharge Permit (314 CMR 4.00).
Surface Water Quality Monitoring	Massachusetts Clean Water Act; MA Surface Water Quality Standards (MSWQS)	M.G.L. c. 21, §§ 26-53; 314 CMR 4.00	Applicable	These standards designate the most sensitive uses for which the various waters of the Commonwealth shall be enhanced, maintained, or protected. Minimum water quality criteria required to sustain the designated uses are established.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet the MSWQS.
Hazardous Waste - Facility Discharge Standards	Massachusetts Supplemental Requirements for Hazardous Waste Management Facilities	MGL c. 21, §§ 26-53; 314 CMR 8.00	Relevant and Appropriate	This regulation establishes additional requirements that must be satisfied for a RCRA facility (a wastewater treatment works which manages hazardous waste) that has a wastewater discharge permit.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet these standards.

Table 2.1-6
Action-Specific ARARs, Criteria, Advisories, and Guidance
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Air Emissions	Massachusetts Ambient Air Quality Standards	310 CMR 6.00	Applicable	These regulations establish primary and secondary standards for emissions of sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead.	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.
Air Emissions	Massachusetts Air Pollution Control Regulations	310 CMR 7.00	Applicable	These regulations set emission limits necessary to attain ambient air quality standards, including standards for visible emissions (7.06); dust, odor, construction and demolition (7.09); noise (7.10); and volatile organic compounds (7.18).	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.
Institutional Controls	Massachusetts Contingency Plan, Implementation of Activity and Use Limitations	310 CMR 40.1070(4)	Relevant and Appropriate	Establish standards for the use of Notice of Activity and Use Limitations, a form of institutional controls, at CERCLA sites in Massachusetts.	Institutional controls will be established consistent with state standards for enforceable restrictions on contaminated property to prevent human contact with contamination and to protect remedial infrastructure.
Monitoring Wells	Massachusetts Standard References for Monitoring Wells	WSC-310-91	To Be Considered	Guidance on locating, drilling, installing, sampling and decommissioning monitoring wells.	Monitoring wells that may be required as part of a post-remediation monitoring program will be installed, maintained and decommissioned based on these guidance standards.
Sediment/Erosion Control; Stormwater Management	Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas	Prepared for Massachusetts Executive Office of Environmental Affairs (original print March 1997; reprint May 2003)	To Be Considered	Guidance on preventing erosion and sedimentation.	Remedial activities will be managed to control erosion and sedimentation.

Prepared By / Date: APP 04/11/2019
Checked By / Date: MJM 05/08/2019

Table 2.1-6
Action-Specific ARARs, Criteria, Advisories, and Guidance
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
IDW = Investigation Derived Waste
MGL = Massachusetts General Law
MSWQC = Massachusetts Surface Water Quality Criteria
NESHAP = National Emission Standards for Hazardous Air Pollutant
NPDES = National Pollution Discharge Elimination System
OSWER = Office of Solid Waste and Emergency Response
POTW = Publicly Owned Treatment Works
ppmw = parts per million by weight
RCRA = Resource Conservation and Recovery Act
USC = United States Code
USEPA = United States Environmental Protection Agency

Table 2.1-7
Location-Specific ARARs, Criteria, Advisories, and Guidance
South Ditch Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards					
Floodplains and Wetlands	Floodplain Management and Protection of Wetlands	44 CFR Part 9 (implementing Executive Orders 11988 and 11990)	Applicable	Federal Emergency Management Agency (FEMA) regulations set forth the policy, procedure, and responsibilities to implement and enforce Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). These regulations prohibit activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. These regulations require the avoidance of impacts associated with the occupancy and modification of federally-designated 100-year and 500-year floodplains and require the avoidance of development within a floodplain wherever there is a practicable alternative. An assessment of impacts to the 500-year floodplain is required for critical actions, which includes siting waste facilities in a floodplain. These regulations require public notice when proposing any action in or affecting floodplains or wetlands.	If there is no practical alternative method of work in federal jurisdictional wetlands, or 100-year or 500-year floodplains, then all practical measures will be taken to minimize and mitigate any adverse impacts. Erosion and sediment control measures will be adopted during remedial activities to protect these wetlands and floodplains. After completion of work, there will be no significant net loss of flood storage capacity and no significant net increase in flood stage or velocities. Floodplain habitat will be restored to the extent practicable. Public comment will be solicited as part of the Proposed Plan concerning any proposed alteration to wetlands and floodplains.
Floodplains	RCRA Floodplain Restrictions for Hazardous Waste Facilities	42 USC § 6901 et seq.; 40 CFR § 264.18(b)	Applicable	A hazardous waste treatment, storage, or disposal facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout or to result in no adverse effects on human health or the environment if washout were to occur.	Any hazardous waste generated during remedial activities will be managed so that it will not impact floodplain resources.
Floodplains	RCRA Floodplain Restrictions for Solid Waste Disposal Facilities and Practices	40 CFR § 257.3-1	Applicable	Solid waste practices must not restrict the flow of a 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources.	Any solid waste generated from remedial activities involving excavation activities will be managed so that it will not impact floodplain resources.

Table 2.1-7
Location-Specific ARARs, Criteria, Advisories, and Guidance
South Ditch Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Wetlands, Aquatic Ecosystem	Clean Water Act (CWA) Section 404 and regulations	33 USC § 1344; 40 CFR Parts 230 & 231; and 33 CFR Parts 320-323	Applicable	For discharge of dredged or fill material into water bodies or wetlands, there must be no practicable alternative with less adverse impact on aquatic ecosystem; discharge cannot cause or contribute to violation of state water quality standards or toxic effluent standards or jeopardize threatened or endangered species; discharge cannot significantly degrade waters of U.S.; practicable steps must be taken to minimize and mitigate adverse impacts; and impacts on flood level, flood velocity, and flood storage capacity must be evaluated. Sets standards for restoration and mitigation required as a result of unavoidable impacts to aquatic resources. USEPA must determine which alternative is the "Least Environmentally Damaging Practicable Alternative" (LEDPA) to protect wetland and aquatic resources.	Remedial alternatives will be developed and designed to comply with these regulations. Compensatory wetlands mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives.
Wetlands	U.S. Army Corps of Engineers, New England District Compensatory Mitigation Guidance (09-07-2016)	New England District Compensatory Mitigation Guidance (09-07-2016)	To Be Considered	This Guidance is to be considered when compensatory mitigation to address impacts to federal jurisdiction wetlands is appropriate for a particular remedial activity.	Activities affecting federal jurisdictional wetlands will be conducted in accordance with these guidance standards for mitigation and restoration.
Surface Waters, Wetland/Waterway Habitat for Endangered Species, Migratory Species	Fish and Wildlife Coordination Act	16 USC §§ 662-663; 40 CFR Part 6	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss to the maximum extent practicable.	To the extent necessary, actions will be taken to develop measures to prevent, mitigate, or compensate for project-related impacts to habitat and wildlife. The USFWS, acting as a review agency for the USEPA, will be kept informed of proposed remedial activities.
Endangered Species	Endangered Species Act	50 CFR §§ 17.11-17.12; 50 CFR Part 402	Applicable, if endangered species are encountered	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	Protection of endangered species and their habitat will be considered during development and design of remedial alternatives.

Table 2.1-7
Location-Specific ARARs, Criteria, Advisories, and Guidance
South Ditch Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Historical/ Archeological Resources	National Historic Preservation Act	16 USC § 469 et seq.; 36 CFR Part 65	Applicable, if subject historical resources are present	When a federal agency finds, or is notified, that its activities in connection with a federal construction project may cause irreparable loss or destruction of significant scientific, pre-historical, historical, or archeological data, the substantive standards under the Act will be met.	Any undisturbed areas altered by the remedial activities will be assessed to ensure no protected resource areas are present. If present, federal and state preservation officials will be consulted to address measures to avoid, minimize, and/or mitigate any impacts to protected resource areas.
Atlantic Flyway	Migratory Bird Treaty Act	16 USC § 703 et seq.	Applicable, if subject protected species are present	Protects migratory birds, their nests and eggs. A depredation permit issued by the U.S. Fish and Wildlife Service is required to take, possess, or transport migratory birds or disturb their nests, eggs, or young.	Remedial activities will be evaluated to protect migratory birds, their nests and eggs. If migratory bird protected areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.
State Standards					
Floodplains, Wetlands, Surface Waters	Massachusetts Wetland Protection Act and Regulations	MGL c. 131, § 40; 310 CMR 10.00	Applicable	These regulations restrict dredging, filling, altering, or polluting inland wetland resource areas (defined as areas within the 100-year floodplain) and impose performance standards for work in such areas. Protected resource areas include: 10.54 (Bank); 10.55 (Bordering Vegetated Wetlands); 10.56 (Land under Water Bodies and Waterways); 10.57 (Land Subject to Flooding); and 10.58 (Riverfront Area).	Any remedial activity conducted within a state regulated wetland resource area will comply with the substantive requirements of these regulations. Mitigation of impacts on state wetland resource areas will be addressed.
Floodplains	Massachusetts Hazardous Waste regulations, Location Standards for Land Subject to Flooding	310 CMR 30.701	Applicable	Any new or expanded hazardous waste storage or treatment facility (which only receives hazardous waste from on-site sources), the active portion of which is located within the boundary of land subject to flooding from the statistical 100-year frequency storm, shall be flood-proofed. Flood-proofing shall be designed, constructed, operated and maintained to prevent floodwaters from coming into contact with hazardous waste.	To the extent any hazardous waste is generated during the remedial activities, the wastes will be managed so that it will not impact floodplain resources.

Table 2.1-7
Location-Specific ARARs, Criteria, Advisories, and Guidance
South Ditch Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Wetlands, Aquatic Ecosystem	Massachusetts Water Quality Certification for Discharge of Dredged or Fill Material	MGL c. 21, §§ 26-53; 314 CMR 9.00	Applicable	For discharges of dredged or fill material, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; appropriate and practicable steps must be taken to avoid and minimize potential adverse impacts to wetlands and land under water; stormwater discharges must be controlled with BMPs; and there must not be substantial adverse impacts to the physical, chemical, or biological integrity of surface waters. For dredging and dredged material management, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; and if avoidance is not possible, then minimize, or if neither avoidance or minimization are possible, then mitigate potential adverse impacts.	The remedial alternatives' effects on the aquatic ecosystem will be evaluated and avoided, and/or minimized. Compensatory mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives. Any required removal of soil/sediment from wetland or surface water areas will be designated for eventual restoration. Excavation and filling activities to be performed impacting the aquatic ecosystem will be in accordance with the substantive requirements of these regulations.
Endangered Species	Massachusetts Endangered Species Regulations	321 CMR 10.00	Applicable, if endangered species are encountered	Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural Heritage Program.	The protection of state listed endangered species will be considered during the development and design of remedial alternatives.
Historical/ Archeological Resources	Protection of Properties Included in the State Register of Historic Places	MGL c. 9, §§ 26-27C; 950 CMR 71.00	Applicable, if subject historical resources are present	Projects must eliminate, limit, or mitigate adverse effects to properties listed in the State Register of Historic Places (historic and archaeological properties). Establishes coordination with the National Historic Preservation Act.	If protected resource areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials.

Table 2.1-7
Location-Specific ARARs, Criteria, Advisories, and Guidance
South Ditch Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Area of Critical Environmental Concern	Massachusetts Areas of Critical Environmental Concern (ACECs) Regulations	310 CMR 12.00	Applicable, if ACEC is identified	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical interrelationships among a number of components. An eligible area must contain features from four or more of the following groups: (1) fisheries, (2) coastal features, (3) estuarine wetlands, (4) inland wetlands, (5) inland surface waters, (6) water supply areas (e.g., aquifer recharge area); (7) natural hazard areas (e.g., floodplain); (8) agricultural areas; (9) historical/archeological resources; (10) habitat resources (e.g., for endangered wildlife); or (11) special use areas. After an area is designated as an ACEC, the aim is to preserve and restore these areas.	If ACEC is identified in the site area, activities will be controlled to minimize impacts to affected species.

Prepared By / Date: APP 04/11/2019
Checked By / Date: MJM 05/08/2019

Notes:
ACEC = Areas of Critical Environmental Concern
ARAR = Applicable or Relevant and Appropriate Requirement
BMP = Best Management Practice
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
CWA = Clean Water Act
DAPL = Dense Aqueous Phase Liquid
FEMA = Federal Emergency Management Agency
LEDPA = Least Environmentally Damaging Practicable Alternative
MGL = Massachusetts General Law
RCRA = Resource Conservation and Recovery Act
USEPA = United States Environmental Protection Agency
USFWS = United States Fish and Wildlife Service
USC = United States Code

Table 2.1-8
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
South Ditch Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards				
Clean Water Act (CWA) National Recommended Water Quality Criteria (NRWQC)	33 USC §1314(a); 40 CFR Part 131	Relevant and Appropriate	NRWQC are established for the protection of aquatic life and human health in surface water for approximately 150 pollutants.	NRWQCs will be used during development of surface water PRGs for protection of ecological receptors.

Prepared By / Date: APP 04/11/2019
Checked By / Date: MJM 05/08/2019

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
MCLGs = Maximum Contaminant Level Goals
NRWQC = National Recommended Water Quality Criteria
PRGs = Preliminary Remediation Goals
USC = United States Code

Table 2.1-9
Action-Specific ARARs, Criteria, Advisories, and Guidance
South Ditch Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards					
Discharges to Surface Water; Storm Water Controls	Clean Water Act National Pollutant Discharge Elimination System (NPDES)	40 CFR Parts 122 and 125	Applicable	The NPDES permit program specifies the permissible concentration or level of contaminants in the discharge from any point source to waters of the United States. Also, includes storm water standards for activities disturbing more than one acre.	Any discharges to surface waters related to excavation and dewatering activities will need to have the discharges meet the substantive discharge standards (the Massachusetts Surface Water Discharge Permit Program [314 CMR 3.00] has similar requirements).
Discharges to Surface Water	Clean Water Act; Toxic Pollutant Effluent Standards	40 CFR Part 129	Applicable	Regulates surface water discharges of specific toxic pollutants, specifically certain pesticides and PCBs.	Any discharge of water contaminated with the specific toxic pollutants generated during remedial activities will be treated to meet applicable toxic pollutant discharge standards if the water is to be discharged to surface waters.
Sediment Remediation	Contaminated Sediment Remediation Guidance for Hazardous Waste Sites	EPA-540-R-05-012; OSWER 9355.0-85 (December 2005)	To Be Considered	Guidance for making remedy decisions for contaminated sediment sites. Some of the relevant sections of the guidance address Remedial Investigations (Ch. 2), FS Considerations (Ch. 3), Monitored Natural Recovery (Ch. 4), In-Situ Capping (Ch. 5), and Dredging and Excavation (Ch. 6).	Remedial alternatives will be developed and implemented with consideration of this guidance.
Investigation-Derived waste (IDW)	Guide to Management of Investigation-Derived Wastes	USEPA OSWER Publication 9345.3-03FS, January 1992	To Be Considered	Guidance on management of IDW in a manner that ensures protection of human health and the environment.	IDW generated during remedial activities and monitoring comply with this guidance
State Standards					
Discharges to Surface Waters	Massachusetts Clean Water Act; Surface Water Discharge Permit Regulations	MGL c. 21, §§ 26-53; 314 CMR 3.00	Applicable, if surface water discharge occurs	These regulations provide that discharges to waters of the Commonwealth shall not result in exceedances of Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00).	Any discharges to surface waters related to excavation and dewatering activities will need to have the discharges meet the substantive discharge standards of the Massachusetts Surface Water Discharge Permit (314 CMR 4.00).
Surface Water Quality Monitoring	Massachusetts Clean Water Act; MA Surface Water Quality Standards (MSWQS)	M.G.L. c. 21, §§ 26-53; 314 CMR 4.00	Applicable	These standards designate the most sensitive uses for which the various waters of the Commonwealth shall be enhanced, maintained, or protected. Minimum water quality criteria required to sustain the designated uses are established.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet the MSWQS.

Table 2.1-9
Action-Specific ARARs, Criteria, Advisories, and Guidance
South Ditch Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Facility Discharge Standards	Massachusetts Supplemental Requirements for Hazardous Waste Management Facilities	MGL c. 21, §§ 26-53; 314 CMR 8.00	Relevant and Appropriate	This regulation establishes additional requirements that must be satisfied for a RCRA facility (a wastewater treatment works which manages hazardous waste) that has a wastewater discharge permit.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet these standards.
Institutional Controls	Massachusetts Contingency Plan, Implementation of Activity and Use Limitations	310 CMR 40.1070(4)	Relevant and Appropriate	Establish standards for the use of Notice of Activity and Use Limitations, a form of institutional controls, at CERCLA sites in Massachusetts.	Institutional controls will be established consistent with state standards for enforceable restrictions on contaminated property to prevent human contact with contamination and to protect remedial infrastructure.
Monitoring Wells	Massachusetts Standard References for Monitoring Wells	WSC-310-91	To Be Considered	Guidance on locating, drilling, installing, sampling and decommissioning monitoring wells.	Monitoring wells that may be required as part of a post-remediation monitoring program will be installed, maintained and decommissioned based on these guidance standards.
Sediment/Erosion Control; Stormwater Management	Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas	Prepared for Massachusetts Executive Office of Environmental Affairs (original print March 1997; reprint May 2003)	To Be Considered	Guidance on preventing erosion and sedimentation.	Remedial activities will be managed to control erosion and sedimentation.

Prepared By / Date: APP 04/11/2019
Checked By / Date: MJM 05/08/2019

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
IDW = Investigation Derived Waste
MGL = Massachusetts General Law
MSWQC = Massachusetts Surface Water Quality Criteria
NPDES = National Pollution Discharge Elimination System
OSWER = Office of Solid Waste and Emergency Response
RCRA = Resource Conservation and Recovery Act
USEPA = United States Environmental Protection Agency

Table 2.3-1
Risks for Chromium, BEHP, and Ammonia in OU1 and OU2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Exposure Area and Medium	Chromium	BEHP	Ammonia
EA5 Soil			
Plants	X	-	-
Soil Invertebrates	X	-	-
Robin	X	X	-
Shrew	X	X	-
Fox	-	-	-
Hawk	-	-	-
Lower South Ditch Sediment			
Benthic Invertebrates/Amphibians	X	-	-
Marsh Wren	-	X	-
Green Herron	-	-	-
Muskrat	-	-	-
Raccoon	-	-	-
South Ditch Surface Water		-	
Benthic Invertebrates	X	-	X

Prepared by: APP 05/08/2019
Checked by: MJM 05/08/2019

Notes:
BEHP = Bis(2-ethylhexyl)phthalate)
'X' – Risks identified
'-' – Risks not identified

Table 2.3-2
Ecological PRGs for EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Contaminant	Receptor	PRG (mg/kg) For Target HQ [a]		Average Background (mg/kg)	EA5	
		HQ = 1	HQ = 10		Max	Ave
Chromium				6.2	26,344	6,648
	Plants [a]	**310**	**3,100**			
	Invertebrates	310	3,100			
	Shrew [b]	21,000	216,000			
	Robin[b]	1,990	21,344			
BEHP				0.019	103	31
	Shrew	**9.6**	**96**			
	Robin	51	519			

Prepared by: APP 05/08/2019
Checked by: MJM 05/08/2019

Notes:
[a] ***Recommended PRG*** for each target HQ is the lowest value, shown in boldfaced font.
[b] The chromium PRG for shrew and robin assume a fixed invertebrate tissue concentration of 4 mg/kg, as explained in the BERA.
BEHP = Bis(2-ethylhexyl)phthalate)
HQ = hazard Quotient
mg/kg - milligrams per kilogram
PRG = Preliminary Remediation Goal

Table 2.3-3
Ecological PRGs for Lower South Ditch Sediment

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Contaminant	Receptor	PRG (mg/kg) For Target HQ		Average Background (mg/kg)	Lower South Ditch	
		HQ = 1	HQ = 10		Max	Ave
Chromium				NA	3,000	1,922
	Invertebrates/ Amphibians	111	1,110			
BEHP				NA	920	322
	Marsh Wren	67	678			

Prepared by: APP 05/8/2019
Checked by: MJM 05/08/2019

Notes:
BEHP = Bis(2-ethylhexyl)phthalate)
HQ = hazard Quotient
mg/kg - milligrams per kilogram
NA = not applicable
PRG = Preliminary Remediation Goal

Table 2.3-4
Ecological PRGs for South Ditch Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Contaminant	Receptor	PRG (mg/L) For Target HQ		Average Background (mg/L)	South Ditch	
		HQ = 1	HQ = 10		RME	CTE
Chromium [a]				NA		
	Invertebrates	0.46	4.6		3.3	1.1
Ammonia [b]				NA		
	Invertebrates	36	360		73	56

Prepared by: APP 05/08/2019
Checked by: MJM 05/08/2019

Notes:
[a] Filtered (dissolved) concentration.
[b] The ammonia PRG is based on the freshwater chronic aquatic life National Recommended Water Quality Criterion (NRWQC) in USEPA 2013 using a default pH of 7 and assuming that salmonid fish are absent as explained in the BERA.
CTE = Central Tendency Exposure
HQ = Hazard Quotient
mg/L- milligrams per liter
NA = not applicable
RME = Reasonable Maximum Exposure

Table 3.2-1
Screening of Remedial Technologies
TMPs in OU1 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
No Action	None	No action taken	Not effective	Implementable	No Cost	Yes	Required for baseline comparison
Institutional Controls	Access and Use Restrictions						
	Deed covenants	Prohibit residential use and development of site through restrictive language in deeds and other instruments of property transfer.	Effective	Implementable	Low	Yes	Modify existing deed covenants, which currently provide restrictions on future use and activities, to include language to address potential vapor intrusion concerns associated with future buildings that may be constructed on the Property. Would also include requirements for health & safety plans to mitigate potential inhalation exposures for construction workers during excavation activities.
	Environmental Monitoring						
	Soil and sediment sampling	Collection and analysis of soil and sediment samples.	Effective	Implementable	Low	Yes	May be used in conjunction with other technologies and to assess remedy effectiveness.
Treatment	Solidification/Stabilization	Relies on encapsulation of the waste through mixing with additives and binders to immobilize contaminants by converting them into less soluble, mobile, or toxic states.	Effective; if implementable	Difficult to implement due to small volume of soil and sediment, and presence of tree roots and vegetation. The additives and binders would increase the volume of sediment and surface soil, thereby changing the stream bed elevation and negatively affecting stream flow characteristics.	Medium	No	Implementation could negatively affect stream configuration and flow characteristics.

Table 3.2-1
Screening of Remedial Technologies
TMPs in OU1 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
Treatment (continued)	Air Sparging/Soil Vapor Extraction	Relies on the mass transfer stripping of VOCs in soils using a suitable vacuum source.	Effective for removal of VOCs.	Implementable	Medium-High	Yes	Effective and implementable. Because there are currently no occupied buildings in the HHRA EA7 area, the vapor migration pathway is incomplete and treatment of TMPs is not necessary under current site conditions for direct contact or vapor intrusion. However, the technology has been retained because it would be effective and implementable to address TMPs concerns related to potential future buildings and construction worker TMP inhalation during excavation.
	In-situ Chemical Oxidation Soil Mixing	Chemical oxidant is mixing into the subsurface at the smear zone to enhance reduction/degradation of contaminants.	Chemical oxidation effective for VOCs such as TMPs.	Implementable; however, difficult to effectively deliver the reagents thoroughly throughout the subsurface treatment zone. High volatility of TMPs may require work be conducted in Level C and a perimeter air monitoring program would be required. Need to protect workers with HASP.	Medium	No	Eliminated due to implementability concerns and short-term risks to workers and nearby receptors.
	In-situ Chemical Oxidation Injections	Chemical oxidant is injected into the subsurface using direct push drilling techniques to enhance reduction/degradation of contaminants.	Chemical oxidation effective for VOCs such as TMPs.	Implementable; however, difficult to effectively deliver the reagents thoroughly throughout the subsurface treatment zone. May require multiple injection events to reach cleanup levels and for oxidation of daughter products.	Medium	No	Eliminated due to implementability concerns.

Table 3.2-1
Screening of Remedial Technologies
TMPs in OU1 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
Treatment (continued)	Ex-situ Low Temperature Thermal Desorption	The process removes and destroys organic compounds.	Effective for treatment of excavated soil contaminated with VOCs such as TMPs.	Implementable. High energy costs associated with technology. High volatility of TMPs may require work be conducted in Level C and a perimeter air monitoring program would be required. Need to protect workers with HASP.	Medium-High	No	Eliminated due to implementability concerns and short-term risks to workers and nearby receptors.
	In-situ Thermal Desorption	The process removes, oxidizes, or destroys organic compounds, but may not effectively treat inorganic constituents.	Effective for removal of VOCs.	Implementable	High	No	Thermal desorption is effective and implementable for TMPs in soil. However, in-situ thermal desorption would be more difficult to implement then ex-situ treatment and at a higher cost. Therefore, in-situ treatment was eliminated from further consideration.
	Barriers/Ventilation/Depressurization	Sub-slab ventilation or depressurization are methods to mitigate subsurface vapors from entering a building through the building's basement or floor slab. Vapors removed from beneath the building are then discharged to the atmosphere.	Effective for removal of VOCs if future buildings are constructed in the vicinity of HHRA EA7, EA3, and Lake Poly.	Implementable in the future to address VOCs (e.g., TMPs) if future buildings are constructed in the vicinity of HHRA EA7.	Medium-High	Yes	Effective, and implementable in the future if future buildings are constructed in the vicinity of HHRA EA7, EA3, and Lake Poly.
Removal	Mechanical excavation	Excavation using conventional earthmoving equipment.	Effective. Interrupts direct exposure pathway and reduces erosion and leaching if combined with protective disposal option.	Implementable. High volatility of TMPs may require work be conducted in Level C and a perimeter air monitoring program would be required.	Medium	No	Eliminated due to implementability concerns and short-term risks to workers and nearby receptors. Used in conjunction with treatment/disposal technologies.

Table 3.2-1
Screening of Remedial Technologies
TMPs in OU1 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
Disposal							
	Off-Site Disposal	Permitted landfill	Effective	Implementable	Medium	No	Removal technologies were eliminated. Therefore, disposal was also eliminated as there would not be any excavated soil generated during remedial actions.

Prepared by: APP 04/23/2019
Checked by: MJM 05/08/2019

Notes:
COC = Chemical of Concern
EA = Exposure Area
HASP = Health and Safety Plan
HHRA = Human Health Risk Assessment
TMPs = Trimethylpentenes
VOC = Volatile Organic Compound

Table 3.2-2
Screening of Remedial Technologies
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
No Action	None	No action taken	Not effective	Implementable	No Cost	Yes	Required for baseline comparison
Institutional Controls	Access and Use Restrictions						
	Deed covenants	Prohibit residential use and development of site through restrictive language in deeds and other instruments of property transfer.	Effective	Implementable	Low	No	South Ditch sediment and EA5 soil remediation is to address risk to ecological receptors; therefore, deed covenants are not applicable.
	Environmental Monitoring						
	Soil and sediment sampling	Collection and analysis of soil and sediment samples.	Effective	Implementable	Low	Yes	May be used in conjunction with other technologies and to assess remedy effectiveness.
Containment	Capping						
	Subaqueous Cap	Install geosynthetic barrier over contaminated sediment in South Ditch.	Not effective	Not implementable due to very minimal water depth in South Ditch.	Medium-High	No	Would degrade ecological habitat of South Ditch. Would not prevent groundwater discharge. Water depth too shallow to implement.
Treatment	Monitored Natural Recovery	Relies on natural sediment deposition processes to cover contaminated sediment, thereby reducing site exposure risks.	Not effective as the relatively low stream flow and sediment deposition rate would take a substantial duration to isolate contaminated sediments.	Implementable	Medium-Low	No	Not effective for sediment in Lower South Ditch due to relatively low stream flow and sediment deposition rate.
	Enhanced Bioremediation	Relies on biological processes to reduce the toxicity, mobility, and volume of contaminants. Amendments and nutrients are added to soil to enhance/accelerate natural degradation processes.	Not effective for chromium or BEHP, the primary COCs in surface soil and sediment.	Implementable	Medium-Low	No	Not effective for chromium or BEHP, which are primary COCs in surface soil and sediment.

Table 3.2-2
Screening of Remedial Technologies
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
Treatment (continued)	Solidification/Stabilization	Relies on encapsulation of the waste through mixing with additives and binders to immobilize contaminants by converting them into less soluble, mobile, or toxic states.	Effective; if implementable	Difficult to implement in-situ due to small volume of soil and sediment, and presence of tree roots and vegetation. The additives and binders would increase the volume of sediment and surface soil, thereby changing the stream bed elevation and negatively affecting stream flow characteristics.	Medium	Yes	In-situ implementation could negatively affect stream configuration and flow characteristics. Ex-situ implementation was retained for further evaluation in conjunction with excavation and off-site disposal.
	Chemical Reduction/Oxidation	Reducing compounds or oxidizing chemicals are injected to enhance reduction/degradation or immobilization of contaminants.	Chemical reduction effective for inorganics (e.g., hexavalent chromium), but may be less effective for SVOCs such as BEHP, which is a primary COC.	Difficult to implement in surface soil and sediments.	Medium	No	Effective, but difficult to implement in surface soil and sediment. Hexavalent chromium is not a COC in soil and sediment being addressed. Oxidation to reduce organics would create hexavalent chromium from trivalent chromium.
Removal	Mechanical excavation						
		Excavation using conventional earthmoving equipment.	Effective. Interrupts direct exposure pathway and reduces erosion and leaching if combined with protective disposal option.	Implementable. Need to protect workers with HASP. Need to identify suitable disposal method.	Medium	Yes	Used in conjunction with treatment/disposal technologies.
Disposal	On-site Disposal						
	Consolidate on-site and cap	Excavated material would be consolidated on site under a capping system.	Effective. Would require appropriate design to ensure cap stability on steep slopes. Capping interrupts direct exposure pathway and can be designed to prevent leaching and migration of contaminants.	Implementable; however, requires administrative controls and deed restrictions on future land use at site. Requires long-term monitoring and maintenance.	Medium-High	No	The relatively small volume of contaminated surface soil and sediment requiring remediation would result in significantly higher costs to construct and maintain an on-site disposal area than to dispose of the material off-site.

Table 3.2-2
Screening of Remedial Technologies
OU1/OU2 Sediment and EA5 Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
Disposal (continued)	Off-Site Disposal	Permitted landfill	Effective	Implementable	Medium	Yes	More cost-effective than on-site disposal, due to small volume of material, and design, construction, and maintenance of an on-site disposal area.

Prepared by: APP 04/23/2019
Checked by: MJM 05/08/2019

Notes:
BEHP = Bis(2-ethylhexyl)phthalate
COC = Chemical of Concern
EA = Exposure Area
HASP = Health and Safety Plan
HHRA = Human Health Risk Assessment
SVOC = Semivolatile Organic Compound
TMPs = Trimethylpentenes

Table 3.2-3
Screening of Remedial Technologies
South Ditch Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
No Action	None	No action taken	Not effective	Implementable	No Cost	Yes	Required for baseline comparison
Institutional Controls	Access and Use Restrictions						
	Deed covenants	Restricts land use through restrictive language in deeds and other instruments of property transfer.	Effective, but not applicable to ecological receptors or for reducing ecological risks.	Implementable	Low	No	Not applicable to ecological receptors.
	Environmental Monitoring						
	Surface water sampling	Collection and analysis of surface water samples to aid in assessing potential exposure risks.	Effective	Implementable	Low	Yes	May be used in conjunction with other technologies
Removal							
	Diversion/Extraction	Surface water flow would be diverted and treated to remove COCs.	Effective	Implementable	Medium-High	No	Since groundwater discharge is the base flow for South Ditch, implementing this technology would eliminate the stream.
	Stream Diversion	Re-route the stream to a new channel along Ephemeral Drainage.	Ineffective. Rerouting the stream would not reduce COC concentrations.	Implementable	Medium	No	Not Effective.
	Groundwater Interception	Intercept contaminated groundwater prior to discharge to South Ditch.	Effective. Would remove the continuing source of contaminated ground water from South Ditch by reducing flow to runoff and containment area discharge only.	Implementable. Technology is essentially the same as dewatering.	High	No	Since groundwater discharge is the base flow for South Ditch, implementing this technology would eliminate the stream.

Table 3.2-3
Screening of Remedial Technologies
South Ditch Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
Ex-Situ Treatment							
	Enhanced Bioremediation	Relies on amendments, nutrients, and/or microorganisms that are added to enhance biological degradation.	Not Effective. Bioremediation is not effective for inorganics (e.g., chromium) or ammonia, which are the primary COCs in South Ditch surface water.	Difficult to implement for the same reasons that it would be ineffective.	Medium-High	No	Not Effective.
	Chemical Reduction/Oxidation	Reducing compounds or oxidizing chemicals are added to enhance reduction/degradation or immobilization of contaminants.	Not Effective. Oxidation would increase toxicity and mobility of chromium.	Difficult to Implement	Medium	No	Not effective for chromium or ammonia. Oxidation would produce hexavalent chromium (which is currently not a COC), increasing overall toxicity and mobility.
	Adsorption	Diverted surface water is pumped through columns or tanks filled with sorbent materials to remove COCs.	Conditionally Effective. The technology is effective at reducing chromium and ammonia concentrations; however, if the continuing source of groundwater is not removed, this technology would be required indefinitely.	Implementable	High	No	Since groundwater discharge is the base flow for South Ditch, diverting surface water to implement this technology would eliminate the stream.
	Ultraviolet (UV) Oxidation	Strong oxidizers are added and media is irradiated by UV light to destroy organic compounds.	Effective for NDMA with pretreatment of other constituents. Not effective for chromium or ammonia.	Implementable	Medium-High	No	Not effective for chromium or ammonia.
	Break Point Chlorination	Addition of chlorine to oxidize COCs.	Effective for ammonia in dilute solutions. Not effective for chromium.	Implementable	Medium	No	Not effective for chromium. Could be used in conjunction with other technologies. However, since groundwater discharge is the base flow for South Ditch, diverting surface water to implement this technology would eliminate the stream.

Table 3.2-3
Screening of Remedial Technologies
South Ditch Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
In-Situ Treatment	Permeable Reactive Barrier (PRB)	A barrier created of reactive material such as ZVI and/or zeolites is placed downgradient of contamination to treat COCs as groundwater flows through the barrier, prior to discharge to South Ditch.	Effective	Implementable; however, groundwater discharges along the entire length of South Ditch. Installation of a PRB along the entire length of South Ditch would result in significant negative impacts to the wetlands in the vicinity of South Ditch.	Medium-High	Yes	Retained as a potentially viable technology for further evaluation.
	Adsorption	Relies on an adsorbent material to remove contaminants from the water. Activated carbon can be effective for chromium reduction/removal. Zeolites (hydrated aluminum-silicate minerals) have been found to be effective at removing ammonia from wastewaters.	Effective. A combination of adsorbent materials could be placed in South Ditch to allow surface water to flow through the adsorbent materials.	Difficult to implement due to contaminated groundwater discharge along the entire length of South Ditch. Periodic removal and replacement of adsorbent materials would be required and would be destructive to ecological habitat.	Medium	Yes	Technically feasible; however, periodic replacement of adsorbent materials over many decades would be destructive to ecological habitat.
Containment	Subsurface Walls	Create a subsurface boundary such as a slurry wall or grouted sheet pile wall between the continuing source of contaminated groundwater (OU3) and South Ditch.	Effective	Difficult Implementation	Medium	No	Unnecessarily disruptive to groundwater flow.

Prepared by: APP 04/23/2019
Checked by: MJM 05/08/2019

Notes:
COC = Chemical of Concern
NDMA = n-Nitrosodimethylamine
OU = Operable Unit
PRB = Permeable Reactive Barrier
ZVI = Zero Valent Iron

Table 5.2-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards					
Floodplains and Wetlands	Floodplain Management and Protection of Wetlands	44 CFR Part 9 (implementing Executive Orders 11988 and 11990)	Applicable	Federal Emergency Management Agency (FEMA) regulations set forth the policy, procedure, and responsibilities to implement and enforce Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). These regulations prohibit activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. These regulations require the avoidance of impacts associated with the occupancy and modification of federally-designated 100-year and 500-year floodplains and require the avoidance of development within a floodplain wherever there is a practicable alternative. An assessment of impacts to the 500-year floodplain is required for critical actions, which includes siting waste facilities in a floodplain. These regulations require public notice when proposing any action in or affecting floodplains or wetlands.	If there is no practical alternative method of work in federal jurisdictional wetlands, or 100-year or 500-year floodplains, then all practical measures will be taken to minimize and mitigate any adverse impacts. Erosion and sediment control measures will be adopted during remedial activities to protect these wetlands and floodplains. After completion of work, there will be no significant net loss of flood storage capacity and no significant net increase in flood stage or velocities. Floodplain habitat will be restored to the extent practicable. Public comment will be solicited as part of the Proposed Plan concerning any proposed alteration to wetlands and floodplains.
Floodplains	RCRA Floodplain Restrictions for Hazardous Waste Facilities	42 USC § 6901 et seq.; 40 CFR § 264.18(b)	Applicable	A hazardous waste treatment, storage, or disposal facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout or to result in no adverse effects on human health or the environment if washout were to occur.	Any hazardous waste generated during remedial activities will be managed so that it will not impact floodplain resources.
Floodplains	RCRA Floodplain Restrictions for Solid Waste Disposal Facilities and Practices	40 CFR § 257.3-1	Applicable	Solid waste practices must not restrict the flow of a 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources.	Any solid waste generated from remedial activities involving excavation activities will be managed so that it will not impact floodplain resources.

Table 5.2-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Wetlands, Aquatic Ecosystem	Clean Water Act (CWA) Section 404 and regulations	33 USC § 1344; 40 CFR Parts 230 & 231; and 33 CFR Parts 320-323	Applicable	For discharge of dredged or fill material into water bodies or wetlands, there must be no practicable alternative with less adverse impact on aquatic ecosystem; discharge cannot cause or contribute to violation of state water quality standards or toxic effluent standards or jeopardize threatened or endangered species; discharge cannot significantly degrade waters of U.S.; practicable steps must be taken to minimize and mitigate adverse impacts; and impacts on flood level, flood velocity, and flood storage capacity must be evaluated. Sets standards for restoration and mitigation required as a result of unavoidable impacts to aquatic resources. USEPA must determine which alternative is the "Least Environmentally Damaging Practicable Alternative" (LEDPA) to protect wetland and aquatic resources.	Remedial alternatives will be developed and designed to comply with these regulations. Compensatory wetlands mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives.
Wetlands	U.S. Army Corps of Engineers, New England District Compensatory Mitigation Guidance (09-07-2016)	New England District Compensatory Mitigation Guidance (09-07-2016)	To Be Considered	This Guidance is to be considered when compensatory mitigation to address impacts to federal jurisdiction wetlands is appropriate for a particular remedial activity.	Activities affecting federal jurisdictional wetlands will be conducted in accordance with these guidance standards for mitigation and restoration.
Surface Waters, Wetland/Waterway Habitat for Endangered Species, Migratory Species	Fish and Wildlife Coordination Act	16 USC §§ 662-663; 40 CFR Part 6	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss to the maximum extent practicable.	To the extent necessary, actions will be taken to develop measures to prevent, mitigate, or compensate for project-related impacts to habitat and wildlife. The USFWS, acting as a review agency for the USEPA, will be kept informed of proposed remedial activities.
Endangered Species	Endangered Species Act	50 CFR §§ 17.11-17.12; 50 CFR Part 402	Applicable, if endangered species are encountered	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	Protection of endangered species and their habitat will be considered during development and design of remedial alternatives.

Table 5.2-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Historical/ Archeological Resources	National Historic Preservation Act	16 USC § 469 et seq.; 36 CFR Part 65	Applicable, if subject historical resources are present	When a federal agency finds, or is notified, that its activities in connection with a federal construction project may cause irreparable loss or destruction of significant scientific, pre-historical, historical, or archeological data, the substantive standards under the Act will be met.	Any undisturbed areas altered by the remedial activities will be assessed to ensure no protected resource areas are present. If present, federal and state preservation officials will be consulted to address measures to avoid, minimize, and/or mitigate any impacts to protected resource areas.
Atlantic Flyway	Migratory Bird Treaty Act	16 USC § 703 et seq.	Applicable, if subject protected species are present	Protects migratory birds, their nests and eggs. A depredation permit issued by the U.S. Fish and Wildlife Service is required to take, possess, or transport migratory birds or disturb their nests, eggs, or young.	Remedial activities will be evaluated to protect migratory birds, their nests and eggs. If migratory bird protected areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.
State Standards					
Floodplains, Wetlands, Surface Waters	Massachusetts Wetland Protection Act and Regulations	MGL c. 131, § 40; 310 CMR 10.00	Applicable	These regulations restrict dredging, filling, altering, or polluting inland wetland resource areas (defined as areas within the 100-year floodplain) and impose performance standards for work in such areas. Protected resource areas include: 10.54 (Bank); 10.55 (Bordering Vegetated Wetlands); 10.56 (Land under Water Bodies and Waterways); 10.57 (Land Subject to Flooding); and 10.58 (Riverfront Area).	Any remedial activity conducted within a state regulated wetland resource area will comply with the substantive requirements of these regulations. Mitigation of impacts on state wetland resource areas will be addressed.
Floodplains	Massachusetts Hazardous Waste regulations, Location Standards for Land Subject to Flooding	310 CMR 30.701	Applicable	Any new or expanded hazardous waste storage or treatment facility (which only receives hazardous waste from on-site sources), the active portion of which is located within the boundary of land subject to flooding from the statistical 100-year frequency storm, shall be flood-proofed. Flood-proofing shall be designed, constructed, operated and maintained to prevent floodwaters from coming into contact with hazardous waste.	To the extent any hazardous waste is generated during the remedial activities, the wastes will be managed so that it will not impact floodplain resources.

Table 5.2-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Wetlands, Aquatic Ecosystem	Massachusetts Water Quality Certification for Discharge of Dredged or Fill Material	MGL c. 21, §§ 26-53; 314 CMR 9.00	Applicable	For discharges of dredged or fill material, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; appropriate and practicable steps must be taken to avoid and minimize potential adverse impacts to wetlands and land under water; stormwater discharges must be controlled with BMPs; and there must not be substantial adverse impacts to the physical, chemical, or biological integrity of surface waters. For dredging and dredged material management, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; and if avoidance is not possible, then minimize, or if neither avoidance or minimization are possible, then mitigate potential adverse impacts.	The remedial alternatives' effects on the aquatic ecosystem will be evaluated and avoided, and/or minimized. Compensatory mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives. Any required removal of soil/sediment from wetland or surface water areas will be designated for eventual restoration. Excavation and filling activities to be performed impacting the aquatic ecosystem will be in accordance with the substantive requirements of these regulations.
Endangered Species	Massachusetts Endangered Species Regulations	321 CMR 10.00	Applicable, if endangered species are encountered	Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural Heritage Program.	The protection of state listed endangered species will be considered during the development and design of remedial alternatives.
Historical/ Archeological Resources	Protection of Properties Included in the State Register of Historic Places	MGL c. 9, §§ 26-27C; 950 CMR 71.00	Applicable, if subject historical resources are present	Projects must eliminate, limit, or mitigate adverse effects to properties listed in the State Register of Historic Places (historic and archaeological properties). Establishes coordination with the National Historic Preservation Act.	If protected resource areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials.

Table 5.2-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Area of Critical Environmental Concern	Massachusetts Areas of Critical Environmental Concern (ACECs) Regulations	310 CMR 12.00	Applicable, if ACEC is identified	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical interrelationships among a number of components. An eligible area must contain features from four or more of the following groups: (1) fisheries, (2) coastal features, (3) estuarine wetlands, (4) inland wetlands, (5) inland surface waters, (6) water supply areas (e.g., aquifer recharge area); (7) natural hazard areas (e.g., floodplain); (8) agricultural areas; (9) historical/archeological resources; (10) habitat resources (e.g., for endangered wildlife); or (11) special use areas. After an area is designated as an ACEC, the aim is to preserve and restore these areas.	If ACEC is identified in the site area, activities will be controlled to minimize impacts to affected species.

Prepared By / Date: APP 04/29/2019
Checked By / Date: MJM 05/08/2019

Notes:
ACEC = Areas of Critical Environmental Concern
ARAR = Applicable or Relevant and Appropriate Requirement
BMP = Best Management Practice
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
CWA = Clean Water Act
DAPL = Dense Aqueous Phase Liquid
FEMA = Federal Emergency Management Agency
LEDPA = Least Environmentally Damaging Practicable Alternative
MGL = Massachusetts General Law
RCRA = Resource Conservation and Recovery Act
USEPA = United States Environmental Protection Agency
USFWS = United States Fish and Wildlife Service
USC = United States Code

Table 5.2-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards				
USEPA Risk Reference Doses (RfDs)	USEPA RfDs	To Be Considered	RfDs are estimates of daily exposure levels that are likely to cause significant adverse non-carcinogenic health effects over a lifetime.	RfDs will be considered during development of PRGs.
USEPA Carcinogenic Assessment Group, Cancer Slope Factors (CSFs)	USEPA CSFs	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to site contaminants and represent the most up-to-date information on cancer risk from USEPA's Carcinogenic Assessment Group.	CSFs will be considered during development of PRGs.
Guidelines for Carcinogenic Risk Assessment	EPA/630/P-03/001F, March 2005	To Be Considered	These guidance values are to be used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	These guidelines will be considered during development of PRGs.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F, March 2005	To Be Considered	These Guidance values are to be used to evaluate the potential carcinogenic hazard to children caused by exposure to contaminants.	These guidelines will be considered during development of PRGs.
Clean Water Act (CWA) National Recommended Water Quality Criteria (NRWQC)	33 USC §1314(a); 40 CFR Part 131	Relevant and Appropriate	NRWQC are established for the protection of aquatic life and human health in surface water for approximately 150 pollutants.	NRWQCs will be considered during development of remedial alternatives that include discharge of treated groundwater to a surface water body.
Regional Screening Levels for Chemical Contaminants at Superfund Sites		To Be Considered	Regional Screening Levels (RSLs) are risk-based tools for screening contaminants at Superfund sites. RSLs are not intended to be cleanup standards.	RSLs will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.

Table 5.2-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites	OSWER 9355.4-24 (2002)	To Be Considered	EPA guidance for evaluating soil contamination. Used to develop risk-based cleanup standards, including based on the leaching of soil contaminants to groundwater.	This guidance will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.
Soil Screening Guidance: Technical Background Document	EPA/540/R95/ 128 (1996)	To Be Considered	EPA guidance for evaluating soil contamination. Used to develop risk-based cleanup standards.	This guidance will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.
Ontario Ministry of Environment and Energy (OMEE) Severe Effect Levels (SELs) for Freshwater Sediments	(Persaud et al., 1993)	To Be Considered	The SEL value is the concentration at which the majority of the sediment-dwelling organisms are affected. Used to develop risk-based cleanup standards.	SELs will be used to assess ecological risks due to exposure to chemicals in sediment and to develop sediment PRGs.
Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Probable Effects Concentrations (PECs)	(MacDonald et al., 2000)	To Be Considered	The SEL value is the concentration at which the majority of the sediment-dwelling organisms are affected. Used to develop risk-based cleanup standards.	PECs will be used to assess ecological risks due to exposure to chemicals in sediment and to develop sediment PRGs.

Prepared By / Date: APP 04/29/2019
Checked By / Date: MJM 05/08/2019

Table 5.2-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
CSF = cancer slope factor
MCLs = Maximum Contaminant Levels
MCLGs = Maximum Contaminant Level Goals
NRWQC = National Recommended Water Quality Criteria
OMEG = Ontario Ministry of Environment and Energy
OSWER = Office of Solid Waste and Emergency Response
PEC = Probable Effects Concentration
PRGs = Preliminary Remediation Goals
RfD = reference dose
RSL = Regional Screening Level
SDWA = Safe Drinking Water Act
SEL - Severe Effect Level
USC = United States Code
USEPA = United States Environmental Protection Agency

Table 5.2-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards					
Hazardous Waste Treatment, Storage, Disposal	Resource Conservation and Recovery Act (RCRA) Subtitle C; Hazardous Waste Identification; Generator and Handler Requirements; Tracking Requirements; Storage, Treatment and Disposal Requirements; Groundwater Monitoring Requirements; Closure and Post Closure Requirements; Land Disposal Restriction Requirements	42 USC § 6901 et seq.; 40 CFR Parts 260-262, Part 264/(including Subparts B, C, D, E, F, G, I, J, K, L, M, N, W, X) and Part 268	Potentially Applicable or Relevant and Appropriate	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. These provisions have been adopted by the Commonwealth.	Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous waste. Non-hazardous wastes will be disposed of appropriately. Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.

Table 5.2-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Air Emissions	RCRA, Air Emission Standards for Process Vents, Equipment Leaks, Tanks, Surface Impoundments, and Containers	40 CFR Part 264, Subparts AA, BB, and CC	Applicable, if hazardous waste with volatile organic concentrations of at least 10 parts per million by weight (ppmw) (Subpart AA), with organic concentrations of at least 10 % by weight (Subpart BB), will be treated, stored, or disposed of in tanks, surface impoundments, or containers, and thresholds are met (Subpart CC). Relevant and Appropriate, if less than thresholds.	RCRA emissions standards not delegated to the State. Standards for process vents for systems that manage hazardous wastes that have organic concentrations of at least 10 ppmw. Standards for air equipment leaks for systems that manage hazardous wastes with organic concentrations of at least 10% by weight. Standards for certain tanks, surface impoundments, containers that treat, store, or dispose of hazardous wastes.	Any hazardous wastes generated during remedial activities that meet these rules' threshold requirements will be managed in accordance with these regulations.
Discharges to Surface Water; Storm Water Controls	Clean Water Act National Pollutant Discharge Elimination System (NPDES)	40 CFR Parts 122 and 125	Applicable	The NPDES permit program specifies the permissible concentration or level of contaminants in the discharge from any point source to waters of the United States. Also, includes storm water standards for activities disturbing more than one acre.	Any discharges to surface waters related to excavation and dewatering activities will need to have the discharges meet the substantive discharge standards (the Massachusetts Surface Water Discharge Permit Program [314 CMR 3.00] has similar requirements).
Discharges to Surface Water	Clean Water Act; Toxic Pollutant Effluent Standards	40 CFR Part 129	Applicable	Regulates surface water discharges of specific toxic pollutants, specifically certain pesticides and PCBs.	Any discharge of water contaminated with the specific toxic pollutants generated during remedial activities will be treated to meet applicable toxic pollutant discharge standards if the water is to be discharged to surface waters.

Table 5.2-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Discharge to a Publicly Owned Treatment Works (POTW)	General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR Part 403	Applicable	Establishes responsibilities of federal, state, and local government, industry and the public to implement National Pretreatment Standards to control pollutants which pass through or interfere with treatment processes in POTWs or which may contaminate sewage sludge.	If remedial actions, such as excavation and dewatering activities, result in liquid waste streams that are discharged to a POTW, pretreatment of such waste streams will be evaluated for compliance with applicable requirements of the regulation.
Air Emissions	Clean Air Act (CAA), Hazardous Air Pollutants; National Emission Standards for Hazardous Air Pollutants (NESHAPs)	42 USC § 112(b)(1); 40 CFR Part 61	Potentially Applicable	These regulations establish emissions standards for 189 hazardous air pollutants.	No air emissions from remedial activities, such as soil excavation, will cause air quality standards to be exceeded. Dust standards will be complied with during remedial activities.
Sediment Remediation	Contaminated Sediment Remediation Guidance for Hazardous Waste Sites	EPA-540-R-05-012; OSWER 9355.0-85 (December 2005)	To Be Considered	Guidance for making remedy decisions for contaminated sediment sites. Some of the relevant sections of the guidance address Remedial Investigations (Ch. 2), FS Considerations (Ch. 3), Monitored Natural Recovery (Ch. 4), In-Situ Capping (Ch. 5), and Dredging and Excavation (Ch. 6).	Remedial alternatives will be developed and implemented with consideration of this guidance.
Investigation-Derived waste (IDW)	Guide to Management of Investigation-Derived Wastes	USEPA OSWER Publication 9345.3-03FS, January 1992	To Be Considered	Guidance on management of IDW in a manner that ensures protection of human health and the environment.	IDW generated during remedial activities and monitoring comply with this guidance
Vapor Intrusion	OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air.	OSWER 9200.2-154 (June 2015)	To Be Considered	EPA guidance for addressing vapor intrusion issues at CERCLA sites.	This guidance will be considered during development and implementation of remedial alternatives related to vapor intrusion.
State Standards					
Hazardous Waste Identification	Massachusetts Hazardous Waste Management Rules for Identification and Listing of Hazardous Wastes	310 CMR 30.100	Applicable	Massachusetts is delegated to administer RCRA through its state regulations. These regulations establish requirements for determining whether wastes are either listed or characteristic hazardous waste.	These Massachusetts regulations supplement federal RCRA requirements. Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous wastes. Non-hazardous wastes will be disposed of appropriately.

Table 5.2-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Generator Standards	Massachusetts Hazardous Waste Rules – Requirements for Generators	310 CMR 30.300	Applicable for listed wastes that still display characteristics, or for hazardous wastes generated as part of a cleanup; Relevant and Appropriate for non-listed hazardous waste left in-place	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.
Hazardous Waste - Management Facility Standards	Massachusetts Hazardous Waste Rules – Management Standards for All Hazardous Waste Facilities	310 CMR 30.500	Applicable for listed wastes that still display characteristics, or for hazardous wastes generated as part of a cleanup; Relevant and Appropriate for non-listed hazardous waste left in-place	General facility requirements for waste analysis, security measures, inspections, and training requirements. Section 30.580 addresses closure and, Section 30.590 addresses post-closure of hazardous waste facilities.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.
Hazardous Waste - Groundwater	Massachusetts Hazardous Waste Rules – Groundwater Protection	310 CMR 30.660	Applicable	310 CMR 30.661 through 30.673 prescribe requirements for regulated units that receive hazardous waste, except for certain waste piles, to protect groundwater.	Any hazardous waste generated by remedial alternatives that involve excavation of soil/sediment will be managed to prevent contaminant migration to groundwater.

Table 5.2-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Containers	Massachusetts Hazardous Waste Rules – Use and Management of Containers	310 CMR 30.680	Potentially Applicable	310 CMR 30.681 through 30.689 prescribe requirements for the use of containers, such as drums, to store hazardous waste. Provides specifications for *inter alia* labelling and marking, management of containers, inspections, and closure.	Establishes requirements for the management of containers, such as drums, that are used to store hazardous wastes. Alternatives handling containers of hazardous waste will comply with this ARAR.
Hazardous Waste - Tanks	Massachusetts Hazardous Waste Rules – Storage and Treatment in Tanks	310 CMR 30.690	Potentially Applicable	310 CMR 30.691 through 30.699 prescribe requirements for the use of tanks to store and treat hazardous waste. Provides specifications for *inter alia* design and installation, containment and detection of leaks, general operating requirements, inspections, and closure and post-closure care.	Alternatives utilizing tanks for storage or treatment of hazardous waste will comply with this ARAR.
Discharges to Surface Waters	Massachusetts Clean Water Act; Surface Water Discharge Permit Regulations	MGL c. 21, §§ 26-53; 314 CMR 3.00	Applicable, if surface water discharge occurs	These regulations provide that discharges to waters of the Commonwealth shall not result in exceedances of Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00).	Any discharges to surface waters related to excavation and dewatering activities will need to have the discharges meet the substantive discharge standards of the Massachusetts Surface Water Discharge Permit (314 CMR 4.00).
Surface Water Quality Monitoring	Massachusetts Clean Water Act; MA Surface Water Quality Standards (MSWQS)	M.G.L. c. 21, §§ 26-53; 314 CMR 4.00	Applicable	These standards designate the most sensitive uses for which the various waters of the Commonwealth shall be enhanced, maintained, or protected. Minimum water quality criteria required to sustain the designated uses are established.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet the MSWQS.
Hazardous Waste - Facility Discharge Standards	Massachusetts Supplemental Requirements for Hazardous Waste Management Facilities	MGL c. 21, §§ 26-53; 314 CMR 8.00	Relevant and Appropriate	This regulation establishes additional requirements that must be satisfied for a RCRA facility (a wastewater treatment works which manages hazardous waste) that has a wastewater discharge permit.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet these standards.

Table 5.2-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Air Emissions	Massachusetts Ambient Air Quality Standards	310 CMR 6.00	Applicable	These regulations establish primary and secondary standards for emissions of sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead.	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.
Air Emissions	Massachusetts Air Pollution Control Regulations	310 CMR 7.00	Applicable	These regulations set emission limits necessary to attain ambient air quality standards, including standards for visible emissions (7.06); dust, odor, construction and demolition (7.09); noise (7.10); and volatile organic compounds (7.18).	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.
Institutional Controls	Massachusetts Contingency Plan, Implementation of Activity and Use Limitations	310 CMR 40.1070(4)	Relevant and Appropriate	Establish standards for the use of Notice of Activity and Use Limitations, a form of institutional controls, at CERCLA sites in Massachusetts.	Institutional controls will be established consistent with state standards for enforceable restrictions on contaminated property to prevent human contact with contamination and to protect remedial infrastructure.
Monitoring Wells	Massachusetts Standard References for Monitoring Wells	WSC-310-91	To Be Considered	Guidance on locating, drilling, installing, sampling and decommissioning monitoring wells.	Monitoring wells that may be required as part of a post-remediation monitoring program will be installed, maintained and decommissioned based on these guidance standards.
Sediment/Erosion Control; Stormwater Management	Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas	Prepared for Massachusetts Executive Office of Environmental Affairs (original print March 1997; reprint May 2003)	To Be Considered	Guidance on preventing erosion and sedimentation.	Remedial activities will be managed to control erosion and sedimentation.

Prepared By / Date: APP 04/11/2019
Checked By / Date: MJM 05/08/2019

Table 5.2-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
DAPL = Dense Aqueous Phase Liquid
DEP = Department of Environmental Protection
IDW = Investigation Derived Waste
MGL = Massachusetts General Law
MNA = Monitored Natural Attenuation
MSWQC = Massachusetts Surface Water Quality Criteria
NAPL = Non-Aqueous Phase Liquid
NESHAP = National Emission Standards for Hazardous Air Pollutant
NPDES = National Pollution Discharge Elimination System
OSWER = Office of Solid Waste and Emergency Response
PCB = Polychlorinated Biphenyl
POTW = Publicly Owned Treatment Works
ppmw = parts per million by weight
RCRA = Resource Conservation and Recovery Act
UIC = Underground Injection Control
USC = United States Code
USEPA = United States Environmental Protection Agency

Table 5.2-4
Cost Estimate for Alternative 2
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

Cost estimate for Alternative 2: Limited Action and Vapor Barrier/SSDS for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and Limited Action for South Ditch Surface Water.

Year 0 = 2019

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Vapor Barrier/SSDS	30,500	SF	$4	$122,000	ITRC 2008; NAVFAC 2011
Excavation and Off-Site Disposal					
Pre-Design Investigation	1	LS	$17,900	$17,900	25 soil/sediment locations; pre-excavation characterization
Pre-Excavation Wetland Survey	1	LS	$1,000	$1,000	Wetland Scientist; 1 day field effort
Wetland Restoration Plan	1	LS	$5,000	$5,000	Based on cost for similar effort
Mobilization	1	LS	$13,200	$13,200	Estimate from Environmental Remediation Contractor
Site Staging and Prep	1	LS	$95,300	$95,300	Estimate from Environmental Remediation Contractor
Includes temporary staging area for dewatering, silt fencing, tree removal, and matting for access					
Surface Water/Stormwater Diversion	400	LF	$100	$40,000	Estimate from Environmental Remediation Contractor
Excavation	1	LS	$97,700	$97,700	Estimate from Environmental Remediation Contractor
Material Handling & Loading	1	LS	$23,600	$23,600	Estimate from Environmental Remediation Contractor
Off-Site Disposal as Non-Hazardous	475	ton	$225	$106,875	Estimate from Hazardous Waste Disposal Contractor
Off-Site Disposal w/ Off-Site Stabilization	475	ton	$350	$166,250	Estimate from Hazardous Waste Disposal Contractor
Backfill, Re-grading, & Seeding	1	LS	$97,500	$97,500	Estimate from Environmental Remediation Contractor
Restoration Plantings	1	LS	$2,500	$2,500	
Demobilization	1	LS	$38,100	$38,100	Estimate from Environmental Remediation Contractor
Excavation Area Monthly Inspections	6	LS	$800	$4,800	Monthly for 6 months
Limited Action					
Deed Restriction Modification	0	LS	$12,400	$0	Performed internally by Olin
Monitoring of South Ditch Surface Water	0	LS	$7,644	$0	SW monitoring will continue as currently performed; costs
Evaluation of South Ditch Surface Water Data	0	LS	$1,000	$0	begin in Year 1 and reflected under Annual Costs
Toxicity Testing of South Ditch Surface Water	1	LS	$6,500	$6,500	Toxicity testing to verify RAO compliance; one *Daphnia magna* test
Toxicity Testing of South Ditch Sediment	1	LS	$13,000	$13,000	Toxicity testing to verify RAO compliance; one *Hyalella azteca* test + one control test
Contingency	0	%	20%	$170,200	
		TOTAL CAPITAL COSTS		$1,021,425	

Table 5.2-4
Cost Estimate for Alternative 2
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

ANNUAL COSTS YEARS 1 - 2					
Description	**Quantity**	**Units**	**Unit Cost**	**Extended Cost**	**Note**
Vapor Barrier/SSDS	0	Months	$0	$0	O&M to be assumed by building owner once SSDS construction complete
Excavation and Off-Site Disposal	0	Months	$0	$0	Completed in Year 0; No O&M
Limited Action and Monitoring					
Surface Water Monitoring (Semi-Annual)	2	LS	$700	$1,400	Assumed 3 surface water samples analyzed for dissolved chromium & ammonia @ $100 per sample; 1 person @ 1/2 day for sample collection and field measurements.
Ecological Recovery Inspection (Semi-Annual)	2	LS	$800	$1,600	Performed in Years 1 & 2; then at 5-year intervals
Annual Monitoring and Performance Report	1	LS	$10,000	$10,000	Based on costs for similar sites and reporting
		TOTAL ANNUAL COSTS		$13,000	Years 1 - 2

ANNUAL COSTS YEARS 3 - 30					
Description	**Quantity**	**Units**	**Unit Cost**	**Extended Cost**	**Note**
Vapor Barrier/SSDS	0	Months	$0	$0	O&M to be assumed by building owner once SSDS construction complete
Excavation and Off-Site Disposal	0	Months	$0	$0	Completed in Year 0; No O&M
Limited Action and Monitoring					
Surface Water Monitoring (Semi-Annual)	2	LS	$700	$1,400	Assumed 3 surface water samples analyzed for dissolved chromium & ammonia @ $100 per sample; 1 person @ 1/2 day for sample collection and field measurements.
Annual Monitoring and Performance Report	1	LS	$10,000	$10,000	Based on costs for similar sites and reporting.
		TOTAL ANNUAL COSTS		$11,400	Years 3 - 30

5-YEAR PERIODIC COSTS					
Description	**Quantity**	**Units**	**Unit Cost**	**Extended Cost**	**Note**
Vapor Barrier/SSDS	0	Months	$0	$0	O&M to be assumed by building owner once SSDS construction complete
Excavation and Off-Site Disposal					
Ecological Recovery Inspection	1	LS	$800	$800	(in advance of 5-Year Review Report)
Limited Action and Monitoring	0	LS	$0	$0	Annual costs only; No 5-year costs
Reporting					
5-Year Review Report	1	LS	$10,000	$10,000	Incremental cost only; will be performed site-wide
Deed Restrictions Verification and Maintenance	0	LS	$5,000	$0	Performed internally by Olin
		TOTAL 5-YEAR COSTS		$10,800	

Table 5.2-4
Cost Estimate for Alternative 2
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$1,021,425	1.0000	$1,021,425	
Annual Costs	1	$13,000	0.9728	$12,646	
Annual Costs	2	$13,000	0.9463	$12,301	
Annual Costs	3	$11,400	0.9205	$10,494	
Annual Costs	4	$11,400	0.8954	$10,208	
Annual Costs	5	$11,400	0.8710	$9,930	
5-Year Periodic Costs	5	$10,800	0.8710	$9,407	
Annual Costs	6	$11,400	0.8473	$9,659	
Annual Costs	7	$11,400	0.8242	$9,396	
Annual Costs	8	$11,400	0.8018	$9,140	
Annual Costs	9	$11,400	0.7799	$8,891	
Annual Costs	10	$11,400	0.7587	$8,649	
5-Year Periodic Costs	10	$10,800	0.7587	$8,194	
Annual Costs	11	$11,400	0.7380	$8,414	
Annual Costs	12	$11,400	0.7179	$8,184	
Annual Costs	13	$11,400	0.6984	$7,961	
Annual Costs	14	$11,400	0.6794	$7,745	
Annual Costs	15	$11,400	0.6609	$7,534	
5-Year Periodic Costs	15	$10,800	0.6609	$7,137	
Annual Costs	16	$11,400	0.6429	$7,328	
Annual Costs	17	$11,400	0.6253	$7,129	
Annual Costs	18	$11,400	0.6083	$6,935	
Annual Costs	19	$11,400	0.5917	$6,746	
Annual Costs	20	$11,400	0.5756	$6,562	
5-Year Periodic Costs	20	$10,800	0.5756	$6,217	
Annual Costs	21	$11,400	0.5599	$6,383	
Annual Costs	22	$11,400	0.5447	$6,209	
Annual Costs	23	$11,400	0.5299	$6,040	
Annual Costs	24	$11,400	0.5154	$5,876	
Annual Costs	25	$11,400	0.5014	$5,716	
5-Year Periodic Costs	25	$10,800	0.5014	$5,415	
Annual Costs	26	$11,400	0.4877	$5,560	
Annual Costs	27	$11,400	0.4744	$5,409	
Annual Costs	28	$11,400	0.4615	$5,261	
Annual Costs	29	$11,400	0.4490	$5,118	
Annual Costs	30	$11,400	0.4367	$4,979	
5-Year Periodic Costs	30	$10,800	0.4367	$4,717	
		$1,431,425		$1,294,916	
	TOTAL COST OF ALTERNATIVE		**$1,431,000**		
	TOTAL PRESENT WORTH OF ALTERNATIVE		**$1,295,000**		
	PROJECT DURATION		**30 Years**		

Prepared/Date: KPW 05/03/2019
Revised/Date: APP 05/09/2019
Checked/Date: MJM 05/09/2019

Interstate Technology and Regulatory Council (ITRC) 2008. Vapor Intrusion: A Practical Guide. ITRC, January 2007.
Naval Facilities Engineering Command (NAVFAC) 2011; Vapor Intrusion Mitigation in Construction of New Buildings Fact Sheet; NAVFAC Navy Alternative Restoration Technology Team, August 2011.

Table 5.3-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards					
Floodplains and Wetlands	Floodplain Management and Protection of Wetlands	44 CFR Part 9 (implementing Executive Orders 11988 and 11990)	Applicable	Federal Emergency Management Agency (FEMA) regulations set forth the policy, procedure, and responsibilities to implement and enforce Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). These regulations prohibit activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. These regulations require the avoidance of impacts associated with the occupancy and modification of federally-designated 100-year and 500-year floodplains and require the avoidance of development within a floodplain wherever there is a practicable alternative. An assessment of impacts to the 500-year floodplain is required for critical actions, which includes siting waste facilities in a floodplain. These regulations require public notice when proposing any action in or affecting floodplains or wetlands.	If there is no practical alternative method of work in federal jurisdictional wetlands, or 100-year or 500-year floodplains, then all practical measures will be taken to minimize and mitigate any adverse impacts. Erosion and sediment control measures will be adopted during remedial activities to protect these wetlands and floodplains. After completion of work, there will be no significant net loss of flood storage capacity and no significant net increase in flood stage or velocities. Floodplain habitat will be restored to the extent practicable. Public comment will be solicited as part of the Proposed Plan concerning any proposed alteration to wetlands and floodplains.
Floodplains	RCRA Floodplain Restrictions for Hazardous Waste Facilities	42 USC § 6901 et seq.; 40 CFR § 264.18(b)	Applicable	A hazardous waste treatment, storage, or disposal facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout or to result in no adverse effects on human health or the environment if washout were to occur.	Any hazardous waste generated during remedial activities will be managed so that it will not impact floodplain resources.
Floodplains	RCRA Floodplain Restrictions for Solid Waste Disposal Facilities and Practices	40 CFR § 257.3-1	Applicable	Solid waste practices must not restrict the flow of a 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources.	Any solid waste generated from remedial activities involving excavation activities will be managed so that it will not impact floodplain resources.

Table 5.3-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Wetlands, Aquatic Ecosystem	Clean Water Act (CWA) Section 404 and regulations	33 USC § 1344; 40 CFR Parts 230 & 231; and 33 CFR Parts 320-323	Applicable	For discharge of dredged or fill material into water bodies or wetlands, there must be no practicable alternative with less adverse impact on aquatic ecosystem; discharge cannot cause or contribute to violation of state water quality standards or toxic effluent standards or jeopardize threatened or endangered species; discharge cannot significantly degrade waters of U.S.; practicable steps must be taken to minimize and mitigate adverse impacts; and impacts on flood level, flood velocity, and flood storage capacity must be evaluated. Sets standards for restoration and mitigation required as a result of unavoidable impacts to aquatic resources. USEPA must determine which alternative is the "Least Environmentally Damaging Practicable Alternative" (LEDPA) to protect wetland and aquatic resources.	Remedial alternatives will be developed and designed to comply with these regulations. Compensatory wetlands mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives.
Wetlands	U.S. Army Corps of Engineers, New England District Compensatory Mitigation Guidance (09-07-2016)	New England District Compensatory Mitigation Guidance (09-07-2016)	To Be Considered	This Guidance is to be considered when compensatory mitigation to address impacts to federal jurisdiction wetlands is appropriate for a particular remedial activity.	Activities affecting federal jurisdictional wetlands will be conducted in accordance with these guidance standards for mitigation and restoration.
Surface Waters, Wetland/Waterway Habitat for Endangered Species, Migratory Species	Fish and Wildlife Coordination Act	16 USC §§ 662-663; 40 CFR Part 6	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss to the maximum extent practicable.	To the extent necessary, actions will be taken to develop measures to prevent, mitigate, or compensate for project-related impacts to habitat and wildlife. The USFWS, acting as a review agency for the USEPA, will be kept informed of proposed remedial activities.
Endangered Species	Endangered Species Act	50 CFR §§ 17.11-17.12; 50 CFR Part 402	Applicable, if endangered species are encountered	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	Protection of endangered species and their habitat will be considered during development and design of remedial alternatives.

Table 5.3-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Historical/ Archeological Resources	National Historic Preservation Act	16 USC § 469 et seq.; 36 CFR Part 65	Applicable, if subject historical resources are present	When a federal agency finds, or is notified, that its activities in connection with a federal construction project may cause irreparable loss or destruction of significant scientific, pre-historical, historical, or archeological data, the substantive standards under the Act will be met.	Any undisturbed areas altered by the remedial activities will be assessed to ensure no protected resource areas are present. If present, federal and state preservation officials will be consulted to address measures to avoid, minimize, and/or mitigate any impacts to protected resource areas.
Atlantic Flyway	Migratory Bird Treaty Act	16 USC § 703 et seq.	Applicable, if subject protected species are present	Protects migratory birds, their nests and eggs. A depredation permit issued by the U.S. Fish and Wildlife Service is required to take, possess, or transport migratory birds or disturb their nests, eggs, or young.	Remedial activities will be evaluated to protect migratory birds, their nests and eggs. If migratory bird protected areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.
State Standards					
Floodplains, Wetlands, Surface Waters	Massachusetts Wetland Protection Act and Regulations	MGL c. 131, § 40; 310 CMR 10.00	Applicable	These regulations restrict dredging, filling, altering, or polluting inland wetland resource areas (defined as areas within the 100-year floodplain) and impose performance standards for work in such areas. Protected resource areas include: 10.54 (Bank); 10.55 (Bordering Vegetated Wetlands); 10.56 (Land under Water Bodies and Waterways); 10.57 (Land Subject to Flooding); and 10.58 (Riverfront Area).	Any remedial activity conducted within a state regulated wetland resource area will comply with the substantive requirements of these regulations. Mitigation of impacts on state wetland resource areas will be addressed.
Floodplains	Massachusetts Hazardous Waste regulations, Location Standards for Land Subject to Flooding	310 CMR 30.701	Applicable	Any new or expanded hazardous waste storage or treatment facility (which only receives hazardous waste from on-site sources), the active portion of which is located within the boundary of land subject to flooding from the statistical 100-year frequency storm, shall be flood-proofed. Flood-proofing shall be designed, constructed, operated and maintained to prevent floodwaters from coming into contact with hazardous waste.	To the extent any hazardous waste is generated during the remedial activities, the wastes will be managed so that it will not impact floodplain resources.

Table 5.3-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Wetlands, Aquatic Ecosystem	Massachusetts Water Quality Certification for Discharge of Dredged or Fill Material	MGL c. 21, §§ 26-53; 314 CMR 9.00	Applicable	For discharges of dredged or fill material, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; appropriate and practicable steps must be taken to avoid and minimize potential adverse impacts to wetlands and land under water; stormwater discharges must be controlled with BMPs; and there must not be substantial adverse impacts to the physical, chemical, or biological integrity of surface waters. For dredging and dredged material management, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; and if avoidance is not possible, then minimize, or if neither avoidance or minimization are possible, then mitigate potential adverse impacts.	The remedial alternatives' effects on the aquatic ecosystem will be evaluated and avoided, and/or minimized. Compensatory mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives. Any required removal of soil/sediment from wetland or surface water areas will be designated for eventual restoration. Excavation and filling activities to be performed impacting the aquatic ecosystem will be in accordance with the substantive requirements of these regulations.
Endangered Species	Massachusetts Endangered Species Regulations	321 CMR 10.00	Applicable, if endangered species are encountered	Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural Heritage Program.	The protection of state listed endangered species will be considered during the development and design of remedial alternatives.
Historical/ Archeological Resources	Protection of Properties Included in the State Register of Historic Places	MGL c. 9, §§ 26-27C; 950 CMR 71.00	Applicable, if subject historical resources are present	Projects must eliminate, limit, or mitigate adverse effects to properties listed in the State Register of Historic Places (historic and archaeological properties). Establishes coordination with the National Historic Preservation Act.	If protected resource areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials.

Table 5.3-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Area of Critical Environmental Concern	Massachusetts Areas of Critical Environmental Concern (ACECs) Regulations	310 CMR 12.00	Applicable, if ACEC is identified	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical interrelationships among a number of components. An eligible area must contain features from four or more of the following groups: (1) fisheries, (2) coastal features, (3) estuarine wetlands, (4) inland wetlands, (5) inland surface waters, (6) water supply areas (e.g., aquifer recharge area); (7) natural hazard areas (e.g., floodplain); (8) agricultural areas; (9) historical/archeological resources; (10) habitat resources (e.g., for endangered wildlife); or (11) special use areas. After an area is designated as an ACEC, the aim is to preserve and restore these areas.	If ACEC is identified in the site area, activities will be controlled to minimize impacts to affected species.

Prepared By / Date: APP 04/29/2019
Checked By / Date: MJM 05/08/2019

Notes:
ACEC = Areas of Critical Environmental Concern
ARAR = Applicable or Relevant and Appropriate Requirement
BMP = Best Management Practice
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
CWA = Clean Water Act
DAPL = Dense Aqueous Phase Liquid
FEMA = Federal Emergency Management Agency
LEDPA = Least Environmentally Damaging Practicable Alternative
MGL = Massachusetts General Law
RCRA = Resource Conservation and Recovery Act
USEPA = United States Environmental Protection Agency
USFWS = United States Fish and Wildlife Service
USC = United States Code

Table 5.3-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards				
USEPA Risk Reference Doses (RfDs)	USEPA RfDs	To Be Considered	RfDs are estimates of daily exposure levels that are likely to cause significant adverse non-carcinogenic health effects over a lifetime.	RfDs will be considered during development of PRGs.
USEPA Carcinogenic Assessment Group, Cancer Slope Factors (CSFs)	USEPA CSFs	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to site contaminants and represent the most up-to-date information on cancer risk from USEPA's Carcinogenic Assessment Group.	CSFs will be considered during development of PRGs.
Guidelines for Carcinogenic Risk Assessment	EPA/630/P-03/001F, March 2005	To Be Considered	These guidance values are to be used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	These guidelines will be considered during development of PRGs.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F, March 2005	To Be Considered	These Guidance values are to be used to evaluate the potential carcinogenic hazard to children caused by exposure to contaminants.	These guidelines will be considered during development of PRGs.
Clean Water Act (CWA) National Recommended Water Quality Criteria (NRWQC)	33 USC §1314(a); 40 CFR Part 131	Relevant and Appropriate	NRWQC are established for the protection of aquatic life and human health in surface water for approximately 150 pollutants.	NRWQCs will be considered during development of remedial alternatives that include discharge of treated groundwater to a surface water body.
Regional Screening Levels for Chemical Contaminants at Superfund Sites		To Be Considered	Regional Screening Levels (RSLs) are risk-based tools for screening contaminants at Superfund sites. RSLs are not intended to be cleanup standards.	RSLs will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.

Table 5.3-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites	OSWER 9355.4-24 (2002)	To Be Considered	EPA guidance for evaluating soil contamination. Used to develop risk-based cleanup standards, including based on the leaching of soil contaminants to groundwater.	This guidance will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.
Soil Screening Guidance: Technical Background Document	EPA/540/R95/ 128 (1996)	To Be Considered	EPA guidance for evaluating soil contamination. Used to develop risk-based cleanup standards.	This guidance will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.
Ontario Ministry of Environment and Energy (OMEE) Severe Effect Levels (SELs) for Freshwater Sediments	(Persaud et al., 1993)	To Be Considered	The SEL value is the concentration at which the majority of the sediment-dwelling organisms are affected. Used to develop risk-based cleanup standards.	SELs will be used to assess ecological risks due to exposure to chemicals in sediment and to develop sediment PRGs.
Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Probable Effects Concentrations (PECs)	(MacDonald et al., 2000)	To Be Considered	The SEL value is the concentration at which the majority of the sediment-dwelling organisms are affected. Used to develop risk-based cleanup standards.	PECs will be used to assess ecological risks due to exposure to chemicals in sediment and to develop sediment PRGs.

Prepared By / Date: APP 04/29/2019
Checked By / Date: MJM 05/08/2019

Table 5.3-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
CSF = cancer slope factor
MCLs = Maximum Contaminant Levels
MCLGs = Maximum Contaminant Level Goals
NRWQC = National Recommended Water Quality Criteria
OMEG = Ontario Ministry of Environment and Energy
OSWER = Office of Solid Waste and Emergency Response
PEC = Probable Effects Concentration
PRGs = Preliminary Remediation Goals
RfD = reference dose
RSL = Regional Screening Level
SDWA = Safe Drinking Water Act
SEL - Severe Effect Level
USC = United States Code
USEPA = United States Environmental Protection Agency

Table 5.3-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards					
Hazardous Waste Treatment, Storage, Disposal	Resource Conservation and Recovery Act (RCRA) Subtitle C; Hazardous Waste Identification; Generator and Handler Requirements; Tracking Requirements; Storage, Treatment and Disposal Requirements; Groundwater Monitoring Requirements; Closure and Post Closure Requirements; Land Disposal Restriction Requirements	42 USC § 6901 et seq.; 40 CFR Parts 260-262, Part 264/(including Subparts B, C, D, E, F, G, I, J, K, L, M, N, W, X) and Part 268	Potentially Applicable or Relevant and Appropriate	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. These provisions have been adopted by the Commonwealth.	Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous waste. Non-hazardous wastes will be disposed of appropriately. Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.

Table 5.3-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Air Emissions	RCRA, Air Emission Standards for Process Vents, Equipment Leaks, Tanks, Surface Impoundments, and Containers	40 CFR Part 264, Subparts AA, BB, and CC	Applicable, if hazardous waste with volatile organic concentrations of at least 10 parts per million by weight (ppmw) (Subpart AA), with organic concentrations of at least 10 % by weight (Subpart BB), will be treated, stored, or disposed of in tanks, surface impoundments, or containers, and thresholds are met (Subpart CC). Relevant and Appropriate, if less than thresholds.	RCRA emissions standards not delegated to the State. Standards for process vents for systems that manage hazardous wastes that have organic concentrations of at least 10 ppmw. Standards for air equipment leaks for systems that manage hazardous wastes with organic concentrations of at least 10% by weight. Standards for certain tanks, surface impoundments, containers that treat, store, or dispose of hazardous wastes.	Any hazardous wastes generated during remedial activities that meet these rules' threshold requirements will be managed in accordance with these regulations.
Discharges to Surface Water; Storm Water Controls	Clean Water Act National Pollutant Discharge Elimination System (NPDES)	40 CFR Parts 122 and 125	Applicable	The NPDES permit program specifies the permissible concentration or level of contaminants in the discharge from any point source to waters of the United States. Also, includes storm water standards for activities disturbing more than one acre.	Any discharges to surface waters related to excavation and dewatering activities will need to have the discharges meet the substantive discharge standards (the Massachusetts Surface Water Discharge Permit Program [314 CMR 3.00] has similar requirements).
Discharges to Surface Water	Clean Water Act; Toxic Pollutant Effluent Standards	40 CFR Part 129	Applicable	Regulates surface water discharges of specific toxic pollutants, specifically certain pesticides and PCBs.	Any discharge of water contaminated with the specific toxic pollutants generated during remedial activities will be treated to meet applicable toxic pollutant discharge standards if the water is to be discharged to surface waters.

Table 5.3-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Discharge to a Publicly Owned Treatment Works (POTW)	General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR Part 403	Applicable	Establishes responsibilities of federal, state, and local government, industry and the public to implement National Pretreatment Standards to control pollutants which pass through or interfere with treatment processes in POTWs or which may contaminate sewage sludge.	If remedial actions, such as excavation and dewatering activities, result in liquid waste streams that are discharged to a POTW, pretreatment of such waste streams will be evaluated for compliance with applicable requirements of the regulation.
Air Emissions	Clean Air Act (CAA), Hazardous Air Pollutants; National Emission Standards for Hazardous Air Pollutants (NESHAPs)	42 USC § 112(b)(1); 40 CFR Part 61	Potentially Applicable	These regulations establish emissions standards for 189 hazardous air pollutants.	No air emissions from remedial activities, such as soil excavation, will cause air quality standards to be exceeded. Dust standards will be complied with during remedial activities.
Sediment Remediation	Contaminated Sediment Remediation Guidance for Hazardous Waste Sites	EPA-540-R-05-012; OSWER 9355.0-85 (December 2005)	To Be Considered	Guidance for making remedy decisions for contaminated sediment sites. Some of the relevant sections of the guidance address Remedial Investigations (Ch. 2), FS Considerations (Ch. 3), Monitored Natural Recovery (Ch. 4), In-Situ Capping (Ch. 5), and Dredging and Excavation (Ch. 6).	Remedial alternatives will be developed and implemented with consideration of this guidance.
Investigation-Derived waste (IDW)	Guide to Management of Investigation-Derived Wastes	USEPA OSWER Publication 9345.3-03FS, January 1992	To Be Considered	Guidance on management of IDW in a manner that ensures protection of human health and the environment.	IDW generated during remedial activities and monitoring comply with this guidance
Vapor Intrusion	OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air.	OSWER 9200.2-154 (June 2015)	To Be Considered	EPA guidance for addressing vapor intrusion issues at CERCLA sites.	This guidance will be considered during development and implementation of remedial alternatives related to vapor intrusion.
State Standards					
Hazardous Waste Identification	Massachusetts Hazardous Waste Management Rules for Identification and Listing of Hazardous Wastes	310 CMR 30.100	Applicable	Massachusetts is delegated to administer RCRA through its state regulations. These regulations establish requirements for determining whether wastes are either listed or characteristic hazardous waste.	These Massachusetts regulations supplement federal RCRA requirements. Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous wastes. Non-hazardous wastes will be disposed of appropriately.

Table 5.3-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Generator Standards	Massachusetts Hazardous Waste Rules – Requirements for Generators	310 CMR 30.300	Applicable for listed wastes that still display characteristics, or for hazardous wastes generated as part of a cleanup; Relevant and Appropriate for non-listed hazardous waste left in-place	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.
Hazardous Waste - Management Facility Standards	Massachusetts Hazardous Waste Rules – Management Standards for All Hazardous Waste Facilities	310 CMR 30.500	Applicable for listed wastes that still display characteristics, or for hazardous wastes generated as part of a cleanup; Relevant and Appropriate for non-listed hazardous waste left in-place	General facility requirements for waste analysis, security measures, inspections, and training requirements. Section 30.580 addresses closure and, Section 30.590 addresses post-closure of hazardous waste facilities.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.
Hazardous Waste - Groundwater	Massachusetts Hazardous Waste Rules – Groundwater Protection	310 CMR 30.660	Applicable	310 CMR 30.661 through 30.673 prescribe requirements for regulated units that receive hazardous waste, except for certain waste piles, to protect groundwater.	Any hazardous waste generated by remedial alternatives that involve excavation of soil/sediment will be managed to prevent contaminant migration to groundwater.

Table 5.3-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Containers	Massachusetts Hazardous Waste Rules – Use and Management of Containers	310 CMR 30.680	Potentially Applicable	310 CMR 30.681 through 30.689 prescribe requirements for the use of containers, such as drums, to store hazardous waste. Provides specifications for *inter alia* labelling and marking, management of containers, inspections, and closure.	Establishes requirements for the management of containers, such as drums, that are used to store hazardous wastes. Alternatives handling containers of hazardous waste will comply with this ARAR.
Hazardous Waste - Tanks	Massachusetts Hazardous Waste Rules – Storage and Treatment in Tanks	310 CMR 30.690	Potentially Applicable	310 CMR 30.691 through 30.699 prescribe requirements for the use of tanks to store and treat hazardous waste. Provides specifications for *inter alia* design and installation, containment and detection of leaks, general operating requirements, inspections, and closure and post-closure care.	Alternatives utilizing tanks for storage or treatment of hazardous waste will comply with this ARAR.
Discharges to Surface Waters	Massachusetts Clean Water Act; Surface Water Discharge Permit Regulations	MGL c. 21, §§ 26-53; 314 CMR 3.00	Applicable, if surface water discharge occurs	These regulations provide that discharges to waters of the Commonwealth shall not result in exceedances of Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00).	Any discharges to surface waters related to excavation and dewatering activities will need to have the discharges meet the substantive discharge standards of the Massachusetts Surface Water Discharge Permit (314 CMR 4.00).
Surface Water Quality Monitoring	Massachusetts Clean Water Act; MA Surface Water Quality Standards (MSWQS)	M.G.L. c. 21, §§ 26-53; 314 CMR 4.00	Applicable	These standards designate the most sensitive uses for which the various waters of the Commonwealth shall be enhanced, maintained, or protected. Minimum water quality criteria required to sustain the designated uses are established.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet the MSWQS.
Hazardous Waste - Facility Discharge Standards	Massachusetts Supplemental Requirements for Hazardous Waste Management Facilities	MGL c. 21, §§ 26-53; 314 CMR 8.00	Relevant and Appropriate	This regulation establishes additional requirements that must be satisfied for a RCRA facility (a wastewater treatment works which manages hazardous waste) that has a wastewater discharge permit.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet these standards.

Table 5.3-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Air Emissions	Massachusetts Ambient Air Quality Standards	310 CMR 6.00	Applicable	These regulations establish primary and secondary standards for emissions of sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead.	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.
Air Emissions	Massachusetts Air Pollution Control Regulations	310 CMR 7.00	Applicable	These regulations set emission limits necessary to attain ambient air quality standards, including standards for visible emissions (7.06); dust, odor, construction and demolition (7.09); noise (7.10); and volatile organic compounds (7.18).	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.
Institutional Controls	Massachusetts Contingency Plan, Implementation of Activity and Use Limitations	310 CMR 40.1070(4)	Relevant and Appropriate	Establish standards for the use of Notice of Activity and Use Limitations, a form of institutional controls, at CERCLA sites in Massachusetts.	Institutional controls will be established consistent with state standards for enforceable restrictions on contaminated property to prevent human contact with contamination and to protect remedial infrastructure.
Monitoring Wells	Massachusetts Standard References for Monitoring Wells	WSC-310-91	To Be Considered	Guidance on locating, drilling, installing, sampling and decommissioning monitoring wells.	Monitoring wells that may be required as part of a post-remediation monitoring program will be installed, maintained and decommissioned based on these guidance standards.
Sediment/Erosion Control; Stormwater Management	Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas	Prepared for Massachusetts Executive Office of Environmental Affairs (original print March 1997; reprint May 2003)	To Be Considered	Guidance on preventing erosion and sedimentation.	Remedial activities will be managed to control erosion and sedimentation.

Prepared By / Date: APP 04/11/2019
Checked By / Date: MJM 05/08/2019

Table 5.3-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
DAPL = Dense Aqueous Phase Liquid
DEP = Department of Environmental Protection
IDW = Investigation Derived Waste
MGL = Massachusetts General Law
MNA = Monitored Natural Attenuation
MSWQC = Massachusetts Surface Water Quality Criteria
NAPL = Non-Aqueous Phase Liquid
NESHAP = National Emission Standards for Hazardous Air Pollutant
NPDES = National Pollution Discharge Elimination System
OSWER = Office of Solid Waste and Emergency Response
PCB = Polychlorinated Biphenyl
POTW = Publicly Owned Treatment Works
ppmw = parts per million by weight
RCRA = Resource Conservation and Recovery Act
UIC = Underground Injection Control
USC = United States Code
USEPA = United States Environmental Protection Agency

Table 5.3-4
Cost Estimate for Alternative 3
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

Cost estimate for Alternative 3: Limited Action and Vapor Barrier/SSDS for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and In-situ Chemical Adsorption for South Ditch Surface Water

Year 0 = 2019

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Vapor Barrier/SSDS	30,500	SF	$4	$122,000	ITRC 2008; NAVFAC 2011
Excavation and Off-Site Disposal					
Pre-Design Investigation	1	LS	$17,900	$17,900	25 soil/sediment locations; pre-excavation characterization
Pre-Excavation Wetland Survey	1	LS	$1,000	$1,000	Wetland Scientist; 1 day field effort
Wetland Restoration Plan	1	LS	$5,000	$5,000	Based on cost for similar effort
Mobilization	1	LS	$13,200	$13,200	Estimate from Environmental Remediation Contractor
Site Staging and Prep	1	LS	$95,300	$95,300	Estimate from Environmental Remediation Contractor
Includes temporary staging area for dewatering, silt fencing, tree removal, and matting for access					
Surface Water/Stormwater Diversion	400	LF	$100	$40,000	Estimate from Environmental Remediation Contractor
Excavation	1	LS	$97,700	$97,700	Estimate from Environmental Remediation Contractor
Material Handling & Loading	1	LS	$23,600	$23,600	Estimate from Environmental Remediation Contractor
Off-Site Disposal as Non-Hazardous	475	ton	$225	$106,875	Estimate from Hazardous Waste Disposal Contractor
Off-Site Disposal w/ Off-Site Stabilization	475	ton	$350	$166,250	
Backfill, Re-grading, & Seeding	1	LS	$97,500	$97,500	Estimate from Environmental Remediation Contractor
Restoration Plantings	1	LS	$2,500	$2,500	
Demobilization	1	LS	$38,100	$38,100	Estimate from Environmental Remediation Contractor
Excavation Area Monthly Inspections	6	LS	$800	$4,800	Monthly for 6 months
Limited Action					
Deed Restriction Modification	0	LS	$12,400	$0	Performed internally by Olin
Monitoring of South Ditch Surface Water	0	LS	$7,644	$0	SW monitoring will continue as currently performed; costs
Evaluation of South Ditch Surface Water Data	0	LS	$1,000	$0	begin in Year 1 and reflected under Annual Costs
Toxicity Testing of South Ditch Surface Water	1	LS	$6,500	$6,500	Toxicity testing to verify RAO compliance; one *Daphnia magna* test
Toxicity Testing of South Ditch Sediment	1	LS	$13,000	$13,000	Toxicity testing to verify RAO compliance; one *Hyalella azteca* test + one control test
In-Situ Chemical Adsorption for Surface Water					
General Requirements	1	LS	$100	$100	Assume 2% of construction cost (rounded)
Erosion and Sediment Control Measures	0	LS	$100	$0	Assume stream is dry and no dewatering needed. Otherwise, assume 1% of construction cost (rounded)
Installation Labor	1	LS	$1,680	$1,680	Assuming 1 days
Installation Oversight	1	LS	$900	$900	Assume staff onsite for construction oversight
Equipment	1	LS	$2,400	$2,400	Excavator, dump truck, misc. equipment
Construction Materials	1	LS	$700	$700	Concrete, forms, 2 gabion baskets, zeolite and activated carbon media
Contingency	0	%	20%	$171,400	
			TOTAL CAPITAL COSTS	$1,028,405	

Table 5.3-4
Cost Estimate for Alternative 3
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

ANNUAL COSTS YEARS 1 - 2

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Vapor Barrier/SSDS	0	Months	$0	$0	O&M to be assumed by building owner once SSDS construction complete
Excavation and Off-Site Disposal	0	Months	$0	$0	Completed in Year 0; No O&M
Limited Action and Monitoring					
Surface Water Monitoring (Semi-Annual)	2	LS	$700	$1,400	Assumed 3 surface water samples analyzed for dissolved chromium & ammonia @ $100 per sample; 1 person @ 1/2 day for sample collection and field measurements.
Ecological Recovery Inspection (Semi-Annual)	2	LS	$800	$1,600	Performed in Years 1 & 2; then at 5-year intervals
In-situ Chemical Adsorption					
5-Year adsorption media replacement event	0	LS	$2,700	$0	Performed every 5 years; not an annual cost
Annual Monitoring and Performance Report	1	LS	$10,000	$10,000	Based on costs for similar sites and reporting
		TOTAL ANNUAL COSTS		$13,000	Years 1 - 2

ANNUAL COSTS YEARS 3 - 30

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Vapor Barrier/SSDS	0	Months	$0	$0	O&M to be assumed by building owner once SSDS construction complete
Excavation and Off-Site Disposal	0	Months	$0	$0	Completed in Year 0; No O&M
Limited Action and Monitoring					
Surface Water Monitoring (Semi-Annual)	2	LS	$700	$1,400	Assumed 3 surface water samples analyzed for dissolved chromium & ammonia @ $100 per sample; 1 person @ 1/2 day for sample collection and field measurements.
In-situ Chemical Adsorption					
5-Year adsorption media replacement event	0	LS	$2,700	$0	Performed every 5 years; not an annual cost
Annual Monitoring and Performance Report	1	LS	$10,000	$10,000	Based on costs for similar sites and reporting
		TOTAL ANNUAL COSTS		$11,400	Years 3 - 30

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Vapor Barrier/SSDS	0	Months	$0	$0	O&M to be assumed by building owner once SSDS construction complete
Excavation and Off-Site Disposal					
Ecological Recovery Inspection	1	LS	$800	$800	(in advance of 5-Year Review Report)
Limited Action and Monitoring	0	LS	$0	$0	Annual costs only; No 5-year costs
In-situ Chemical Adsorption					
5-Year adsorption media replacement event	1	LS	$2,700	$2,700	Based on material costs plus 1/2 day personnel
Reporting					
5-Year Review Report	1	LS	$10,000	$10,000	Incremental cost only; will be performed site-wide
Deed Restrictions Verification and Maintenance	0	LS	$5,000	$0	Performed internally by Olin
		TOTAL 5-YEAR COSTS		$13,500	

Table 5.3-4
Cost Estimate for Alternative 3
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$1,028,405	1.0000	$1,028,405	
Annual Costs	1	$13,000	0.9728	$12,646	
Annual Costs	2	$13,000	0.9463	$12,301	
Annual Costs	3	$11,400	0.9205	$10,494	
Annual Costs	4	$11,400	0.8954	$10,208	
Annual Costs	5	$11,400	0.8710	$9,930	
5-Year Periodic Costs	5	$13,500	0.8710	$11,759	
Annual Costs	6	$11,400	0.8473	$9,659	
Annual Costs	7	$11,400	0.8242	$9,396	
Annual Costs	8	$11,400	0.8018	$9,140	
Annual Costs	9	$11,400	0.7799	$8,891	
Annual Costs	10	$11,400	0.7587	$8,649	
5-Year Periodic Costs	10	$13,500	0.7587	$10,242	
Annual Costs	11	$11,400	0.7380	$8,414	
Annual Costs	12	$11,400	0.7179	$8,184	
Annual Costs	13	$11,400	0.6984	$7,961	
Annual Costs	14	$11,400	0.6794	$7,745	
Annual Costs	15	$11,400	0.6609	$7,534	
5-Year Periodic Costs	15	$13,500	0.6609	$8,921	
Annual Costs	16	$11,400	0.6429	$7,328	
Annual Costs	17	$11,400	0.6253	$7,129	
Annual Costs	18	$11,400	0.6083	$6,935	
Annual Costs	19	$11,400	0.5917	$6,746	
Annual Costs	20	$11,400	0.5756	$6,562	
5-Year Periodic Costs	20	$13,500	0.5756	$7,771	
Annual Costs	21	$11,400	0.5599	$6,383	
Annual Costs	22	$11,400	0.5447	$6,209	
Annual Costs	23	$11,400	0.5299	$6,040	
Annual Costs	24	$11,400	0.5154	$5,876	
Annual Costs	25	$11,400	0.5014	$5,716	
5-Year Periodic Costs	25	$13,500	0.5014	$6,769	
Annual Costs	26	$11,400	0.4877	$5,560	
Annual Costs	27	$11,400	0.4744	$5,409	
Annual Costs	28	$11,400	0.4615	$5,261	
Annual Costs	29	$11,400	0.4490	$5,118	
Annual Costs	30	$11,400	0.4367	$4,979	
5-Year Periodic Costs	30	$13,500	0.4367	$5,896	
		$1,454,605		$1,312,168	
		TOTAL COST OF ALTERNATIVE	**$1,455,000**		
		TOTAL PRESENT WORTH OF ALTERNATIVE	**$1,312,000**		
		PROJECT DURATION	**30 Years**		

Prepared/Date: KPW 05/03/2019
Revised/Date: APP 05/09/2019
Checked/Date: MJM 05/09/2019

Interstate Technology and Regulatory Council (ITRC) 2008. Vapor Intrusion: A Practical Guide. ITRC, January 2007.
Naval Facilities Engineering Command (NAVFAC) 2011; Vapor Intrusion Mitigation in Construction of New Buildings Fact Sheet; NAVFAC Navy Alternative Restoration Technology Team, August 2011.

Table 5.4-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards					
Floodplains and Wetlands	Floodplain Management and Protection of Wetlands	44 CFR Part 9 (implementing Executive Orders 11988 and 11990)	Applicable	Federal Emergency Management Agency (FEMA) regulations set forth the policy, procedure, and responsibilities to implement and enforce Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). These regulations prohibit activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. These regulations require the avoidance of impacts associated with the occupancy and modification of federally-designated 100-year and 500-year floodplains and require the avoidance of development within a floodplain wherever there is a practicable alternative. An assessment of impacts to the 500-year floodplain is required for critical actions, which includes siting waste facilities in a floodplain. These regulations require public notice when proposing any action in or affecting floodplains or wetlands.	If there is no practical alternative method of work in federal jurisdictional wetlands, or 100-year or 500-year floodplains, then all practical measures will be taken to minimize and mitigate any adverse impacts. Erosion and sediment control measures will be adopted during remedial activities to protect these wetlands and floodplains. After completion of work, there will be no significant net loss of flood storage capacity and no significant net increase in flood stage or velocities. Floodplain habitat will be restored to the extent practicable. Public comment will be solicited as part of the Proposed Plan concerning any proposed alteration to wetlands and floodplains.
Floodplains	RCRA Floodplain Restrictions for Hazardous Waste Facilities	42 USC § 6901 et seq.; 40 CFR § 264.18(b)	Applicable	A hazardous waste treatment, storage, or disposal facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout or to result in no adverse effects on human health or the environment if washout were to occur.	Any hazardous waste generated during remedial activities will be managed so that it will not impact floodplain resources.
Floodplains	RCRA Floodplain Restrictions for Solid Waste Disposal Facilities and Practices	40 CFR § 257.3-1	Applicable	Solid waste practices must not restrict the flow of a 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources.	Any solid waste generated from remedial activities involving excavation activities will be managed so that it will not impact floodplain resources.

Table 5.4-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Wetlands, Aquatic Ecosystem	Clean Water Act (CWA) Section 404 and regulations	33 USC § 1344; 40 CFR Parts 230 & 231; and 33 CFR Parts 320-323	Applicable	For discharge of dredged or fill material into water bodies or wetlands, there must be no practicable alternative with less adverse impact on aquatic ecosystem; discharge cannot cause or contribute to violation of state water quality standards or toxic effluent standards or jeopardize threatened or endangered species; discharge cannot significantly degrade waters of U.S.; practicable steps must be taken to minimize and mitigate adverse impacts; and impacts on flood level, flood velocity, and flood storage capacity must be evaluated. Sets standards for restoration and mitigation required as a result of unavoidable impacts to aquatic resources. USEPA must determine which alternative is the "Least Environmentally Damaging Practicable Alternative" (LEDPA) to protect wetland and aquatic resources.	Remedial alternatives will be developed and designed to comply with these regulations. Compensatory wetlands mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives.
Wetlands	U.S. Army Corps of Engineers, New England District Compensatory Mitigation Guidance (09-07-2016)	New England District Compensatory Mitigation Guidance (09-07-2016)	To Be Considered	This Guidance is to be considered when compensatory mitigation to address impacts to federal jurisdiction wetlands is appropriate for a particular remedial activity.	Activities affecting federal jurisdictional wetlands will be conducted in accordance with these guidance standards for mitigation and restoration.
Surface Waters, Wetland/Waterway Habitat for Endangered Species, Migratory Species	Fish and Wildlife Coordination Act	16 USC §§ 662-663; 40 CFR Part 6	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss to the maximum extent practicable.	To the extent necessary, actions will be taken to develop measures to prevent, mitigate, or compensate for project-related impacts to habitat and wildlife. The USFWS, acting as a review agency for the USEPA, will be kept informed of proposed remedial activities.
Endangered Species	Endangered Species Act	50 CFR §§ 17.11-17.12; 50 CFR Part 402	Applicable, if endangered species are encountered	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	Protection of endangered species and their habitat will be considered during development and design of remedial alternatives.

Table 5.4-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Historical/ Archeological Resources	National Historic Preservation Act	16 USC § 469 et seq.; 36 CFR Part 65	Applicable, if subject historical resources are present	When a federal agency finds, or is notified, that its activities in connection with a federal construction project may cause irreparable loss or destruction of significant scientific, pre-historical, historical, or archeological data, the substantive standards under the Act will be met.	Any undisturbed areas altered by the remedial activities will be assessed to ensure no protected resource areas are present. If present, federal and state preservation officials will be consulted to address measures to avoid, minimize, and/or mitigate any impacts to protected resource areas.
Atlantic Flyway	Migratory Bird Treaty Act	16 USC § 703 et seq.	Applicable, if subject protected species are present	Protects migratory birds, their nests and eggs. A depredation permit issued by the U.S. Fish and Wildlife Service is required to take, possess, or transport migratory birds or disturb their nests, eggs, or young.	Remedial activities will be evaluated to protect migratory birds, their nests and eggs. If migratory bird protected areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.
State Standards					
Floodplains, Wetlands, Surface Waters	Massachusetts Wetland Protection Act and Regulations	MGL c. 131, § 40; 310 CMR 10.00	Applicable	These regulations restrict dredging, filling, altering, or polluting inland wetland resource areas (defined as areas within the 100-year floodplain) and impose performance standards for work in such areas. Protected resource areas include: 10.54 (Bank); 10.55 (Bordering Vegetated Wetlands); 10.56 (Land under Water Bodies and Waterways); 10.57 (Land Subject to Flooding); and 10.58 (Riverfront Area).	Any remedial activity conducted within a state regulated wetland resource area will comply with the substantive requirements of these regulations. Mitigation of impacts on state wetland resource areas will be addressed.
Floodplains	Massachusetts Hazardous Waste regulations, Location Standards for Land Subject to Flooding	310 CMR 30.701	Applicable	Any new or expanded hazardous waste storage or treatment facility (which only receives hazardous waste from on-site sources), the active portion of which is located within the boundary of land subject to flooding from the statistical 100-year frequency storm, shall be flood-proofed. Flood-proofing shall be designed, constructed, operated and maintained to prevent floodwaters from coming into contact with hazardous waste.	To the extent any hazardous waste is generated during the remedial activities, the wastes will be managed so that it will not impact floodplain resources.

Table 5.4-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Wetlands, Aquatic Ecosystem	Massachusetts Water Quality Certification for Discharge of Dredged or Fill Material	MGL c. 21, §§ 26-53; 314 CMR 9.00	Applicable	For discharges of dredged or fill material, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; appropriate and practicable steps must be taken to avoid and minimize potential adverse impacts to wetlands and land under water; stormwater discharges must be controlled with BMPs; and there must not be substantial adverse impacts to the physical, chemical, or biological integrity of surface waters. For dredging and dredged material management, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; and if avoidance is not possible, then minimize, or if neither avoidance or minimization are possible, then mitigate potential adverse impacts.	The remedial alternatives' effects on the aquatic ecosystem will be evaluated and avoided, and/or minimized. Compensatory mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives. Any required removal of soil/sediment from wetland or surface water areas will be designated for eventual restoration. Excavation and filling activities to be performed impacting the aquatic ecosystem will be in accordance with the substantive requirements of these regulations.
Endangered Species	Massachusetts Endangered Species Regulations	321 CMR 10.00	Applicable, if endangered species are encountered	Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural Heritage Program.	The protection of state listed endangered species will be considered during the development and design of remedial alternatives.
Historical/ Archeological Resources	Protection of Properties Included in the State Register of Historic Places	MGL c. 9, §§ 26-27C; 950 CMR 71.00	Applicable, if subject historical resources are present	Projects must eliminate, limit, or mitigate adverse effects to properties listed in the State Register of Historic Places (historic and archaeological properties). Establishes coordination with the National Historic Preservation Act.	If protected resource areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials.

Table 5.4-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Area of Critical Environmental Concern	Massachusetts Areas of Critical Environmental Concern (ACECs) Regulations	310 CMR 12.00	Applicable, if ACEC is identified	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical interrelationships among a number of components. An eligible area must contain features from four or more of the following groups: (1) fisheries, (2) coastal features, (3) estuarine wetlands, (4) inland wetlands, (5) inland surface waters, (6) water supply areas (e.g., aquifer recharge area); (7) natural hazard areas (e.g., floodplain); (8) agricultural areas; (9) historical/archeological resources; (10) habitat resources (e.g., for endangered wildlife); or (11) special use areas. After an area is designated as an ACEC, the aim is to preserve and restore these areas.	If ACEC is identified in the site area, activities will be controlled to minimize impacts to affected species.

Prepared By / Date: APP 04/29/2019
Checked By / Date: MJM 05/08/2019

Notes:
ACEC = Areas of Critical Environmental Concern
ARAR = Applicable or Relevant and Appropriate Requirement
BMP = Best Management Practice
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
CWA = Clean Water Act
DAPL = Dense Aqueous Phase Liquid
FEMA = Federal Emergency Management Agency
LEDPA = Least Environmentally Damaging Practicable Alternative
MGL = Massachusetts General Law
RCRA = Resource Conservation and Recovery Act
USEPA = United States Environmental Protection Agency
USFWS = United States Fish and Wildlife Service
USC = United States Code

Table 5.4-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards				
USEPA Risk Reference Doses (RfDs)	USEPA RfDs	To Be Considered	RfDs are estimates of daily exposure levels that are likely to cause significant adverse non-carcinogenic health effects over a lifetime.	RfDs will be considered during development of PRGs.
USEPA Carcinogenic Assessment Group, Cancer Slope Factors (CSFs)	USEPA CSFs	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to site contaminants and represent the most up-to-date information on cancer risk from USEPA's Carcinogenic Assessment Group.	CSFs will be considered during development of PRGs.
Guidelines for Carcinogenic Risk Assessment	EPA/630/P-03/001F, March 2005	To Be Considered	These guidance values are to be used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	These guidelines will be considered during development of PRGs.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F, March 2005	To Be Considered	These Guidance values are to be used to evaluate the potential carcinogenic hazard to children caused by exposure to contaminants.	These guidelines will be considered during development of PRGs.
Clean Water Act (CWA) National Recommended Water Quality Criteria (NRWQC)	33 USC §1314(a); 40 CFR Part 131	Relevant and Appropriate	NRWQC are established for the protection of aquatic life and human health in surface water for approximately 150 pollutants.	NRWQCs will be considered during development of remedial alternatives that include discharge of treated groundwater to a surface water body.
Regional Screening Levels for Chemical Contaminants at Superfund Sites		To Be Considered	Regional Screening Levels (RSLs) are risk-based tools for screening contaminants at Superfund sites. RSLs are not intended to be cleanup standards.	RSLs will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.

Table 5.4-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites	OSWER 9355.4-24 (2002)	To Be Considered	EPA guidance for evaluating soil contamination. Used to develop risk-based cleanup standards, including based on the leaching of soil contaminants to groundwater.	This guidance will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.
Soil Screening Guidance: Technical Background Document	EPA/540/R95/ 128 (1996)	To Be Considered	EPA guidance for evaluating soil contamination. Used to develop risk-based cleanup standards.	This guidance will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.
Ontario Ministry of Environment and Energy (OMEE) Severe Effect Levels (SELs) for Freshwater Sediments	(Persaud et al., 1993)	To Be Considered	The SEL value is the concentration at which the majority of the sediment-dwelling organisms are affected. Used to develop risk-based cleanup standards.	SELs will be used to assess ecological risks due to exposure to chemicals in sediment and to develop sediment PRGs.
Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Probable Effects Concentrations (PECs)	(MacDonald et al., 2000)	To Be Considered	The SEL value is the concentration at which the majority of the sediment-dwelling organisms are affected. Used to develop risk-based cleanup standards.	PECs will be used to assess ecological risks due to exposure to chemicals in sediment and to develop sediment PRGs.

Prepared By / Date: APP 04/29/2019
Checked By / Date: MJM 05/08/2019

Table 5.4-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
CSF = cancer slope factor
MCLs = Maximum Contaminant Levels
MCLGs = Maximum Contaminant Level Goals
NRWQC = National Recommended Water Quality Criteria
OMEG = Ontario Ministry of Environment and Energy
OSWER = Office of Solid Waste and Emergency Response
PEC = Probable Effects Concentration
PRGs = Preliminary Remediation Goals
RfD = reference dose
RSL = Regional Screening Level
SDWA = Safe Drinking Water Act
SEL - Severe Effect Level
USC = United States Code
USEPA = United States Environmental Protection Agency

Table 5.4-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards					
Hazardous Waste Treatment, Storage, Disposal	Resource Conservation and Recovery Act (RCRA) Subtitle C; Hazardous Waste Identification; Generator and Handler Requirements; Tracking Requirements; Storage, Treatment and Disposal Requirements; Groundwater Monitoring Requirements; Closure and Post Closure Requirements; Land Disposal Restriction Requirements	42 USC § 6901 et seq.; 40 CFR Parts 260-262, Part 264/(including Subparts B, C, D, E, F, G, I, J, K, L, M, N, W, X) and Part 268	Potentially Applicable or Relevant and Appropriate	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. These provisions have been adopted by the Commonwealth.	Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous waste. Non-hazardous wastes will be disposed of appropriately. Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.

Table 5.4-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Air Emissions	RCRA, Air Emission Standards for Process Vents, Equipment Leaks, Tanks, Surface Impoundments, and Containers	40 CFR Part 264, Subparts AA, BB, and CC	Applicable, if hazardous waste with volatile organic concentrations of at least 10 parts per million by weight (ppmw) (Subpart AA), with organic concentrations of at least 10 % by weight (Subpart BB), will be treated, stored, or disposed of in tanks, surface impoundments, or containers, and thresholds are met (Subpart CC). Relevant and Appropriate, if less than thresholds.	RCRA emissions standards not delegated to the State. Standards for process vents for systems that manage hazardous wastes that have organic concentrations of at least 10 ppmw. Standards for air equipment leaks for systems that manage hazardous wastes with organic concentrations of at least 10% by weight. Standards for certain tanks, surface impoundments, containers that treat, store, or dispose of hazardous wastes.	Any hazardous wastes generated during remedial activities that meet these rules' threshold requirements will be managed in accordance with these regulations.
Discharges to Surface Water; Storm Water Controls	Clean Water Act National Pollutant Discharge Elimination System (NPDES)	40 CFR Parts 122 and 125	Applicable	The NPDES permit program specifies the permissible concentration or level of contaminants in the discharge from any point source to waters of the United States. Also, includes storm water standards for activities disturbing more than one acre.	Any discharges to surface waters related to excavation and dewatering activities will need to have the discharges meet the substantive discharge standards (the Massachusetts Surface Water Discharge Permit Program [314 CMR 3.00] has similar requirements).
Discharges to Surface Water	Clean Water Act; Toxic Pollutant Effluent Standards	40 CFR Part 129	Applicable	Regulates surface water discharges of specific toxic pollutants, specifically certain pesticides and PCBs.	Any discharge of water contaminated with the specific toxic pollutants generated during remedial activities will be treated to meet applicable toxic pollutant discharge standards if the water is to be discharged to surface waters.

Table 5.4-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Discharge to a Publicly Owned Treatment Works (POTW)	General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR Part 403	Applicable	Establishes responsibilities of federal, state, and local government, industry and the public to implement National Pretreatment Standards to control pollutants which pass through or interfere with treatment processes in POTWs or which may contaminate sewage sludge.	If remedial actions, such as excavation and dewatering activities, result in liquid waste streams that are discharged to a POTW, pretreatment of such waste streams will be evaluated for compliance with applicable requirements of the regulation.
Air Emissions	Clean Air Act (CAA), Hazardous Air Pollutants; National Emission Standards for Hazardous Air Pollutants (NESHAPs)	42 USC § 112(b)(1); 40 CFR Part 61	Potentially Applicable	These regulations establish emissions standards for 189 hazardous air pollutants.	No air emissions from remedial activities, such as soil excavation, will cause air quality standards to be exceeded. Dust standards will be complied with during remedial activities.
Sediment Remediation	Contaminated Sediment Remediation Guidance for Hazardous Waste Sites	EPA-540-R-05-012; OSWER 9355.0-85 (December 2005)	To Be Considered	Guidance for making remedy decisions for contaminated sediment sites. Some of the relevant sections of the guidance address Remedial Investigations (Ch. 2), FS Considerations (Ch. 3), Monitored Natural Recovery (Ch. 4), In-Situ Capping (Ch. 5), and Dredging and Excavation (Ch. 6).	Remedial alternatives will be developed and implemented with consideration of this guidance.
Investigation-Derived waste (IDW)	Guide to Management of Investigation-Derived Wastes	USEPA OSWER Publication 9345.3-03FS, January 1992	To Be Considered	Guidance on management of IDW in a manner that ensures protection of human health and the environment.	IDW generated during remedial activities and monitoring comply with this guidance
Vapor Intrusion	OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air.	OSWER 9200.2-154 (June 2015)	To Be Considered	EPA guidance for addressing vapor intrusion issues at CERCLA sites.	This guidance will be considered during development and implementation of remedial alternatives related to vapor intrusion.
State Standards					
Hazardous Waste Identification	Massachusetts Hazardous Waste Management Rules for Identification and Listing of Hazardous Wastes	310 CMR 30.100	Applicable	Massachusetts is delegated to administer RCRA through its state regulations. These regulations establish requirements for determining whether wastes are either listed or characteristic hazardous waste.	These Massachusetts regulations supplement federal RCRA requirements. Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous wastes. Non-hazardous wastes will be disposed of appropriately.

Table 5.4-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Generator Standards	Massachusetts Hazardous Waste Rules – Requirements for Generators	310 CMR 30.300	Applicable for listed wastes that still display characteristics, or for hazardous wastes generated as part of a cleanup; Relevant and Appropriate for non-listed hazardous waste left in-place	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.
Hazardous Waste - Management Facility Standards	Massachusetts Hazardous Waste Rules – Management Standards for All Hazardous Waste Facilities	310 CMR 30.500	Applicable for listed wastes that still display characteristics, or for hazardous wastes generated as part of a cleanup; Relevant and Appropriate for non-listed hazardous waste left in-place	General facility requirements for waste analysis, security measures, inspections, and training requirements. Section 30.580 addresses closure and, Section 30.590 addresses post-closure of hazardous waste facilities.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.
Hazardous Waste - Groundwater	Massachusetts Hazardous Waste Rules – Groundwater Protection	310 CMR 30.660	Applicable	310 CMR 30.661 through 30.673 prescribe requirements for regulated units that receive hazardous waste, except for certain waste piles, to protect groundwater.	Any hazardous waste generated by remedial alternatives that involve excavation of soil/sediment will be managed to prevent contaminant migration to groundwater.

Table 5.4-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Containers	Massachusetts Hazardous Waste Rules – Use and Management of Containers	310 CMR 30.680	Potentially Applicable	310 CMR 30.681 through 30.689 prescribe requirements for the use of containers, such as drums, to store hazardous waste. Provides specifications for *inter alia* labelling and marking, management of containers, inspections, and closure.	Establishes requirements for the management of containers, such as drums, that are used to store hazardous wastes. Alternatives handling containers of hazardous waste will comply with this ARAR.
Hazardous Waste - Tanks	Massachusetts Hazardous Waste Rules – Storage and Treatment in Tanks	310 CMR 30.690	Potentially Applicable	310 CMR 30.691 through 30.699 prescribe requirements for the use of tanks to store and treat hazardous waste. Provides specifications for *inter alia* design and installation, containment and detection of leaks, general operating requirements, inspections, and closure and post-closure care.	Alternatives utilizing tanks for storage or treatment of hazardous waste will comply with this ARAR.
Discharges to Surface Waters	Massachusetts Clean Water Act; Surface Water Discharge Permit Regulations	MGL c. 21, §§ 26-53; 314 CMR 3.00	Applicable, if surface water discharge occurs	These regulations provide that discharges to waters of the Commonwealth shall not result in exceedances of Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00).	Any discharges to surface waters related to excavation and dewatering activities will need to have the discharges meet the substantive discharge standards of the Massachusetts Surface Water Discharge Permit (314 CMR 4.00).
Surface Water Quality Monitoring	Massachusetts Clean Water Act; MA Surface Water Quality Standards (MSWQS)	M.G.L. c. 21, §§ 26-53; 314 CMR 4.00	Applicable	These standards designate the most sensitive uses for which the various waters of the Commonwealth shall be enhanced, maintained, or protected. Minimum water quality criteria required to sustain the designated uses are established.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet the MSWQS.
Hazardous Waste - Facility Discharge Standards	Massachusetts Supplemental Requirements for Hazardous Waste Management Facilities	MGL c. 21, §§ 26-53; 314 CMR 8.00	Relevant and Appropriate	This regulation establishes additional requirements that must be satisfied for a RCRA facility (a wastewater treatment works which manages hazardous waste) that has a wastewater discharge permit.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet these standards.

Table 5.4-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Air Emissions	Massachusetts Ambient Air Quality Standards	310 CMR 6.00	Applicable	These regulations establish primary and secondary standards for emissions of sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead.	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.
Air Emissions	Massachusetts Air Pollution Control Regulations	310 CMR 7.00	Applicable	These regulations set emission limits necessary to attain ambient air quality standards, including standards for visible emissions (7.06); dust, odor, construction and demolition (7.09); noise (7.10); and volatile organic compounds (7.18).	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.
Institutional Controls	Massachusetts Contingency Plan, Implementation of Activity and Use Limitations	310 CMR 40.1070(4)	Relevant and Appropriate	Establish standards for the use of Notice of Activity and Use Limitations, a form of institutional controls, at CERCLA sites in Massachusetts.	Institutional controls will be established consistent with state standards for enforceable restrictions on contaminated property to prevent human contact with contamination and to protect remedial infrastructure.
Monitoring Wells	Massachusetts Standard References for Monitoring Wells	WSC-310-91	To Be Considered	Guidance on locating, drilling, installing, sampling and decommissioning monitoring wells.	Monitoring wells that may be required as part of a post-remediation monitoring program will be installed, maintained and decommissioned based on these guidance standards.
Sediment/Erosion Control; Stormwater Management	Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas	Prepared for Massachusetts Executive Office of Environmental Affairs (original print March 1997; reprint May 2003)	To Be Considered	Guidance on preventing erosion and sedimentation.	Remedial activities will be managed to control erosion and sedimentation.

Prepared By / Date: APP 04/11/2019
Checked By / Date: MJM 05/08/2019

Table 5.4-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
DAPL = Dense Aqueous Phase Liquid
DEP = Department of Environmental Protection
IDW = Investigation Derived Waste
MGL = Massachusetts General Law
MNA = Monitored Natural Attenuation
MSWQC = Massachusetts Surface Water Quality Criteria
NAPL = Non-Aqueous Phase Liquid
NESHAP = National Emission Standards for Hazardous Air Pollutant
NPDES = National Pollution Discharge Elimination System
OSWER = Office of Solid Waste and Emergency Response
PCB = Polychlorinated Biphenyl
POTW = Publicly Owned Treatment Works
ppmw = parts per million by weight
RCRA = Resource Conservation and Recovery Act
UIC = Underground Injection Control
USC = United States Code
USEPA = United States Environmental Protection Agency

Table 5.4-4
Cost Estimate for Alternative 4
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

Cost estimate for Alternative 4: AS/SVE for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and Limited Action for South Ditch Surface Water

Year 0 = 2019

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
AS/SVE System					
Impermeable Surface Cover	7800	SF	$1	$7,878	Applied to unpaved surfaces
SVE Extraction Wells	44	EA	$5,000	$220,000	Based on similar projects
SVE Piping	1550	LF	$10	$16,105	Based on similar projects
AS Injection Wells	22	EA	$5,600	$123,200	Based on similar projects
AS Piping	1550	LF	$6	$9,300	Based on similar projects
Valves/Instrumentation	1	LS	$11,000	$11,000	Based on similar projects
System Upgrades	1	LS	$22,000	$22,000	Based on similar projects
Electrical Hookup	1	LS	$13,200	$13,200	Based on similar projects
System Startup and Testing	1	LS	$15,400	$15,400	Based on similar projects
Transportation and Disposal for IDW	22	Drum	$200	$4,400	Based on similar projects
Installation Oversight	44	Days	$1,000	$44,000	Based on similar projects
Excavation and Off-Site Disposal					
Pre-Design Investigation	1	LS	$17,900	$17,900	25 soil/sediment locations; pre-excavation characterization
Pre-Excavation Wetland Survey	1	LS	$1,000	$1,000	Wetland Scientist; 1 day field effort
Wetland Restoration Plan	1	LS	$5,000	$5,000	Based on cost for similar effort
Mobilization	1	LS	$13,200	$13,200	Estimate from Environmental Remediation Contractor
Site Staging and Prep	1	LS	$95,300	$95,300	Estimate from Environmental Remediation Contractor
Includes temporary staging area for dewatering, silt fencing, tree removal, and matting for access					
Surface Water/Stormwater Diversion	400	LF	$100	$40,000	Estimate from Environmental Remediation Contractor
Excavation	1	LS	$97,700	$97,700	Estimate from Environmental Remediation Contractor
Material Handling & Loading	1	LS	$23,600	$23,600	Estimate from Environmental Remediation Contractor
Off-Site Disposal as Non-Hazardous	475	ton	$225	$106,875	Estimate from Hazardous Waste Disposal Contractor
Off-Site Disposal w/ Off-Site Stabilization	475	ton	$350	$166,250	
Backfill, Re-grading, & Seeding	1	LS	$97,500	$97,500	Estimate from Environmental Remediation Contractor
Restoration Plantings	1	LS	$2,500	$2,500	
Demobilization	1	LS	$38,100	$38,100	Estimate from Environmental Remediation Contractor
Excavation Area Monthly Inspections	6	LS	$800	$4,800	Monthly for 6 months
Limited Action					
Deed Restriction Modification	0	LS	$12,400	$0	Performed internally by Olin
Monitoring of South Ditch Surface Water	0	LS	$7,644	$0	SW monitoring will continue as currently performed; costs
Evaluation of South Ditch Surface Water Data	0	LS	$1,000	$0	begin in Year 1 and reflected under Annual Costs
Toxicity Testing of South Ditch Surface Water	1	LS	$6,500	$6,500	Toxicity testing to verify RAO compliance; one *Daphnia magna* test
Toxicity Testing of South Ditch Sediment	1	LS	$13,000	$13,000	Toxicity testing to verify RAO compliance; one *Hyalella azteca* test + one control test
Contingency	0	%	20%	$239,200	
		TOTAL CAPITAL COSTS		$1,454,908	

Table 5.4-4
Cost Estimate for Alternative 4
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

ANNUAL COSTS YEARS 1 - 2

Description	Quantity	Units	Unit Cost	Extended Cost	Note
AS/SVE System					
Operator	416	Hours	$60	$24,960	Assume 1 operator at 8 hours per week
Annual Groundwater Sampling Event	1	LS	$10,000	$10,000	Based on similar projects
Excavation and Off-Site Disposal	0	Months	$0	$0	Completed in Year 0; No O&M
Limited Action and Monitoring					
Surface Water Monitoring (Semi-Annual)	2	LS	$700	$1,400	Assumed 3 surface water samples analyzed for dissolved chromium & ammonia @ $100 per sample; 1 person @ 1/2 day for sample collection and field measurements.
Ecological Recovery Inspection (Semi-Annual)	2	LS	$800	$1,600	Performed in Years 1 & 2; then at 5-year intervals
Annual Monitoring and Performance Report	1	LS	$10,000	$10,000	Includes AS/SVE Performance and SW Monitoring data; Based on costs for similar sites and reporting
		TOTAL ANNUAL COSTS		$47,960	Years 1 - 2

ANNUAL COSTS YEARS 3 - 5

Description	Quantity	Units	Unit Cost	Extended Cost	Note
AS/SVE System					
Operator	416	Hours	$60	$24,960	Assume 1 operator at 8 hours per week
Annual Groundwater Sampling Event	1	LS	$10,000	$10,000	Based on similar projects
Excavation and Off-Site Disposal	0	Months	$0	$0	Completed in Year 0; No O&M
Limited Action and Monitoring					
Surface Water Monitoring (Semi-Annual)	2	LS	$700	$1,400	Assumed 3 surface water samples analyzed for dissolved chromium & ammonia @ $100 per sample; 1 person @ 1/2 day for sample collection and field measurements.
Annual Monitoring and Performance Report	1	LS	$10,000	$10,000	Includes AS/SVE Performance and SW Monitoring data; Based on costs for similar sites and reporting
		TOTAL ANNUAL COSTS		$46,360	Years 3 - 5

ANNUAL COSTS YEARS 6 - 30

Description	Quantity	Units	Unit Cost	Extended Cost	Note
AS/SVE System					
Operator	0	Hours	$60	$0	AS/SVE System finished in Year 5
Annual Groundwater Sampling Event	0	LS	$10,000	$0	AS/SVE System finished in Year 5
Excavation and Off-Site Disposal	0	Months	$0	$0	Completed in Year 0; No O&M
Limited Action and Monitoring					
Surface Water Monitoring (Semi-Annual)	2	LS	$700	$1,400	Assumed 3 surface water samples analyzed for dissolved chromium & ammonia @ $100 per sample; 1 person @ 1/2 day for sample collection and field measurements.
Annual Monitoring and Performance Report	1	LS	$10,000	$10,000	Includes AS/SVE Performance and SW Monitoring data; Based on costs for similar sites and reporting
		TOTAL ANNUAL COSTS		$11,400	Years 6 - 30

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
AS/SVE System					
Operator	0	Hours	$60	$0	Annual costs only; No 5-year costs
Annual Groundwater Sampling Event	0	LS	$10,000	$0	Annual costs only; No 5-year costs
Excavation and Off-Site Disposal					
Ecological Recovery Inspection	1	LS	$800	$800	(in advance of 5-Year Review Report)
Limited Action and Monitoring	0	LS	$0	$0	Annual costs only; No 5-year costs
Reporting					
5-Year Review Report	1	LS	$10,000	$10,000	Incremental cost only; will be performed site-wide
Deed Restrictions Verification and Maintenance	0	LS	$5,000	$0	Performed internally by Olin
		TOTAL 5-YEAR COSTS		$10,800	

Table 5.4-4
Cost Estimate for Alternative 4
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$1,454,908	1.0000	$1,454,908	
Annual Costs	1	$47,960	0.9728	$46,654	
Annual Costs	2	$47,960	0.9463	$45,383	
Annual Costs	3	$46,360	0.9205	$42,674	
Annual Costs	4	$46,360	0.8954	$41,512	
Annual Costs	5	$46,360	0.8710	$40,381	
5-Year Periodic Costs	5	$10,800	0.8710	$9,407	
Annual Costs	6	$11,400	0.8473	$9,659	
Annual Costs	7	$11,400	0.8242	$9,396	
Annual Costs	8	$11,400	0.8018	$9,140	
Annual Costs	9	$11,400	0.7799	$8,891	
Annual Costs	10	$11,400	0.7587	$8,649	
5-Year Periodic Costs	10	$10,800	0.7587	$8,194	
Annual Costs	11	$11,400	0.7380	$8,414	
Annual Costs	12	$11,400	0.7179	$8,184	
Annual Costs	13	$11,400	0.6984	$7,961	
Annual Costs	14	$11,400	0.6794	$7,745	
Annual Costs	15	$11,400	0.6609	$7,534	
5-Year Periodic Costs	15	$10,800	0.6609	$7,137	
Annual Costs	16	$11,400	0.6429	$7,328	
Annual Costs	17	$11,400	0.6253	$7,129	
Annual Costs	18	$11,400	0.6083	$6,935	
Annual Costs	19	$11,400	0.5917	$6,746	
Annual Costs	20	$11,400	0.5756	$6,562	
5-Year Periodic Costs	20	$10,800	0.5756	$6,217	
Annual Costs	21	$11,400	0.5599	$6,383	
Annual Costs	22	$11,400	0.5447	$6,209	
Annual Costs	23	$11,400	0.5299	$6,040	
Annual Costs	24	$11,400	0.5154	$5,876	
Annual Costs	25	$11,400	0.5014	$5,716	
5-Year Periodic Costs	25	$10,800	0.5014	$5,415	
Annual Costs	26	$11,400	0.4877	$5,560	
Annual Costs	27	$11,400	0.4744	$5,409	
Annual Costs	28	$11,400	0.4615	$5,261	
Annual Costs	29	$11,400	0.4490	$5,118	
Annual Costs	30	$11,400	0.4367	$4,979	
5-Year Periodic Costs	30	$10,800	0.4367	$4,717	
		$2,039,708		$1,889,423	
		TOTAL COST OF ALTERNATIVE	**$2,040,000**		
		TOTAL PRESENT WORTH OF ALTERNATIVE	**$1,889,000**		
		PROJECT DURATION	**30 Years**		

Prepared/Date: KPW 05/03/2019
Revised/Date: APP 05/17/2019
Checked/Date: PHT 05/21/2019

Table 5.5-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards					
Floodplains and Wetlands	Floodplain Management and Protection of Wetlands	44 CFR Part 9 (implementing Executive Orders 11988 and 11990)	Applicable	Federal Emergency Management Agency (FEMA) regulations set forth the policy, procedure, and responsibilities to implement and enforce Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). These regulations prohibit activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. These regulations require the avoidance of impacts associated with the occupancy and modification of federally-designated 100-year and 500-year floodplains and require the avoidance of development within a floodplain wherever there is a practicable alternative. An assessment of impacts to the 500-year floodplain is required for critical actions, which includes siting waste facilities in a floodplain. These regulations require public notice when proposing any action in or affecting floodplains or wetlands.	If there is no practical alternative method of work in federal jurisdictional wetlands, or 100-year or 500-year floodplains, then all practical measures will be taken to minimize and mitigate any adverse impacts. Erosion and sediment control measures will be adopted during remedial activities to protect these wetlands and floodplains. After completion of work, there will be no significant net loss of flood storage capacity and no significant net increase in flood stage or velocities. Floodplain habitat will be restored to the extent practicable. Public comment will be solicited as part of the Proposed Plan concerning any proposed alteration to wetlands and floodplains.
Floodplains	RCRA Floodplain Restrictions for Hazardous Waste Facilities	42 USC § 6901 et seq.; 40 CFR § 264.18(b)	Applicable	A hazardous waste treatment, storage, or disposal facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout or to result in no adverse effects on human health or the environment if washout were to occur.	Any hazardous waste generated during remedial activities will be managed so that it will not impact floodplain resources.
Floodplains	RCRA Floodplain Restrictions for Solid Waste Disposal Facilities and Practices	40 CFR § 257.3-1	Applicable	Solid waste practices must not restrict the flow of a 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources.	Any solid waste generated from remedial activities involving excavation activities will be managed so that it will not impact floodplain resources.

Table 5.5-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Wetlands, Aquatic Ecosystem	Clean Water Act (CWA) Section 404 and regulations	33 USC § 1344; 40 CFR Parts 230 & 231; and 33 CFR Parts 320-323	Applicable	For discharge of dredged or fill material into water bodies or wetlands, there must be no practicable alternative with less adverse impact on aquatic ecosystem; discharge cannot cause or contribute to violation of state water quality standards or toxic effluent standards or jeopardize threatened or endangered species; discharge cannot significantly degrade waters of U.S.; practicable steps must be taken to minimize and mitigate adverse impacts; and impacts on flood level, flood velocity, and flood storage capacity must be evaluated. Sets standards for restoration and mitigation required as a result of unavoidable impacts to aquatic resources. USEPA must determine which alternative is the "Least Environmentally Damaging Practicable Alternative" (LEDPA) to protect wetland and aquatic resources.	Remedial alternatives will be developed and designed to comply with these regulations. Compensatory wetlands mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives.
Wetlands	U.S. Army Corps of Engineers, New England District Compensatory Mitigation Guidance (09-07-2016)	New England District Compensatory Mitigation Guidance (09-07-2016)	To Be Considered	This Guidance is to be considered when compensatory mitigation to address impacts to federal jurisdiction wetlands is appropriate for a particular remedial activity.	Activities affecting federal jurisdictional wetlands will be conducted in accordance with these guidance standards for mitigation and restoration.
Surface Waters, Wetland/Waterway Habitat for Endangered Species, Migratory Species	Fish and Wildlife Coordination Act	16 USC §§ 662-663; 40 CFR Part 6	Applicable	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss to the maximum extent practicable.	To the extent necessary, actions will be taken to develop measures to prevent, mitigate, or compensate for project-related impacts to habitat and wildlife. The USFWS, acting as a review agency for the USEPA, will be kept informed of proposed remedial activities.
Endangered Species	Endangered Species Act	50 CFR §§ 17.11-17.12; 50 CFR Part 402	Applicable, if endangered species are encountered	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	Protection of endangered species and their habitat will be considered during development and design of remedial alternatives.

Table 5.5-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Historical/ Archeological Resources	National Historic Preservation Act	16 USC § 469 et seq.; 36 CFR Part 65	Applicable, if subject historical resources are present	When a federal agency finds, or is notified, that its activities in connection with a federal construction project may cause irreparable loss or destruction of significant scientific, pre-historical, historical, or archeological data, the substantive standards under the Act will be met.	Any undisturbed areas altered by the remedial activities will be assessed to ensure no protected resource areas are present. If present, federal and state preservation officials will be consulted to address measures to avoid, minimize, and/or mitigate any impacts to protected resource areas.
Atlantic Flyway	Migratory Bird Treaty Act	16 USC § 703 et seq.	Applicable, if subject protected species are present	Protects migratory birds, their nests and eggs. A depredation permit issued by the U.S. Fish and Wildlife Service is required to take, possess, or transport migratory birds or disturb their nests, eggs, or young.	Remedial activities will be evaluated to protect migratory birds, their nests and eggs. If migratory bird protected areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.
State Standards					
Floodplains, Wetlands, Surface Waters	Massachusetts Wetland Protection Act and Regulations	MGL c. 131, § 40; 310 CMR 10.00	Applicable	These regulations restrict dredging, filling, altering, or polluting inland wetland resource areas (defined as areas within the 100-year floodplain) and impose performance standards for work in such areas. Protected resource areas include: 10.54 (Bank); 10.55 (Bordering Vegetated Wetlands); 10.56 (Land under Water Bodies and Waterways); 10.57 (Land Subject to Flooding); and 10.58 (Riverfront Area).	Any remedial activity conducted within a state regulated wetland resource area will comply with the substantive requirements of these regulations. Mitigation of impacts on state wetland resource areas will be addressed.
Floodplains	Massachusetts Hazardous Waste regulations, Location Standards for Land Subject to Flooding	310 CMR 30.701	Applicable	Any new or expanded hazardous waste storage or treatment facility (which only receives hazardous waste from on-site sources), the active portion of which is located within the boundary of land subject to flooding from the statistical 100-year frequency storm, shall be flood-proofed. Flood-proofing shall be designed, constructed, operated and maintained to prevent floodwaters from coming into contact with hazardous waste.	To the extent any hazardous waste is generated during the remedial activities, the wastes will be managed so that it will not impact floodplain resources.

Table 5.5-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Wetlands, Aquatic Ecosystem	Massachusetts Water Quality Certification for Discharge of Dredged or Fill Material	MGL c. 21, §§ 26-53; 314 CMR 9.00	Applicable	For discharges of dredged or fill material, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; appropriate and practicable steps must be taken to avoid and minimize potential adverse impacts to wetlands and land under water; stormwater discharges must be controlled with BMPs; and there must not be substantial adverse impacts to the physical, chemical, or biological integrity of surface waters. For dredging and dredged material management, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; and if avoidance is not possible, then minimize, or if neither avoidance or minimization are possible, then mitigate potential adverse impacts.	The remedial alternatives' effects on the aquatic ecosystem will be evaluated and avoided, and/or minimized. Compensatory mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives. Any required removal of soil/sediment from wetland or surface water areas will be designated for eventual restoration. Excavation and filling activities to be performed impacting the aquatic ecosystem will be in accordance with the substantive requirements of these regulations.
Endangered Species	Massachusetts Endangered Species Regulations	321 CMR 10.00	Applicable, if endangered species are encountered	Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural Heritage Program.	The protection of state listed endangered species will be considered during the development and design of remedial alternatives.
Historical/ Archeological Resources	Protection of Properties Included in the State Register of Historic Places	MGL c. 9, §§ 26-27C; 950 CMR 71.00	Applicable, if subject historical resources are present	Projects must eliminate, limit, or mitigate adverse effects to properties listed in the State Register of Historic Places (historic and archaeological properties). Establishes coordination with the National Historic Preservation Act.	If protected resource areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials.

Table 5.5-1
Location-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Area of Critical Environmental Concern	Massachusetts Areas of Critical Environmental Concern (ACECs) Regulations	310 CMR 12.00	Applicable, if ACEC is identified	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical interrelationships among a number of components. An eligible area must contain features from four or more of the following groups: (1) fisheries, (2) coastal features, (3) estuarine wetlands, (4) inland wetlands, (5) inland surface waters, (6) water supply areas (e.g., aquifer recharge area); (7) natural hazard areas (e.g., floodplain); (8) agricultural areas; (9) historical/archeological resources; (10) habitat resources (e.g., for endangered wildlife); or (11) special use areas. After an area is designated as an ACEC, the aim is to preserve and restore these areas.	If ACEC is identified in the site area, activities will be controlled to minimize impacts to affected species.

Prepared By / Date: APP 04/29/2019
Checked By / Date: MJM 05/08/2019

Notes:
ACEC = Areas of Critical Environmental Concern
ARAR = Applicable or Relevant and Appropriate Requirement
BMP = Best Management Practice
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
CWA = Clean Water Act
DAPL = Dense Aqueous Phase Liquid
FEMA = Federal Emergency Management Agency
LEDPA = Least Environmentally Damaging Practicable Alternative
MGL = Massachusetts General Law
RCRA = Resource Conservation and Recovery Act
USEPA = United States Environmental Protection Agency
USFWS = United States Fish and Wildlife Service
USC = United States Code

Table 5.5-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards				
USEPA Risk Reference Doses (RfDs)	USEPA RfDs	To Be Considered	RfDs are estimates of daily exposure levels that are likely to cause significant adverse non-carcinogenic health effects over a lifetime.	RfDs will be considered during development of PRGs.
USEPA Carcinogenic Assessment Group, Cancer Slope Factors (CSFs)	USEPA CSFs	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to site contaminants and represent the most up-to-date information on cancer risk from USEPA's Carcinogenic Assessment Group.	CSFs will be considered during development of PRGs.
Guidelines for Carcinogenic Risk Assessment	EPA/630/P-03/001F, March 2005	To Be Considered	These guidance values are to be used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	These guidelines will be considered during development of PRGs.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F, March 2005	To Be Considered	These Guidance values are to be used to evaluate the potential carcinogenic hazard to children caused by exposure to contaminants.	These guidelines will be considered during development of PRGs.
Clean Water Act (CWA) National Recommended Water Quality Criteria (NRWQC)	33 USC §1314(a); 40 CFR Part 131	Relevant and Appropriate	NRWQC are established for the protection of aquatic life and human health in surface water for approximately 150 pollutants.	NRWQCs will be considered during development of remedial alternatives that include discharge of treated groundwater to a surface water body.
Regional Screening Levels for Chemical Contaminants at Superfund Sites		To Be Considered	Regional Screening Levels (RSLs) are risk-based tools for screening contaminants at Superfund sites. RSLs are not intended to be cleanup standards.	RSLs will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.

Table 5.5-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites	OSWER 9355.4-24 (2002)	To Be Considered	EPA guidance for evaluating soil contamination. Used to develop risk-based cleanup standards, including based on the leaching of soil contaminants to groundwater.	This guidance will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.
Soil Screening Guidance: Technical Background Document	EPA/540/R95/ 128 (1996)	To Be Considered	EPA guidance for evaluating soil contamination. Used to develop risk-based cleanup standards.	This guidance will be used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. RSLs will also be used to derive PRGs for leaching of contaminants from soil as a transport mechanism in groundwater.
Ontario Ministry of Environment and Energy (OMEE) Severe Effect Levels (SELs) for Freshwater Sediments	(Persaud et al., 1993)	To Be Considered	The SEL value is the concentration at which the majority of the sediment-dwelling organisms are affected. Used to develop risk-based cleanup standards.	SELs will be used to assess ecological risks due to exposure to chemicals in sediment and to develop sediment PRGs.
Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Probable Effects Concentrations (PECs)	(MacDonald et al., 2000)	To Be Considered	The SEL value is the concentration at which the majority of the sediment-dwelling organisms are affected. Used to develop risk-based cleanup standards.	PECs will be used to assess ecological risks due to exposure to chemicals in sediment and to develop sediment PRGs.

Prepared By / Date: APP 04/29/2019
Checked By / Date: MJM 05/08/2019

Table 5.5-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
CSF = cancer slope factor
MCLs = Maximum Contaminant Levels
MCLGs = Maximum Contaminant Level Goals
NRWQC = National Recommended Water Quality Criteria
OMEG = Ontario Ministry of Environment and Energy
OSWER = Office of Solid Waste and Emergency Response
PEC = Probable Effects Concentration
PRGs = Preliminary Remediation Goals
RfD = reference dose
RSL = Regional Screening Level
SDWA = Safe Drinking Water Act
SEL - Severe Effect Level
USC = United States Code
USEPA = United States Environmental Protection Agency

Table 5.5-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Federal Standards					
Hazardous Waste Treatment, Storage, Disposal	Resource Conservation and Recovery Act (RCRA) Subtitle C; Hazardous Waste Identification; Generator and Handler Requirements; Tracking Requirements; Storage, Treatment and Disposal Requirements; Groundwater Monitoring Requirements; Closure and Post Closure Requirements; Land Disposal Restriction Requirements	42 USC § 6901 et seq.; 40 CFR Parts 260-262, Part 264/(including Subparts B, C, D, E, F, G, I, J, K, L, M, N, W, X) and Part 268	Potentially Applicable or Relevant and Appropriate	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. These provisions have been adopted by the Commonwealth.	Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous waste. Non-hazardous wastes will be disposed of appropriately. Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.

Table 5.5-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Air Emissions	RCRA, Air Emission Standards for Process Vents, Equipment Leaks, Tanks, Surface Impoundments, and Containers	40 CFR Part 264, Subparts AA, BB, and CC	Applicable, if hazardous waste with volatile organic concentrations of at least 10 parts per million by weight (ppmw) (Subpart AA), with organic concentrations of at least 10 % by weight (Subpart BB), will be treated, stored, or disposed of in tanks, surface impoundments, or containers, and thresholds are met (Subpart CC). Relevant and Appropriate, if less than thresholds.	RCRA emissions standards not delegated to the State. Standards for process vents for systems that manage hazardous wastes that have organic concentrations of at least 10 ppmw. Standards for air equipment leaks for systems that manage hazardous wastes with organic concentrations of at least 10% by weight. Standards for certain tanks, surface impoundments, containers that treat, store, or dispose of hazardous wastes.	Any hazardous wastes generated during remedial activities that meet these rules' threshold requirements will be managed in accordance with these regulations.
Discharges to Surface Water; Storm Water Controls	Clean Water Act National Pollutant Discharge Elimination System (NPDES)	40 CFR Parts 122 and 125	Applicable	The NPDES permit program specifies the permissible concentration or level of contaminants in the discharge from any point source to waters of the United States. Also, includes storm water standards for activities disturbing more than one acre.	Any discharges to surface waters related to excavation and dewatering activities will need to have the discharges meet the substantive discharge standards (the Massachusetts Surface Water Discharge Permit Program [314 CMR 3.00] has similar requirements).
Discharges to Surface Water	Clean Water Act; Toxic Pollutant Effluent Standards	40 CFR Part 129	Applicable	Regulates surface water discharges of specific toxic pollutants, specifically certain pesticides and PCBs.	Any discharge of water contaminated with the specific toxic pollutants generated during remedial activities will be treated to meet applicable toxic pollutant discharge standards if the water is to be discharged to surface waters.

Table 5.5-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Discharge to a Publicly Owned Treatment Works (POTW)	General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR Part 403	Applicable	Establishes responsibilities of federal, state, and local government, industry and the public to implement National Pretreatment Standards to control pollutants which pass through or interfere with treatment processes in POTWs or which may contaminate sewage sludge.	If remedial actions, such as excavation and dewatering activities, result in liquid waste streams that are discharged to a POTW, pretreatment of such waste streams will be evaluated for compliance with applicable requirements of the regulation.
Air Emissions	Clean Air Act (CAA), Hazardous Air Pollutants; National Emission Standards for Hazardous Air Pollutants (NESHAPs)	42 USC § 112(b)(1); 40 CFR Part 61	Potentially Applicable	These regulations establish emissions standards for 189 hazardous air pollutants.	No air emissions from remedial activities, such as soil excavation, will cause air quality standards to be exceeded. Dust standards will be complied with during remedial activities.
Sediment Remediation	Contaminated Sediment Remediation Guidance for Hazardous Waste Sites	EPA-540-R-05-012; OSWER 9355.0-85 (December 2005)	To Be Considered	Guidance for making remedy decisions for contaminated sediment sites. Some of the relevant sections of the guidance address Remedial Investigations (Ch. 2), FS Considerations (Ch. 3), Monitored Natural Recovery (Ch. 4), In-Situ Capping (Ch. 5), and Dredging and Excavation (Ch. 6).	Remedial alternatives will be developed and implemented with consideration of this guidance.
Investigation-Derived waste (IDW)	Guide to Management of Investigation-Derived Wastes	USEPA OSWER Publication 9345.3-03FS, January 1992	To Be Considered	Guidance on management of IDW in a manner that ensures protection of human health and the environment.	IDW generated during remedial activities and monitoring comply with this guidance
Vapor Intrusion	OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air.	OSWER 9200.2-154 (June 2015)	To Be Considered	EPA guidance for addressing vapor intrusion issues at CERCLA sites.	This guidance will be considered during development and implementation of remedial alternatives related to vapor intrusion.

Table 5.5-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
State Standards					
Hazardous Waste Identification	Massachusetts Hazardous Waste Management Rules for Identification and Listing of Hazardous Wastes	310 CMR 30.100	Applicable	Massachusetts is delegated to administer RCRA through its state regulations. These regulations establish requirements for determining whether wastes are either listed or characteristic hazardous waste.	These Massachusetts regulations supplement federal RCRA requirements. Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous wastes. Non-hazardous wastes will be disposed of appropriately.
Hazardous Waste - Generator Standards	Massachusetts Hazardous Waste Rules – Requirements for Generators	310 CMR 30.300	Applicable for listed wastes that still display characteristics, or for hazardous wastes generated as part of a cleanup; Relevant and Appropriate for non-listed hazardous waste left in-place	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.

Table 5.5-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Hazardous Waste - Management Facility Standards	Massachusetts Hazardous Waste Rules – Management Standards for All Hazardous Waste Facilities	310 CMR 30.500	Applicable for listed wastes that still display characteristics, or for hazardous wastes generated as part of a cleanup; Relevant and Appropriate for non-listed hazardous waste left in-place	General facility requirements for waste analysis, security measures, inspections, and training requirements. Section 30.580 addresses closure and, Section 30.590 addresses post-closure of hazardous waste facilities.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.
Hazardous Waste - Groundwater	Massachusetts Hazardous Waste Rules – Groundwater Protection	310 CMR 30.660	Applicable	310 CMR 30.661 through 30.673 prescribe requirements for regulated units that receive hazardous waste, except for certain waste piles, to protect groundwater.	Any hazardous waste generated by remedial alternatives that involve excavation of soil/sediment will be managed to prevent contaminant migration to groundwater.
Hazardous Waste - Containers	Massachusetts Hazardous Waste Rules – Use and Management of Containers	310 CMR 30.680	Potentially Applicable	310 CMR 30.681 through 30.689 prescribe requirements for the use of containers, such as drums, to store hazardous waste. Provides specifications for *inter alia* labelling and marking, management of containers, inspections, and closure.	Establishes requirements for the management of containers, such as drums, that are used to store hazardous wastes. Alternatives handling containers of hazardous waste will comply with this ARAR.
Hazardous Waste - Tanks	Massachusetts Hazardous Waste Rules – Storage and Treatment in Tanks	310 CMR 30.690	Potentially Applicable	310 CMR 30.691 through 30.699 prescribe requirements for the use of tanks to store and treat hazardous waste. Provides specifications for *inter alia* design and installation, containment and detection of leaks, general operating requirements, inspections, and closure and post-closure care.	Alternatives utilizing tanks for storage or treatment of hazardous waste will comply with this ARAR.

Table 5.5-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Discharges to Surface Waters	Massachusetts Clean Water Act; Surface Water Discharge Permit Regulations	MGL c. 21, §§ 26-53; 314 CMR 3.00	Applicable, if surface water discharge occurs	These regulations provide that discharges to waters of the Commonwealth shall not result in exceedances of Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00).	Any discharges to surface waters related to excavation and dewatering activities will need to have the discharges meet the substantive discharge standards of the Massachusetts Surface Water Discharge Permit (314 CMR 4.00).
Surface Water Quality Monitoring	Massachusetts Clean Water Act; MA Surface Water Quality Standards (MSWQS)	M.G.L. c. 21, §§ 26-53; 314 CMR 4.00	Applicable	These standards designate the most sensitive uses for which the various waters of the Commonwealth shall be enhanced, maintained, or protected. Minimum water quality criteria required to sustain the designated uses are established.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet the MSWQS.
Hazardous Waste - Facility Discharge Standards	Massachusetts Supplemental Requirements for Hazardous Waste Management Facilities	MGL c. 21, §§ 26-53; 314 CMR 8.00	Relevant and Appropriate	This regulation establishes additional requirements that must be satisfied for a RCRA facility (a wastewater treatment works which manages hazardous waste) that has a wastewater discharge permit.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet these standards.
Air Emissions	Massachusetts Ambient Air Quality Standards	310 CMR 6.00	Applicable	These regulations establish primary and secondary standards for emissions of sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead.	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.
Air Emissions	Massachusetts Air Pollution Control Regulations	310 CMR 7.00	Applicable	These regulations set emission limits necessary to attain ambient air quality standards, including standards for visible emissions (7.06); dust, odor, construction and demolition (7.09); noise (7.10); and volatile organic compounds (7.18).	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.
Institutional Controls	Massachusetts Contingency Plan, Implementation of Activity and Use Limitations	310 CMR 40.1070(4)	Relevant and Appropriate	Establish standards for the use of Notice of Activity and Use Limitations, a form of institutional controls, at CERCLA sites in Massachusetts.	Institutional controls will be established consistent with state standards for enforceable restrictions on contaminated property to prevent human contact with contamination and to protect remedial infrastructure.

Table 5.5-3
Action-Specific ARARs, Criteria, Advisories, and Guidance
Alternative 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Monitoring Wells	Massachusetts Standard References for Monitoring Wells	WSC-310-91	To Be Considered	Guidance on locating, drilling, installing, sampling and decommissioning monitoring wells.	Monitoring wells that may be required as part of a post-remediation monitoring program will be installed, maintained and decommissioned based on these guidance standards.
Sediment/Erosion Control; Stormwater Management	Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas	Prepared for Massachusetts Executive Office of Environmental Affairs (original print March 1997; reprint May 2003)	To Be Considered	Guidance on preventing erosion and sedimentation.	Remedial activities will be managed to control erosion and sedimentation.

Prepared By / Date: APP 04/11/2019
Checked By / Date: MJM 05/08/2019

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
DAPL = Dense Aqueous Phase Liquid
DEP = Department of Environmental Protection
IDW = Investigation Derived Waste
MGL = Massachusetts General Law
MNA = Monitored Natural Attenuation
MSWQC = Massachusetts Surface Water Quality Criteria
NAPL = Non-Aqueous Phase Liquid
NESHAP = National Emission Standards for Hazardous Air Pollutant
NPDES = National Pollution Discharge Elimination System
OSWER = Office of Solid Waste and Emergency Response
PCB = Polychlorinated Biphenyl
POTW = Publicly Owned Treatment Works
ppmw = parts per million by weight
RCRA = Resource Conservation and Recovery Act
UIC = Underground Injection Control
USC = United States Code
USEPA = United States Environmental Protection Agency

Table 5.5-4
Cost Estimate for Alternative 5
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

Cost estimate for Alternative 5: AS/SVE for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and In-situ Chemical Adsorption for South Ditch Surface Water

Year 0 = 2019

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
AS/SVE System					
Impermeable Surface Cover	7800	SF	$1	$7,878	Applied to unpaved surfaces
SVE Extraction Wells	44	EA	$5,000	$220,000	Based on similar projects
SVE Piping	1550	LF	$10	$16,105	Based on similar projects
AS Injection Wells	22	EA	$5,600	$123,200	Based on similar projects
AS Piping	1550	LF	$6	$9,300	Based on similar projects
Valves/Instrumentation	1	LS	$11,000	$11,000	Based on similar projects
System Upgrades	1	LS	$22,000	$22,000	Based on similar projects
Electrical Hookup	1	LS	$13,200	$13,200	Based on similar projects
System Startup and Testing	1	LS	$15,400	$15,400	Based on similar projects
Transportation and Disposal for IDW	22	Drum	$200	$4,400	Based on similar projects
Installation Oversight	44	Days	$1,000	$44,000	Based on similar projects
Excavation and Off-Site Disposal					
Pre-Design Investigation	1	LS	$17,900	$17,900	25 soil/sediment locations; pre-excavation characterization
Pre-Excavation Wetland Survey	1	LS	$1,000	$1,000	Wetland Scientist; 1 day field effort
Wetland Restoration Plan	1	LS	$5,000	$5,000	Based on cost for similar effort
Mobilization	1	LS	$13,200	$13,200	Estimate from Environmental Remediation Contractor
Site Staging and Prep	1	LS	$95,300	$95,300	Estimate from Environmental Remediation Contractor
Includes temporary staging area for dewatering, silt fencing, tree removal, and matting for access					
Surface Water/Stormwater Diversion	400	LF	$100	$40,000	Estimate from Environmental Remediation Contractor
Excavation	1	LS	$97,700	$97,700	Estimate from Environmental Remediation Contractor
Material Handling & Loading	1	LS	$23,600	$23,600	Estimate from Environmental Remediation Contractor
Off-Site Disposal as Non-Hazardous	475	ton	$225	$106,875	Estimate from Hazardous Waste Disposal Contractor
Off-Site Disposal w/ Off-Site Stabilization	475	ton	$350	$166,250	Estimate from Hazardous Waste Disposal Contractor
Backfill, Re-grading, & Seeding	1	LS	$97,500	$97,500	Estimate from Environmental Remediation Contractor
Restoration Plantings	1	LS	$2,500	$2,500	
Demobilization	1	LS	$38,100	$38,100	Estimate from Environmental Remediation Contractor
Excavation Area Monthly Inspections	6	LS	$800	$4,800	Monthly for 6 months
Limited Action					
Deed Restriction Modification	0	LS	$12,400	$0	Performed internally by Olin
Monitoring of South Ditch Surface Water	0	LS	$7,644	$0	SW monitoring will continue as currently performed; costs
Evaluation of South Ditch Surface Water Data	0	LS	$1,000	$0	begin in Year 1 and reflected under Annual Costs
Toxicity Testing of South Ditch Surface Water	1	LS	$6,500	$6,500	Toxicity testing to verify RAO compliance; one *Daphnia magna* test
Toxicity Testing of South Ditch Sediment	1	LS	$13,000	$13,000	Toxicity testing to verify RAO compliance; one *Hyalella azteca* test + one control test
In-Situ Chemical Adsorption for Surface Water					
General Requirements	1	LS	$100	$100	Assume 2% of construction cost (rounded)
Erosion and Sediment Control Measures	0	LS	$100	$0	Assume stream is dry and no dewatering needed. Otherwise, assume 1% of construction cost (rounded)
Installation Labor	1	LS	$1,680	$1,680	Assuming 1 days
Installation Oversight	1	LS	$900	$900	Assume staff onsite for construction oversight
Equipment	1	LS	$2,400	$2,400	Excavator, dump truck, misc. equipment
Construction Materials	1	LS	$700	$700	Concrete, forms, 2 gabion baskets, zeolite and activated carbon media
Contingency	0	%	20%	$244,300	
		TOTAL CAPITAL COSTS		$1,465,788	

Table 5.5-4
Cost Estimate for Alternative 5
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

ANNUAL COSTS YEARS 1 - 2					
Description	**Quantity**	**Units**	**Unit Cost**	**Extended Cost**	**Note**
AS/SVE System					
Operator	416	Hours	$60	$24,960	Assume 1 operator at 8 hours per week
Annual Groundwater Sampling Event	1	LS	$10,000	$10,000	Based on similar projects
Excavation and Off-Site Disposal	0	Months	$0	$0	Completed in Year 0; No O&M
Limited Action and Monitoring					
Surface Water Monitoring (Semi-Annual)	2	LS	$700	$1,400	Assumed 3 surface water samples analyzed for dissolved chromium & ammonia @ $100 per sample; 1 person @ 1/2 day for sample collection and field measurements.
Ecological Recovery Inspection (Semi-Annual)	2	LS	$800	$1,600	Performed in Years 1 & 2; then at 5-year intervals
In-situ Chemical Adsorption					
5-Year adsorption media replacement event	0	LS	$2,700	$0	Performed every 5 years; not an annual cost
Annual Monitoring and Performance Report	1	LS	$10,000	$10,000	Includes AS/SVE Performance and SW Monitoring data; Based on costs for similar sites and reporting
		TOTAL ANNUAL COSTS		$47,960	Years 1 - 2

ANNUAL COSTS YEARS 3 - 5					
Description	**Quantity**	**Units**	**Unit Cost**	**Extended Cost**	**Note**
AS/SVE System					
Operator	416	Hours	$60	$24,960	Assume 1 operator at 8 hours per week
Annual Groundwater Sampling Event	1	LS	$10,000	$10,000	Based on similar projects
Excavation and Off-Site Disposal	0	Months	$0	$0	Completed in Year 0; No O&M
Limited Action and Monitoring					
Surface Water Monitoring (Semi-Annual)	2	LS	$700	$1,400	Assumed 3 surface water samples analyzed for dissolved chromium & ammonia @ $100 per sample; 1 person @ 1/2 day for sample collection and field measurements.
In-situ Chemical Adsorption					
5-Year adsorption media replacement event	0	LS	$2,700	$0	Performed every 5 years; not an annual cost
Annual Monitoring and Performance Report	1	LS	$10,000	$10,000	Includes AS/SVE Performance and SW Monitoring data; Based on costs for similar sites and reporting
		TOTAL ANNUAL COSTS		$46,360	Years 3 - 5

ANNUAL COSTS YEARS 6 - 30					
Description	**Quantity**	**Units**	**Unit Cost**	**Extended Cost**	**Note**
AS/SVE System					
Operator	0	Hours	$60	$0	AS/SVE System finished in Year 5
Annual Groundwater Sampling Event	0	LS	$10,000	$0	AS/SVE System finished in Year 5
Excavation and Off-Site Disposal	0	Months	$0	$0	Completed in Year 0; No O&M
Limited Action and Monitoring					
Surface Water Monitoring (Semi-Annual)	2	LS	$700	$1,400	Assumed 3 surface water samples analyzed for dissolved chromium & ammonia @ $100 per sample; 1 person @ 1/2 day for sample collection and field measurements.
In-situ Chemical Adsorption					
5-Year adsorption media replacement event	0	LS	$2,700	$0	Performed every 5 years; not an annual cost
Annual Monitoring and Performance Report	1	LS	$10,000	$10,000	Includes AS/SVE Performance and SW Monitoring data; Based on costs for similar sites and reporting
		TOTAL ANNUAL COSTS		$11,400	Years 6 - 30

Table 5.5-4
Cost Estimate for Alternative 5
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
AS/SVE System					
Operator	0	Hours	$60	$0	Annual costs only; No 5-year costs
Annual Groundwater Sampling Event	0	LS	$10,000	$0	Annual costs only; No 5-year costs
Excavation and Off-Site Disposal					
Ecological Recovery Inspection	1	LS	$800	$800	(in advance of 5-Year Review Report)
Limited Action and Monitoring	0	LS	$0	$0	Annual costs only; No 5-year costs
In-situ Chemical Adsorption					
5-Year adsorption media replacement event	1	LS	$2,700	$2,700	Based on material costs plus 1/2 day personnel
Reporting					
5-Year Review Report	1	LS	$10,000	$10,000	Incremental cost only; will be performed site-wide
Deed Restrictions Verification and Maintenance	0	LS	$5,000	$0	Performed internally by Olin
			TOTAL 5-YEAR COSTS	$13,500	

PRESENT VALUE ANALYSIS

Cost Type	Year	Total Cost	Discount Factor	Present Value	Note
Capital Costs	0	$1,465,788	1.0000	$1,465,788	
Annual Costs	1	$47,960	0.9728	$46,654	
Annual Costs	2	$47,960	0.9463	$45,383	
Annual Costs	3	$46,360	0.9205	$42,674	
Annual Costs	4	$46,360	0.8954	$41,512	
Annual Costs	5	$46,360	0.8710	$40,381	
5-Year Periodic Costs	5	$13,500	0.8710	$11,759	
Annual Costs	6	$11,400	0.8473	$9,659	
Annual Costs	7	$11,400	0.8242	$9,396	
Annual Costs	8	$11,400	0.8018	$9,140	
Annual Costs	9	$11,400	0.7799	$8,891	
Annual Costs	10	$11,400	0.7587	$8,649	
5-Year Periodic Costs	10	$13,500	0.7587	$10,242	
Annual Costs	11	$11,400	0.7380	$8,414	
Annual Costs	12	$11,400	0.7179	$8,184	
Annual Costs	13	$11,400	0.6984	$7,961	
Annual Costs	14	$11,400	0.6794	$7,745	
Annual Costs	15	$11,400	0.6609	$7,534	
5-Year Periodic Costs	15	$13,500	0.6609	$8,921	
Annual Costs	16	$11,400	0.6429	$7,328	
Annual Costs	17	$11,400	0.6253	$7,129	
Annual Costs	18	$11,400	0.6083	$6,935	
Annual Costs	19	$11,400	0.5917	$6,746	
Annual Costs	20	$11,400	0.5756	$6,562	
5-Year Periodic Costs	20	$13,500	0.5756	$7,771	
Annual Costs	21	$11,400	0.5599	$6,383	
Annual Costs	22	$11,400	0.5447	$6,209	
Annual Costs	23	$11,400	0.5299	$6,040	
Annual Costs	24	$11,400	0.5154	$5,876	
Annual Costs	25	$11,400	0.5014	$5,716	
5-Year Periodic Costs	25	$13,500	0.5014	$6,769	
Annual Costs	26	$11,400	0.4877	$5,560	
Annual Costs	27	$11,400	0.4744	$5,409	
Annual Costs	28	$11,400	0.4615	$5,261	
Annual Costs	29	$11,400	0.4490	$5,118	
Annual Costs	30	$11,400	0.4367	$4,979	
5-Year Periodic Costs	30	$13,500	0.4367	$5,896	
		$2,066,788		$1,910,575	
TOTAL COST OF ALTERNATIVE			**$2,067,000**		
TOTAL PRESENT WORTH OF ALTERNATIVE			**$1,911,000**		
PROJECT DURATION			**30 Years**		

Prepared/Date: KPW 05/03/2019
Revised/Date: APP 05/17/2019
Checked/Date: PHT 05/21/2019

Table 5.6-1
Comparative Analysis of Remedial Alternatives

Operable Unit 1 & Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Alternative	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Short-term Effectiveness	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Implementability	Total Present Worth
1	No Action	**Not protective.**	**Does not comply.**	**Not Effective.**	**Not Effective.**	**None.**	**No implementation required.**	**$ 0**
2	Limited Action and Vapor Barrier/Sub-Slab Depressurization System for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and Limited Action for South Ditch Surface Water	**Protective.** Potential exposure to TMPs in subsurface soil reduced by deed covenant modifications to include vapor barrier and/or SSDS for future buildings, as well as requirements for health & safety plans to mitigate potential inhalation exposures for construction workers during excavation activities. Removes soil and sediment with COC concentrations above site-specific PRGs. Surface water monitoring will continue to verify ecological PRGs continue to be achieved. Toxicity testing of sediment and surface water will be conducted to demonstrate achievement of RAOs.	**Complies.**	**Effective.** Protective of human health and the environment upon completion of the active, construction-related activities of this remedy.	**Effective.** Effective and permanent by modifying the deed covenants to include language to address potential VI concerns associated with future buildings that may be constructed on the Property and incorporating engineering controls, such as vapor barriers and/or SSDSs, into the design and construction of future building foundations. Requirements would be included for health & safety plans to mitigate potential inhalation exposures for construction workers during excavation activities. Permanently removes soil and sediment with COC concentrations above site-specific PRGs. Surface water monitoring will continue to evaluate and verify that surface water PRGs continue to be achieved. Toxicity testing of sediment and surface water will be conducted to demonstrate achievement of RAOs.	**Reduces volume and mobility** through removal of sediment and soil and disposal in accordance with applicable disposal regulations. Excavated material characterized as hazardous waste would be treated via stabilization prior to off-site disposal. Installation of vapor barriers and/or SSDSs for future buildings that may be constructed at the Site would reduce toxicity and mobility of TMPs in subsurface soil.	**Straightforward.** The technologies used for this alternative are available and sufficiently demonstrated for use at the site. The necessary equipment and materials are readily available. The overall estimated duration to complete the construction-related components of the alternative is approximately 3 months.	**$1,295,000**
3	Limited Action and Vapor Barrier/Sub-Slab Depressurization System for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and In-situ Chemical Adsorption for South Ditch	**Protective.** Potential exposure to TMPs in subsurface soil reduced by deed covenant modifications to include vapor barrier and/or SSDS for future buildings and requirements for health & safety plans to mitigate potential inhalation exposures for construction workers during excavation activities. Removes	**Complies.**	**Effective.** Protective of human health and the environment upon completion of the active, construction-related activities of this remedy.	**Effective.** Effective and permanent by modifying the deed covenants to include language to address potential VI concerns associated with future buildings that may be constructed on the Property and incorporating engineering controls, such as vapor barriers and/or SSDSs, into the design and construction of future building foundations. Requirements would be	**Reduces volume and mobility** through removal and off-site disposal of sediment and soil. Excavated material characterized as hazardous waste would be treated via stabilization prior to off-site disposal. Installation of vapor barriers and/or SSDSs for future buildings constructed at	**Straightforward.** The technologies used for this alternative are available and sufficiently demonstrated for use at the site. The necessary equipment and materials are readily available. The overall estimated duration to complete the construction-related components of the alternative is	**$1,312,000**

Table 5.6-1
Comparative Analysis of Remedial Alternatives

Operable Unit 1 & Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Alternative	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Short-term Effectiveness	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Implementability	Total Present Worth
	Surface Water	soil and sediment with COC concentrations above site-specific PRGs. Surface water treatment should have a positive effect on surface water quality and help support USEPA's objective at the Halls Brook Holding Area Pond for the Industri-Plex Superfund Site. Toxicity testing of sediment and surface water will be conducted to demonstrate achievement of RAOs.			included for health & safety plans to mitigate potential inhalation exposures for construction workers during excavation activities. Permanently removes soil and sediment with COC concentrations above PRGs. In-situ surface water treatment will treat Lower South Ditch surface water to continue to achieve PRGs in surface water prior to discharge to East Ditch. Toxicity testing of sediment and surface water will be conducted to demonstrate achievement of RAOs.	the Site would reduce toxicity and mobility of TMPs in soil. In-situ treatment reduces toxicity, mobility, or volume of COCs in South Ditch surface water.	approximately 3 months.	
4	AS/SVE for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and Limited Action for South Ditch Surface Water	**Protective.** Exposure to TMPs in soil reduced by installation and operation of AS/SVE. Removes soil and sediment with COC concentrations above site-specific PRGs. Surface water monitoring will continue to verify ecological PRGs continue to be achieved. Toxicity testing of sediment and surface water will be conducted to demonstrate achievement of RAOs.	**Complies.**	**Effective.** Protective of human health and the environment upon completion of the active, construction-related activities of this remedy.	**Effective.** AS/SVE system would be effective and permanent by reducing/mitigating potential VI concerns associated with future buildings that may be constructed on the Property. Requirements would be included for health & safety plans to mitigate potential inhalation exposures for construction workers during excavation activities. Permanently removes soil and sediment with COC concentrations above site-specific PRGs. Surface water monitoring will continue to evaluate and verify that surface water PRGs continue to be achieved. Toxicity testing of sediment and surface water will be conducted to demonstrate achievement of RAOs.	**Reduces toxicity, mobility, or volume** of TMPs in soil by installation and operation of AS/SVE system. through removal of sediment and soil and disposal in accordance with applicable waste disposal regulations. Reduces volume and mobility through removal of sediment and soil and disposal in accordance with applicable disposal regulations. Excavated material characterized as hazardous waste would be treated via stabilization prior to off-site disposal.	**Straightforward.** The technologies used for this alternative are available and sufficiently demonstrated for use at the site. The necessary equipment and materials are readily available. The overall estimated duration to complete the construction-related components of the alternative is approximately 6 months. The AS/SVE system is estimated to be in operation for approximately five years.	**$1,889,000**

Table 5.6-1
Comparative Analysis of Remedial Alternatives

Operable Unit 1 & Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Alternative	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Short-term Effectiveness	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Implementability	Total Present Worth
5	AS/SVE for TMPs in Soil; Excavation, Stabilization, and Off-Site Disposal of Lower South Ditch Sediment and EA5 Soil; and In-situ Chemical Adsorption for South Ditch Surface Water	**Protective.** Exposure to TMPs in soil reduced by installation and operation of AS/SVE. Removes soil and sediment with COC concentrations above site-specific PRGs. Surface water treatment should have a positive effect on surface water quality and help support USEPA's objective at the Halls Brook Holding Area Pond for the Industri-Plex Superfund Site. Toxicity testing of sediment and surface water will be conducted to demonstrate achievement of RAOs.	**Complies.**	**Effective.** Protective of human health and the environment upon completion of the active, construction-related activities of this remedy.	**Effective.** AS/SVE system would be effective and permanent by reducing/mitigating potential VI concerns associated with future buildings that may be constructed on the Property. Requirements would be included for health & safety plans to mitigate potential inhalation exposures for construction workers during excavation activities. Permanently removes soil and sediment with COC concentrations above site-specific PRGs. In-situ surface water treatment will treat Lower South Ditch surface water to continue to achieve PRGs in surface water prior to discharge to East Ditch. Toxicity testing of sediment and surface water will be conducted to demonstrate achievement of RAOs.	**Reduces toxicity, mobility, or volume** of TMPs in soil by installation and operation of AS/SVE system. through removal and off-site disposal of sediment and soil. Reduces volume and mobility through removal of sediment and soil and disposal in accordance with applicable disposal regulations. Excavated material characterized as hazardous waste would be treated via stabilization prior to off-site disposal. In-situ treatment of South Ditch surface water reduces toxicity, mobility, or volume of COCs in surface water.	**Straightforward.** The technologies used for this alternative are available and sufficiently demonstrated for use at the site. The necessary equipment and materials are readily available. The overall estimated duration to complete the construction-related components of the alternative is approximately 6 months. The AS/SVE system is estimated to be in operation for approximately five years.	**$1,911,000**

Prepared by: APP 05/20/2019
Checked by: PHT 05/21/2019

Notes:
ARARs = Applicable or Relevant and Appropriate Requirements
AS/SVE = Air Sparging/Soil Vapor Extraction
BHHRA = Baseline Human Health Risk Assessment
COC = Chemical of Concern
EA = Exposure Area
PRG = Preliminary Remediation Goal
RAO = Remedial Action Objective
RCRA = Resource Conservation and Recovery Act
SSDS = Sub-Slab Depressurization System
TMPs = Trimethylpentenes

APPENDIX A

EVALUATION OF GROUNDWATER INTERACTION WITH SOUTH DITCH SURFACE WATER AND SEDIMENT

Appendix A – Evaluation of Groundwater Interaction with South Ditch Surface Water and Sediment

Introduction

In their respective responses to Appendix 6 Specific Comment 8, USEPA and Olin agreed that a detailed discussion of the interaction of groundwater and surface water and sediment be prepared for the revised OU1/OU2 FS. This appendix provides that discussion. This section reviews some of the monitoring history and data for groundwater and surface water in vicinity of South Ditch and provides an explanation why some solute concentrations increased from 2001 through 2007/2008 in both groundwater and surface water and have declined since. Figures supporting this discussion are appended herein. This information has specific bearing on whether surface water quality in South Ditch is expected to continue improving as it has over the last five years and whether recontamination of the sediments with Cr is expected to occur with time. If current trends continue, there would be no need for actions for groundwater as a source to surface water for chromium and ammonia, which were COCs identified for surface water in South Ditch. Both are currently below site-specific PRGs for South Ditch surface water. [1]

Nature and Source of Impacts to South Ditch Surface Water and Sediment

The post closure monitoring program (PCMP) for the Containment Area and sediment remediation in Upper South Ditch was initiated in 2001 to monitor the effects of installation of the slurry wall and the weir structure on groundwater and surface water along South Ditch. These data document, as discussed below, groundwater as a source of chromium and ammonia to surface water. Annual sediment samples have been collected to assess if groundwater discharge and Al/Fe/Cr floc precipitation was re-contaminating the remediated portion of the ditch. Based on this data, re-contamination of this sediment is not occurring. Neither does the sediment, based on available data appear to act as a source to surface water. The high organic content of sediment from decaying leaf matter will maintain elevated sediment concentrations of ammonia (and nitrogen). The source of BEHP in BERA Exposure Area (EA) 5 soil and South Ditch sediment was

[1] While USEPA has articulated that the ammonia surface water PRG should be the same as that established for the Halls Brook Holding Pond at the downstream Industri-plex Superfund site, Olin does not agree since the South Ditch and intervening East Ditch cannot support cold water fish habitat for hydrology reasons. In order to meet USEPA's objective for ammonia at the Halls Brook holding area, the OU1/OU2 FS will recommend passive ammonia removal from surface water that is exiting South Ditch.

discharge from Lake Poly to the former on-Property ditch system rather than discharge of impacted groundwater.

By 2003 and 2004 it became clear that concentrations of DAPL-related constituents (primarily ammonia and sulfate) were increasing in deep overburden groundwater (monitored by well GW-202D) and shallow groundwater (monitored by well GW-202S) adjacent to and underlying Upper South Ditch and along the ditch toward Lower South Ditch (monitored by well GW-79S and piezometer PZ-17RR). Chromium concentrations increased in samples from wells GW-202D and GW-202S. These concentration increases occurred, with obvious seasonality, until 2008. Steady declines of these parameters have been observed since 2008. **Figures A-1** through **A-3** depict time-series plots across the area for ammonia, sulfate, and chromium, respectively. Aluminum shows similar declines based on data presented in the semi-annual status reports. Water levels for these wells are shown in **Figure A-4**.

During the same time period, immediately following installation of the slurry wall, shallow overburden groundwater wells upgradient of the on-Property DAPL pool (GW-24, GW-25) and upgradient of the off-Property West Ditch (off-PWD) DAPL pool (GW-43S) also saw declines in concentrations of ammonia and sulfate. It was unclear at the time why this was occurring upgradient of the Containment Area. Initial thoughts were that installation of the slurry wall had diverted more groundwater south, and the locus of groundwater flow to South Ditch and Ephemeral drainage had been altered.

Effects of Sanmina Wells

The Sanmina wells were located on the western side of Jewel Drive at the former Altron Facility and were used for industrial purposes. As the subsequent discussion will detail, this pumping pulled contaminated groundwater upgradient from the on-Property and off-PWD DAPL areas impacting intervening wells such as GW-43S. Following time periods when the Sanmina wells were temporarily off in 2001 and 2003, and shut down in 2004, concentrations of sulfate and ammonia increased in downgradient groundwater as groundwater reversed direction from the induced gradient and flowed away from Sanmina toward the South Ditch area.

Information concerning Sanmina production well construction details are presented in Appendix A of the Comprehensive Site Assessment, Phase II Field Investigation Report, Wilmington Facility, Wilmington, MA, Olin Corporation (CRA, 1993), and are included in **Appendix A**. Altron B1 was installed in 1992 and screened at approximately 30 feet below ground surface (bgs). Altron B3 was installed in 1992 and screened from 20 ft – 25 ft bgs. Altron B1 was developed and rated at 30 gallons per minute (gpm). Altron B3 was developed and rated at 75 gpm. Sanmina acquired Altron in September 1998. Sanmina ceased business operations in September 2004, including operation of the two referenced wells.

A time-series plot of the pumping history of the Sanmina wells (Altron B1 and B3) is provided as **Figure 2-8,** in **Appendix A,** and is reproduced from the Groundwater Model Update Report from Appendix A of the Draft Focused RI Report (MACTEC, 2008). **Plates 2-3 and 2-4**, also included in Appendix A, are from the Supplemental Smith Phase II Report (Smith, 1997) and depict shallow and deep groundwater contours in October 1995, in relationship to pumping at the Sanmina wells. These plates show how deep and shallow groundwater was pulled westward across Jewel Drive from above the off-PWD DAPL pool and the western side of the on-Property DAPL pool toward the Sanmina wells. Additional potentiometric interpretations from April 1998 showing similar depictions were also provided in **Figures 2-10a and 2-10b** from the Groundwater Model Update Report (MACTEC, 2008), also included in **Appendix A**.

The water elevation time-series plots in **Figure A-4** (**Appendix A**) shows the Sanmina well pumping stresses (which ceased in late 2004) extended out to wells GW-43S, GW-42S, GW-79S, GW-10S, and possibly even GW-CA-1. The average groundwater elevations in these wells increased slightly after the Sanmina wells ceased operations and have remained higher more than a decade later.

The concentration trends in GW-43S for ammonia (**Figure A-1**) and sulfate (**Figure A-2**) mimic the Sanmina pumping rates (higher concentrations and pumping rates in 1997 and 1999/2000). This is not so for chromium (**Figure A-3**), since chromium is subject to pronounced attenuation via precipitation (reactive transport) and as such does not have elevated concentrations in shallow groundwater.

Fluctuations in pumping rates at Sanmina (lows in 2001, 2003, and cessation in late 2004) coincide with brief and repeated increases in solute concentrations along Upper South Ditch in both shallow and deep groundwater between the slurry wall and the weir where groundwater is expected to discharge, as evidenced by data collected from wells GW-202S and GW-202D, respectively. Concentrations also increase shortly afterwards father downstream as monitored by well GW-79S where deeper upgradient groundwater is expected to eventually discharge. This would be expected since reduced pumping at Sanmina would reduce capture of impacted groundwater overlying the Off-PWD DAPL pool and that would instead migrate and discharge to South Ditch.

Effects of the Slurry Wall

Installation of the slurry wall reduced the flux of solutes that could be pulled upgradient by the Sanmina wells. After the slurry wall was installed in December 2000, the concentrations of sulfate and ammonia at GW-43S were further reduced by exclusion of flux from the On-Property DAPL area. These concentration reductions are also evident at GW-24 and GW-25, which are currently upgradient of the slurry wall and were also excluded from flux from the On-Property DAPL area once the slurry wall was in place.

The slurry wall also changed how groundwater moved from the Jewel Drive area to South Ditch once the Sanmina wells ceased operation in 2004. The slurry wall diverts groundwater flow paths to the south toward the weir. This aspect is evident in the sulfate and ammonia data plots for wells GW-25 and GW-24. In 2005 through 2007, a slug of elevated groundwater concentrations passed through GW-25, but not GW-24, which is closer to the slurry wall and no longer in line with, and therefore shielded from, that flow path. This slug likely represents the last remnant of the plume that was pulled upgradient by the Sanmina well operation, and had subsequently began moving back downgradient when the Sanmina wells shut down in late 2004. After that slug moved through, ammonia and sulfate concentrations in GW-24 and GW-25 have continued to decline. A similar pattern and timing is noted in GW-202S. The peak concentrations arrived and passed GW-202D approximately one year later indicating slightly different groundwater velocities in the deeper, more highly impacted overburden groundwater. Very similar peak concentrations occurred shortly thereafter downgradient at PZ-16RR directly under South Ditch indicating groundwater at GW-202D and PZ-16RR and GW-79S are related.

Following the peak concentrations in 2008/2009, wells along South Ditch (GW-202S, GW-202D, GW-78S, GW-79S) and piezometers (GW-18RR, GW-17RRR and GW16RR) show decreasing concentrations for ammonia, sulfate, and chromium. Similar concentration decreases are present at GW-24 and GW-25. Relevant data discussed here have been previously submitted to USEPA as part of the semi-annual status reports.

Effects of DAPL Extraction in the Off-PWD

Since 2012, the elevation of the off-PWD DAPL pool has declined approximately 5 to 6 feet in response to continued extraction. Lowering of the DAPL interface is expected to have contributed some reduction in the flux to groundwater and eventually surface water. The combined effects of the slurry wall, removal of DAPL and lowering the DAPL/Diffuse interface, and attenuation of upgradient impacts from post-Sanmina pumping are believed responsible for the continued decline in groundwater and surface water concentrations along South Ditch.

The current source of chromium and ammonia to groundwater and hence surface water is the diffuse groundwater overlying the off-PWD DAPL pool. The groundwater flow path is directly from the off-PWD DAPL area to the upper South Ditch and the concentrations from one location to the other are consistent with upwardly migrating deeper groundwater discharging to surface water via shallow groundwater. These relationships are depicted in **Sections A-A** for chromium and ammonia. Based on these data, the likely source of both chromium and ammonia is upgradient of the Containment Area, not from it.

Ammonia in Surface Soil along Lower South Ditch

Figure A-5 shows the distribution of ammonia in soil samples collected in proximity to Lower South Ditch. These soil samples represent highly organic wetland soil and have high ammonia concentrations consistent with soil background data and sediment reference locations presented in the Final OU1/OU2 RI Report. As such these soils represent background conditions for ammonia and are not expected to contribute soluble ammonia to surface water or groundwater at concentration that would pose a risk to ecological receptors. They are normal for a wetland environment.

Conclusions

Based on a temporal review of groundwater concentrations and locations, it is clear the operation of the Sanmina wells pulled contaminated groundwater upgradient from the on-Property DAPL pool and the off-PWD DAPL pool areas, and cessation of Sanmina well operation subsequently resulted in consistent decreases in local wells and the South Ditch surface water since 2008. Monitoring data from several wells located between the active Sanmina wells and the on-Property DAPL pool (GW-43S and GW-43SR, GW-25 and GW-24) indicates solute concentrations in these wells were reduced as a direct result of the installation of the slurry wall in December 2000. Intermittent and final cessation of operation of the Sanmina wells from 2001 to 2004 resulted in higher concentration slugs of impacted groundwater migrating toward upper South Ditch from the off-PWD DAPL pool area that was no longer being captured by Sanmina. Once Sanmina ceased operations entirely, the final slug of impacted groundwater moved downgradient to South Ditch resulting in a peak concentration in 2008/2009 that is now receding. Continued operation of the off-PWD DAPL extraction system has further reduced the flux of solutes to groundwater and surface water. Given all of this information, it is likely that impacts in South Ditch surface water are overwhelmingly a result of groundwater discharge, and concentrations of those impacts will continue to decrease as a result of past interim actions and those recommended by the April 2019 Interim Action Feasibility Study. Leaching of ammonia from soil located along South Ditch is not considered as source mechanism for ammonia to either surface water or sediment.

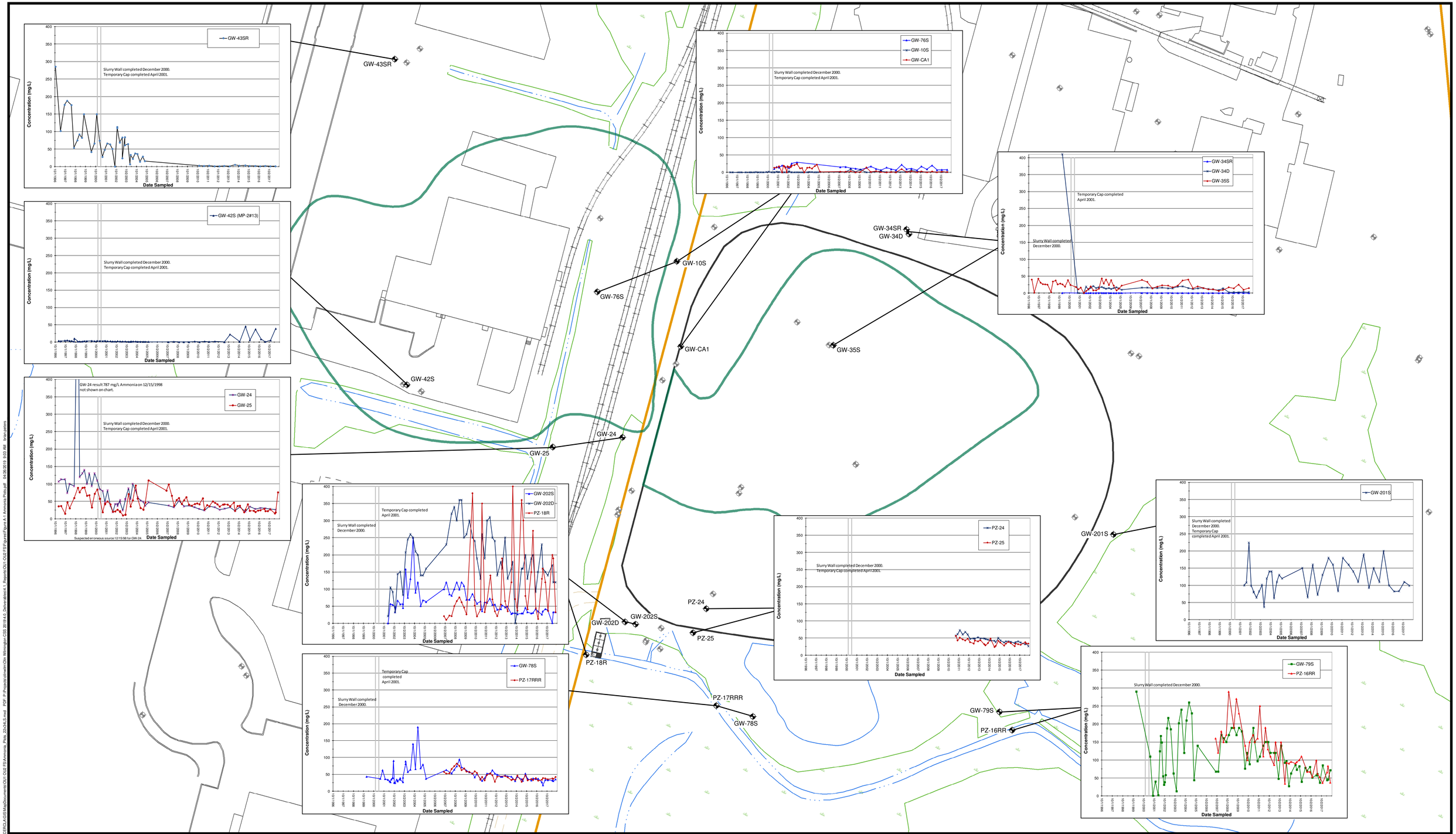
References

CRA, 1993. Conestoga-Rovers & Associates (CRA). Comprehensive Site Assessment, Phase II Field Investigation Report, Wilmington Facility, Wilmington, MA, Olin Corporation

MACTEC, 2007. Draft Focused Remedial Investigation Report, Olin Chemical Superfund Site, Wilmington, Massachusetts.

Smith 1997. Supplemental Phase II Report; Wilmington Massachusetts, Olin Corporation. MADEP RTN: 3-0471. Smith Technology Corporation, PTI Environmental Services; ABB Environmental Serviced, Inc. Geomega

FIGURES



Legend

- Well with Ammonia Plot
- Other Well
- Containment Area
- Approximate DAPL Pool Boundary
- 51 Eames St. Property Boundary
- Water
- Wetland Boundary
- Railroad
- Paved Road
- Unpaved Road

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

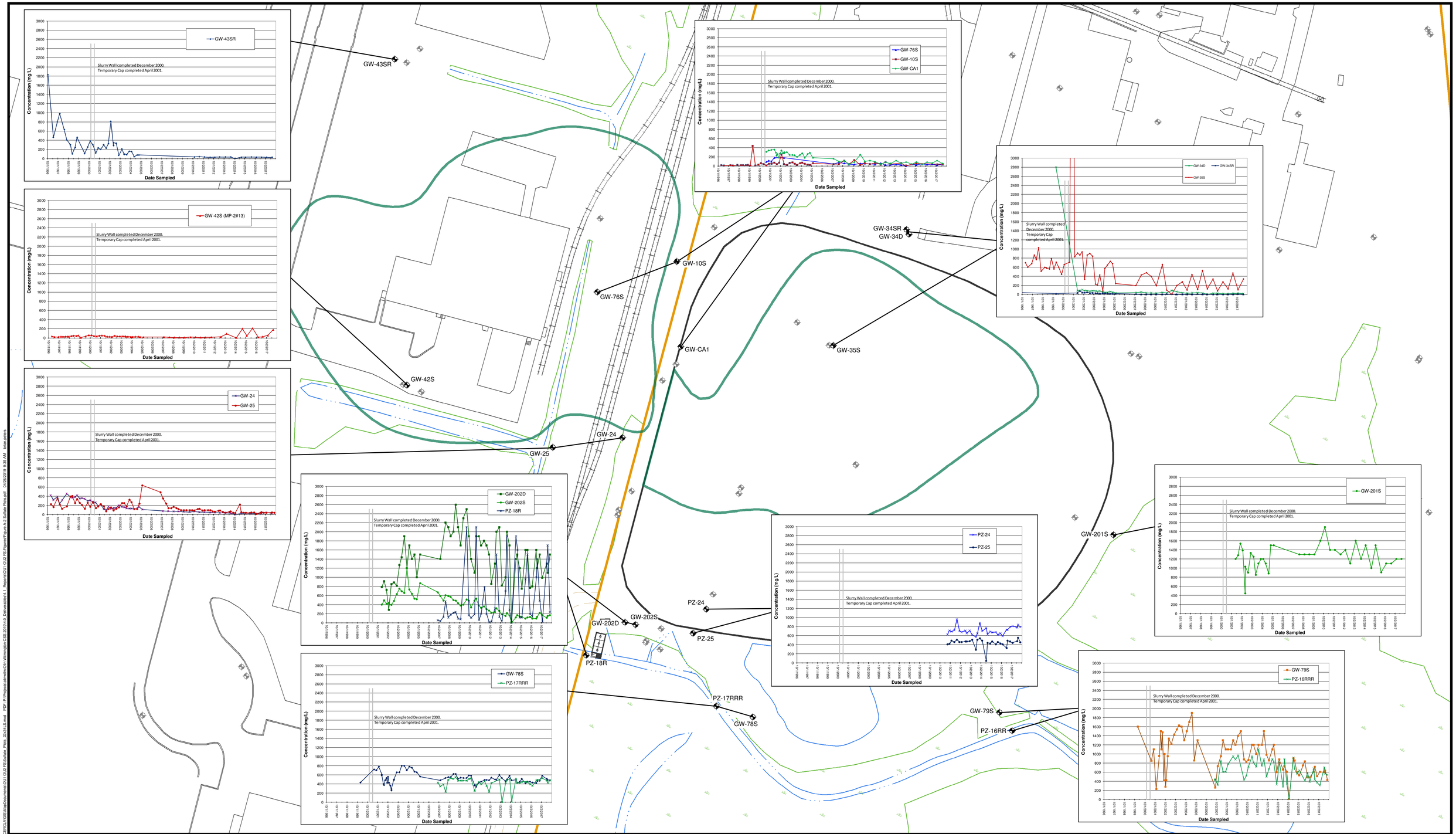
0 50 100 Feet

Figure A-1
Ammonia Plots

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/26/19 | Checked/Date: APP 04/26/19

Document: P:\Projects\Invoir\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\Ammonia_Plots_22x34LS.mxd PDF: P:\Projects\Invoir\Olin Wilmington CSS 2019-4.0_Deliverables\4.1 Reports\OU1 OU2 FS\Figures\Figure A-1 Ammonia Plots.pdf 04/26/2019 9:03 AM brian.peters



Legend

- Well with Sulfate Plot
- Other Well
- Containment Area
- Approximate DAPL Pool Boundary
- 51 Eames St. Property Boundary
- Water
- Wetland Boundary
- Railroad
- Paved Road
- Unpaved Road

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

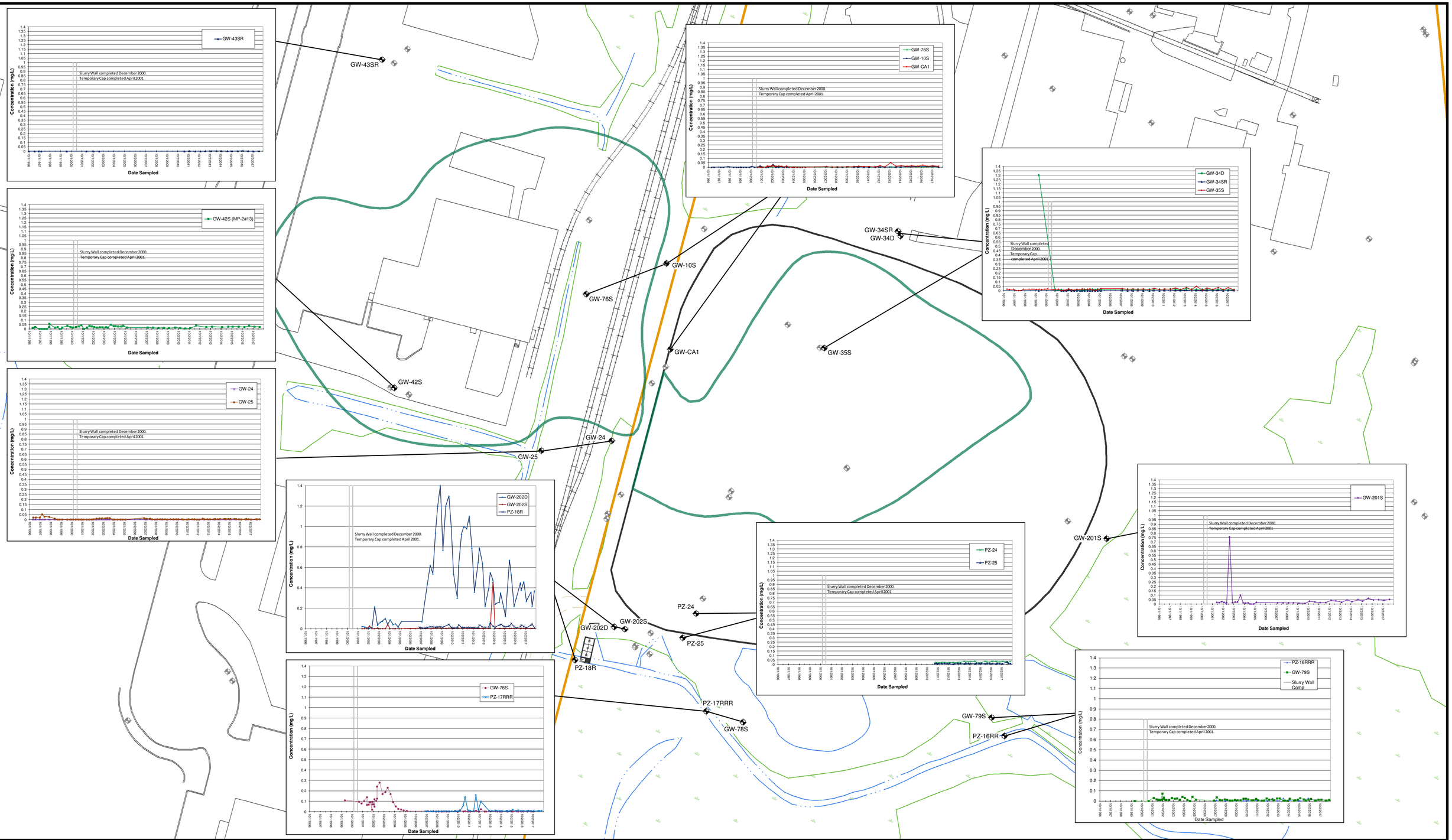
0 50 100 Feet

Figure A-2
Sulfate Plots

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/26/19 | Checked/Date: APP 04/26/19

Document: P:\Projects\olinwilm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\Sulfate Plots_22x34LS.mxd PDF: P:\Projects\olinwilm\Olin Wilmington CSS 2019\4.0 Deliverables\4.1 Reports\OU1-OU2 FS\Figures\Figure A-2 Sulfate Plots.pdf 04/26/2019 9:35 AM brian.peters



Legend

- Well with Dissolved Chromium Plot
- Other Well
- Containment Area
- Approximate DAPL Pool Boundary
- 51 Eames St. Property Boundary
- Water
- Wetland Boundary
- Railroad
- Paved Road
- Unpaved Road

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

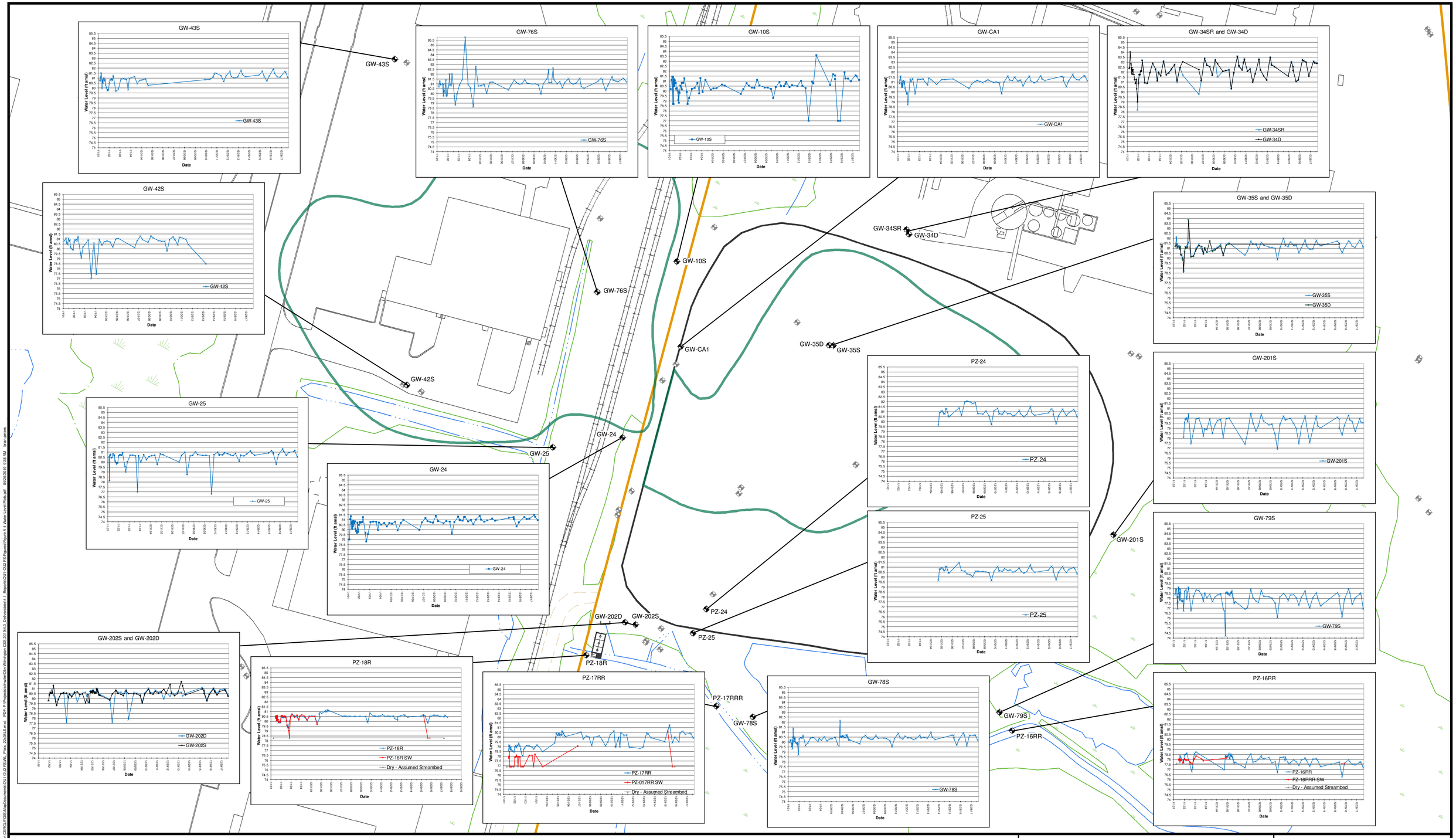
0 50 100 Feet

Figure A-3
Dissolved Chromium Plots

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/26/19 | Checked/Date: APP 04/26/19

Document: P:\Projects\Olin\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\Chromium_Plots_250ft_5.mxd PDF: P:\Projects\Olin\Olin Wilmington CSS 2019\4.0 Deliverables\4.1 Reports\OU1 OU2 FS\Figures\Figure A-3 Dissolved Chromium Plots.pdf 04/26/2019 9:27 AM brian.peters



Legend

- Well with Water Level Plot
- Other Well
- Containment Area
- Approximate DAPL Pool Boundary
- 51 Eames St. Property Boundary
- Water
- Wetland Boundary
- Railroad
- Paved Road
- Unpaved Road

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

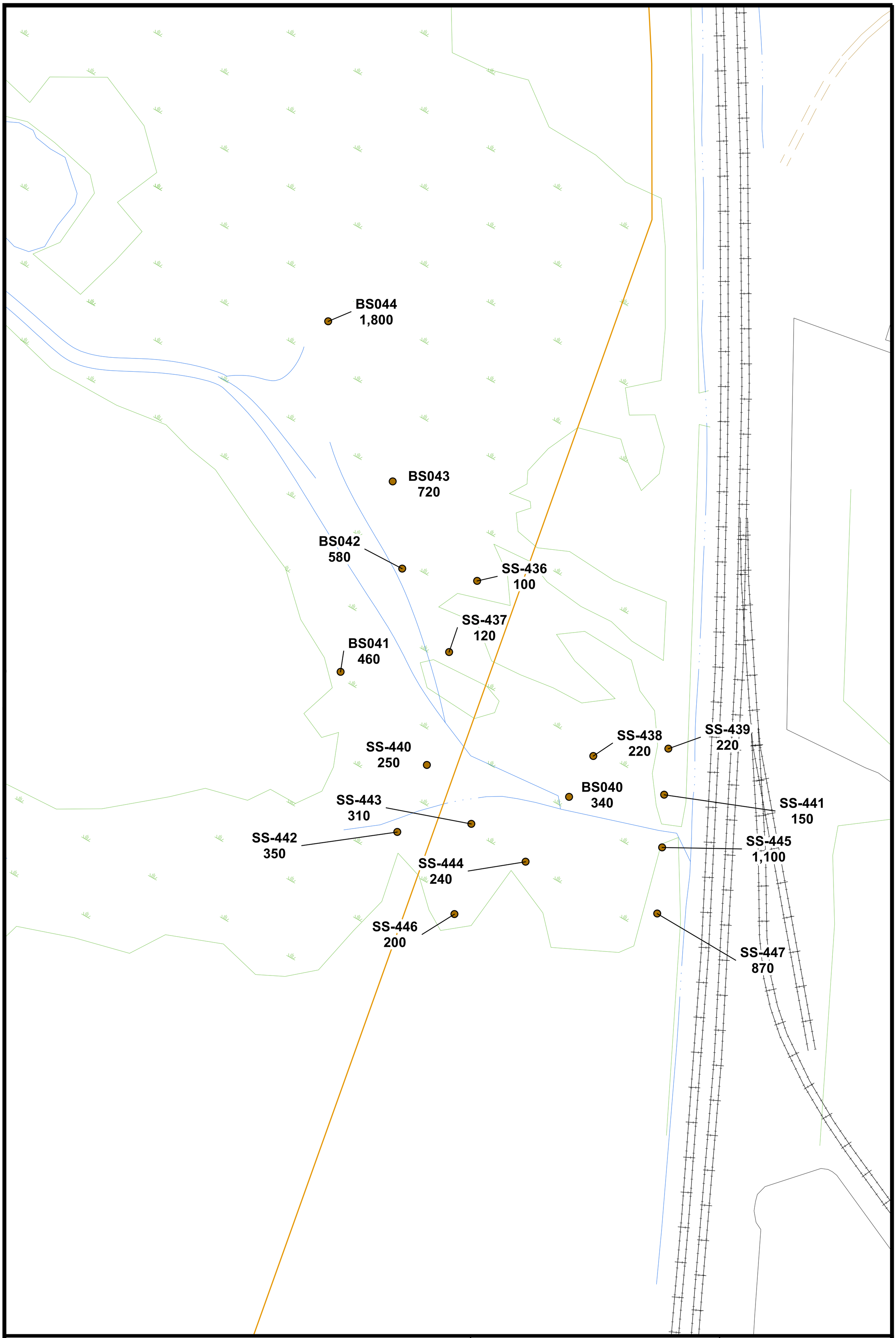
0 50 100
Feet

Figure A-4
Water Level Plots

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/26/19 | Checked/Date: APP 04/26/19

Document: P:\Projects\Invem\Olin Wilmington CERCLA\GIS\MapDocuments\OU1-OU2 FS\WL Plots_22CHLS.mxd PDF: P:\Projects\Invem\Olin Wilmington CSS 2019\4.0 Deliverables\4.1 Reports\OU1-OU2 FS\Figures\Figure A-4 Water Level Plots.pdf 04/26/2019 9:58 AM Brian.Gaitens



Legend

- Soil Sample Location
- 51 Eames St. Property Boundary
- Water
- 300 Concentration of Ammonia (mg/kg)
- Railroad
- Paved Road
- Unpaved Road
- Wetland Boundary

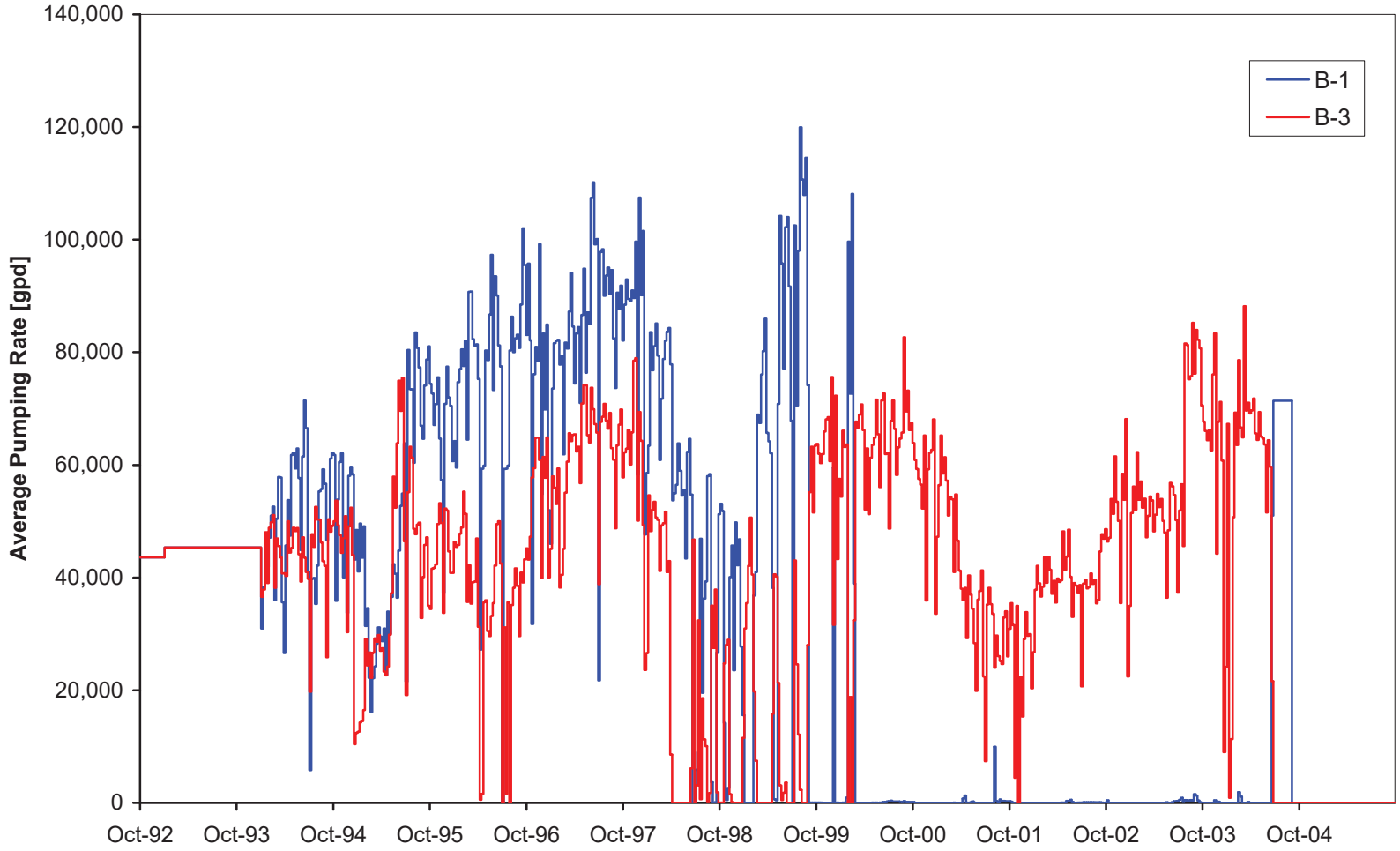
wood.
Wood Environment & Infrastructure Solutions, Inc.
271 Mill Road
Chelmsford, MA 01824
(978) 692-9090

N

0 50 100 Feet

Figure A-5
Surface Soil Samples (0-1 feet) with Ammonia Results in Proximity to Lower South Ditch
Feasibility Study - OU1 and OU2
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: INT 05/17/19 | Checked/Date: JPK 5/17/19



GEOMEGA

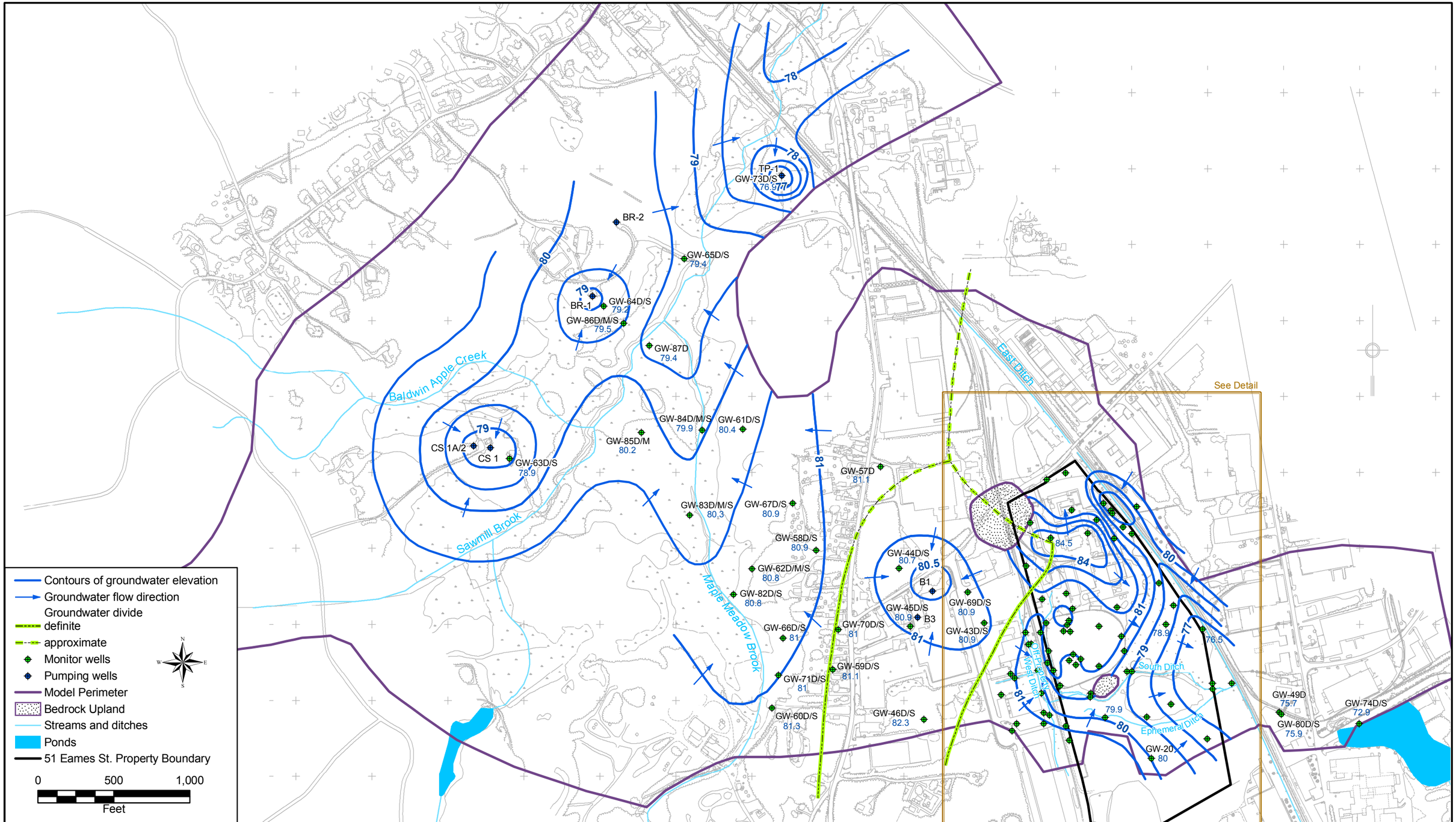
8/4/06

C06432D
Olin

Sanmina pumping rates.

Figure
2-8

BL o:\Olin\2005 Model Update\Chart PumpingSched.xls (Sanmina Rate)



GEOMEGA

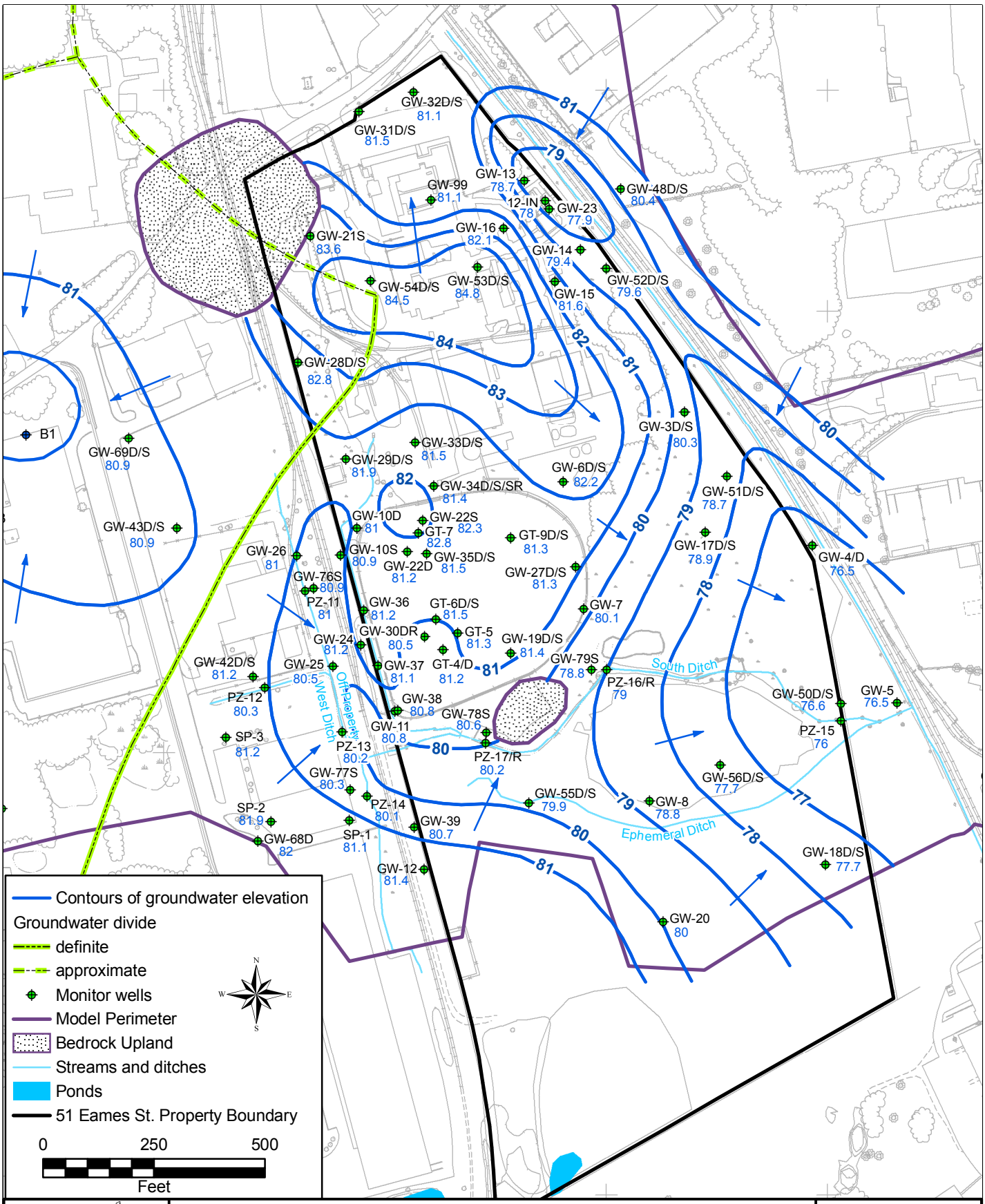
10/16/06

C06432D
Olin

April 1998 water levels.

Figure
2-10a

MV \\Dump\GIS\Olin\ProductionData\apr_mxd\water_levels98.mxd



GEOMEGA

10/17/06

C06432D
Olin

April 1998 water levels.

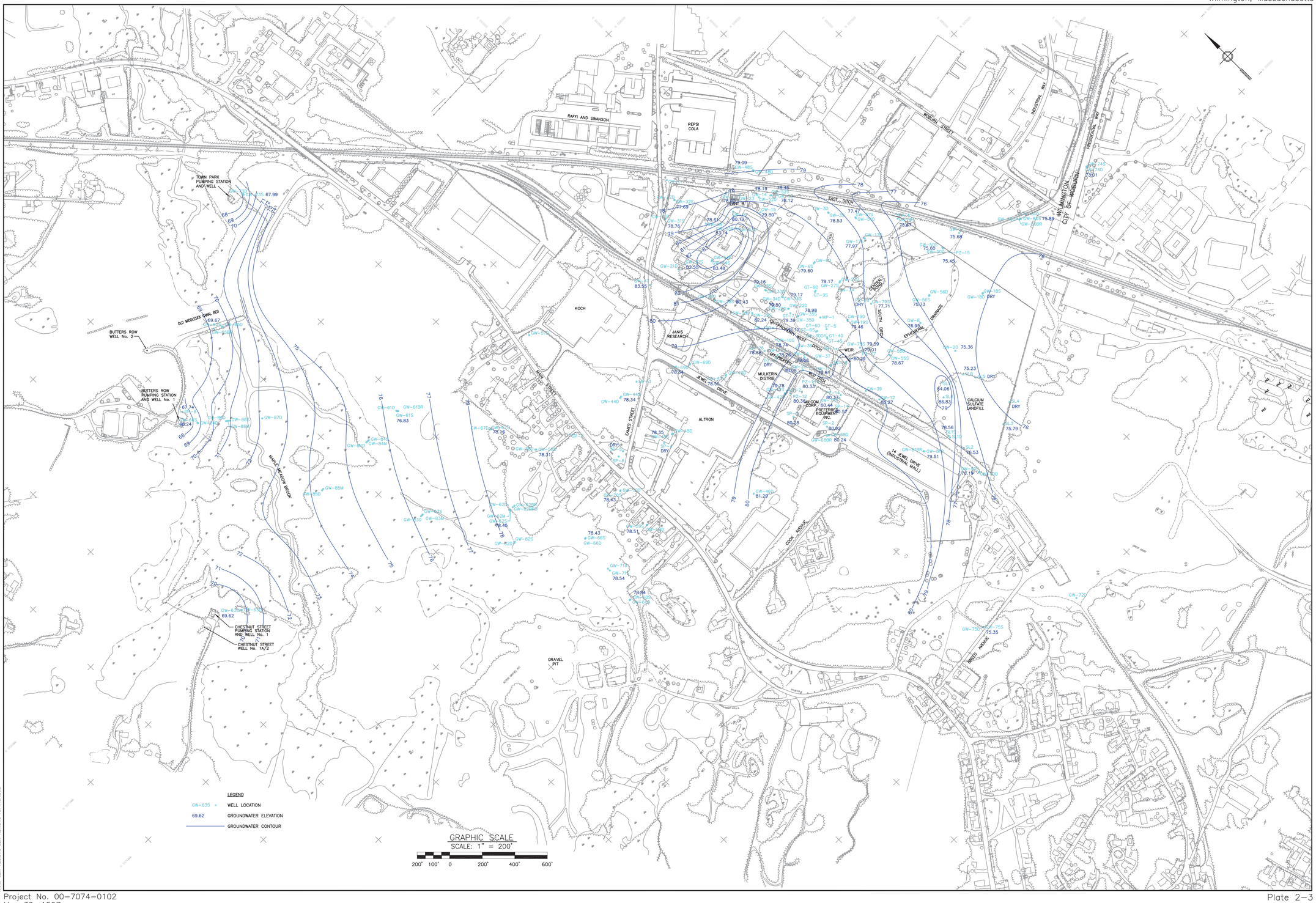
Figure
2-10b

DM S:\Olin\ProductionData\apr_mxd\gw_rprt_0906\water_levels98_inset.mxd

XREF 'OLIN-NEW.dwg' & 'OLIN-ADD.dwg' INSERT 0,0 ROTATE 0°

SMITH TECHNOLOGY CORPORATION

Olin Corporation
Wilmington, Massachusetts



Drawing: 7074-007
Date: OLIN-ADD.DWG, OLIN-NEW.DWG, 7074FIG2A.DWG

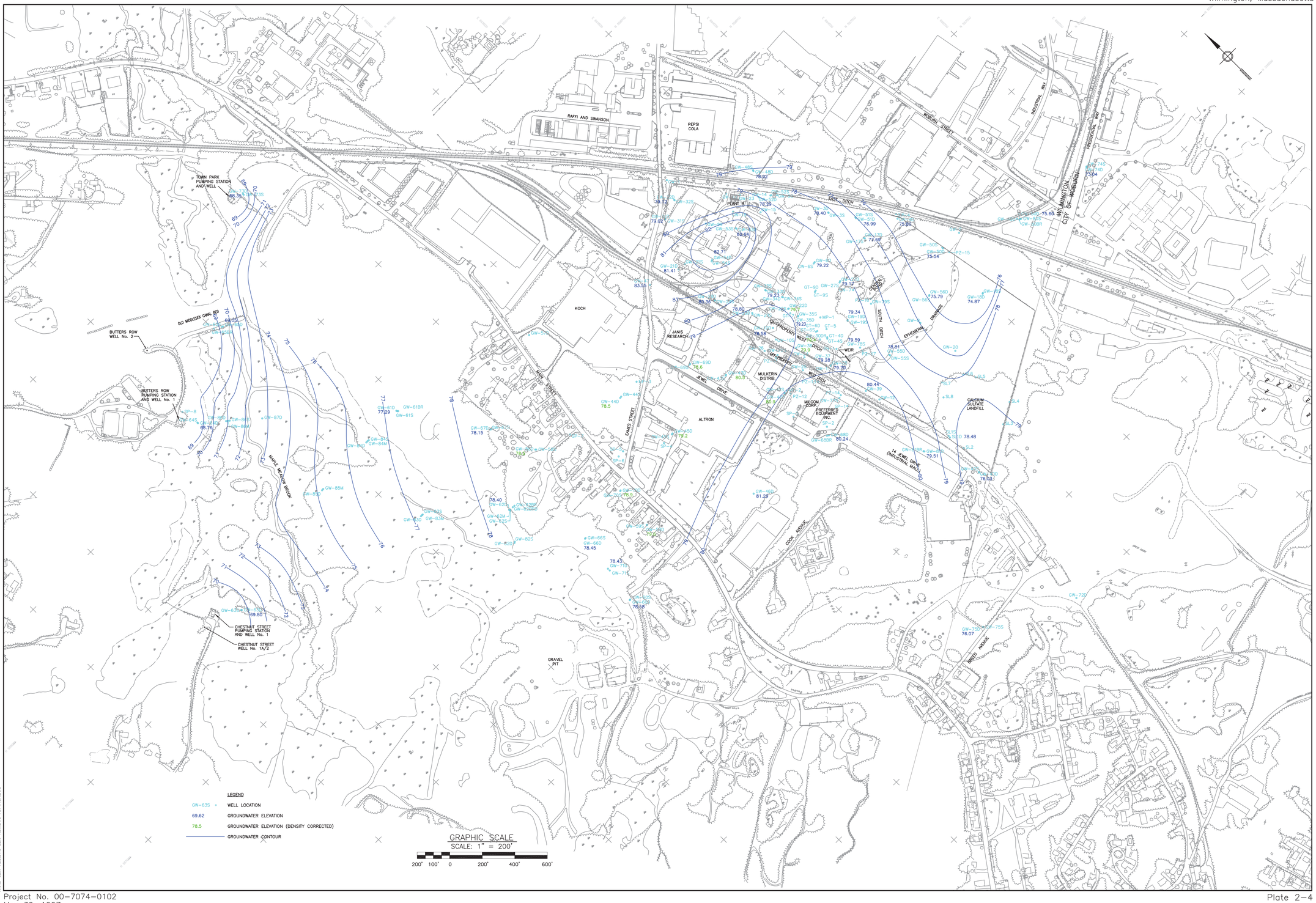
Project No. 00-7074-0102
May 30, 1997

Plate 2-3
Groundwater Contour Map, Water Table, October 1995

XREF 'OLIN-NEW.dwg' & 'OLIN-ADD.dwg' INSERT 0,0 ROTATE 0°

SMITH TECHNOLOGY CORPORATION

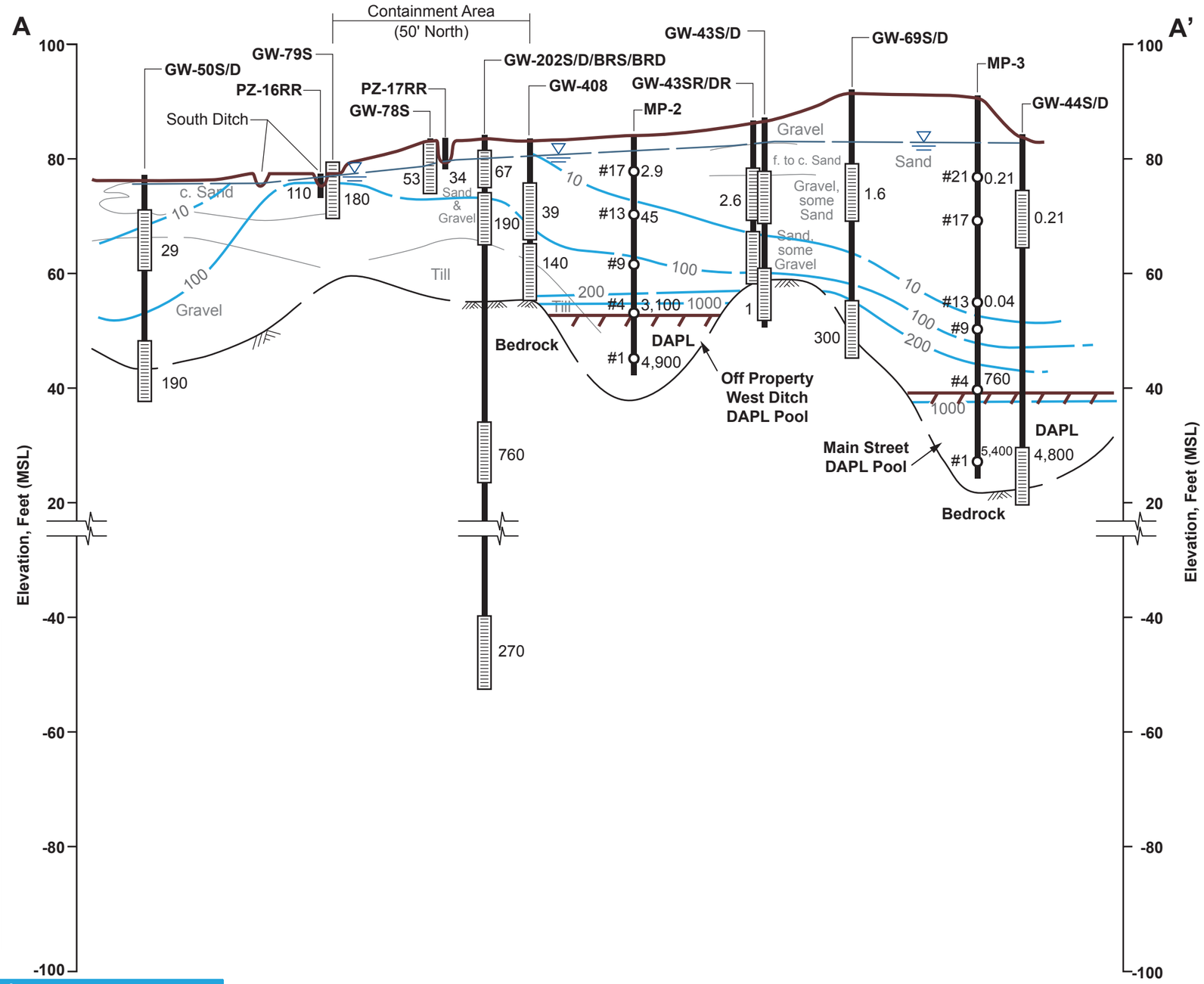
Olin Corporation
Wilmington, Massachusetts

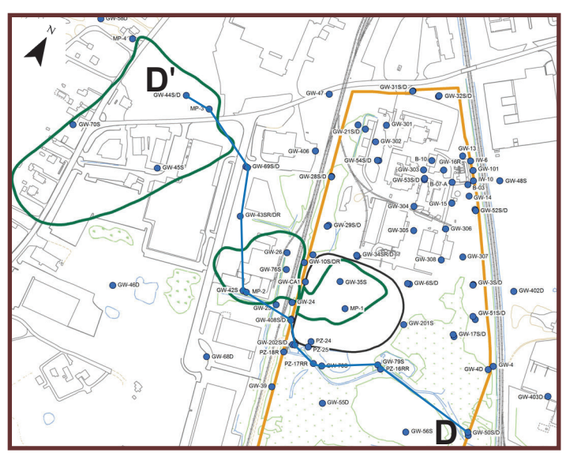


Drawing:7074-007
Date: OLIN-ADD.DWG OLIN-NEW.DWG 7074FIG4.DWG

Project No. 00-7074-0102
May 30, 1997

Plate 2-4
Hydraulic Heads in Deep Wells, October 1995





Cross-Section Location

Legend:

39 Reported concentration in mg/L

Grain Size Descriptors

f. = fine
m. = medium
c. = coarse

Horizontal Scale in Feet

0 500 1000

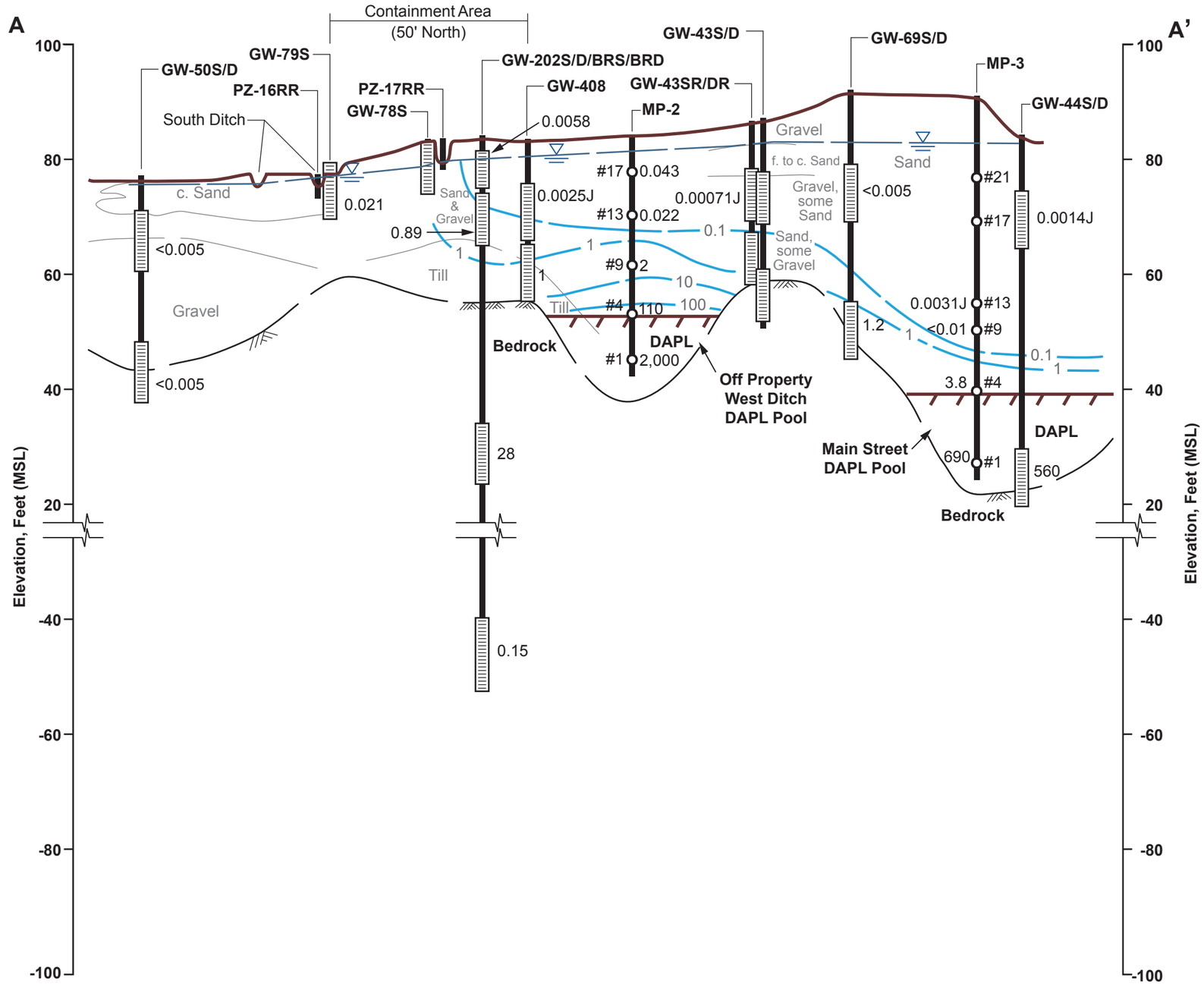
Prepared/Date: JPH 01/21/19
Checked/Date: JBR 01/21/19

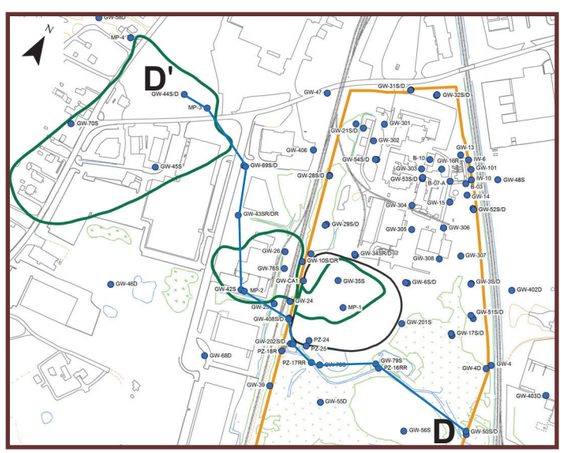
Olin Chemical Superfund Site
Wilmington, Massachusetts

wood.

Ammonia
Section A - A'
Project 6107-19-0016

PORT2018016a.ai





Cross-Section Location

Legend:

2 Reported concentration in mg/L
J Estimated concentration

Grain Size Descriptors

f. = fine
m. = medium
c. = coarse

Horizontal Scale in Feet

0 500 1000

Prepared/Date: JPH 01/21/19
Checked/Date: JBR 01/21/19

Olin Chemical Superfund Site
Wilmington, Massachusetts

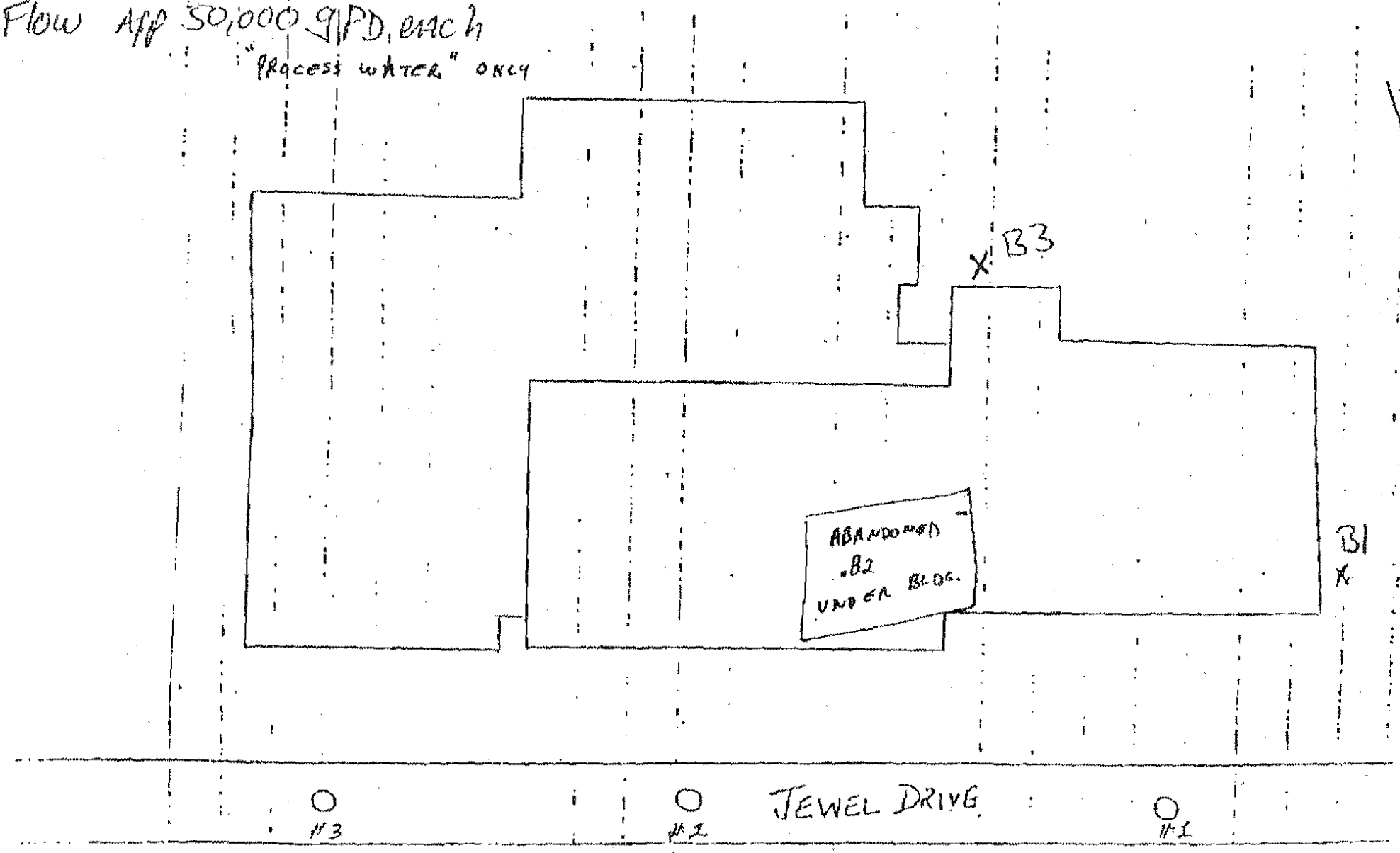
wood.

Chromium
Section A - A'
Project 6107-19-0016

PORT2018016a.ai

B1 & B2 wells
Depth 28' ± 2'
Flow Aff 50,000 GPD each
"Process water" only

ALTRON INC.
SITE PLAN



TOWN OR CITY Waitsfield SITE _____ DATE 30

LOCATION Right front corner of building looking from

Test hole Log

B1 well

EPTH OF STRATUM	FORMATION FOUND EACH STRATUM	
0'-8'	medium to coarse sand & gravel with	DIA. TEST WE
	large boulders	STATIC WL FF
8'-54'	brown medium to coarse sand	STATIC WL FR
54'-67'	gray medium to coarse sand	TOTAL DEPTH
67'	REFUSAL	DEPTH DEVEL
		PIPE LEFT IN
		TYPE SCREEN
		DEPTH SCREE
		DEVELOPED &
	Pumped 40 gpm at 66' with green water	30 G.P.
	and high iron	WATER SAMP
	Pulled back to 57' with high iron	DATE COLLEC
	Pulled back to 30' and developed	R

cord of pumping test to determine specific yield

mped____g.p.m for__hr. from_____observed___ft.__in, drawdown in obs.___ft. away at a de
mped____g.p.m for__hr. from_____observed___ft.__in, drawdown in obs.___ft. away at a de

Specific yield of_____gallons per foot of drawdown

ll driven by L. N. Osborne

SIGNED_____

TOWN OR CITY Wilming SITE _____ DATE COMPLETED _____

LOCATION Rear of Bldg. near receiving dock

#1 Log

B3 Well

'TH OF TRATUM	FORMATION FOUND EACH STRATUM		
'-18'	Brown med. to coarse sand & gravel	free	DIA. TEST WELL 2½"
18'-24'	Brown med. to coarse sand & gravel	free	STATIC WL FROM TOP PIPE 11'
'-36'	Brown fine to med. sand	free	STATIC WL FROM GROUND 11'
36'	Not refusal - high iron content - pulled		TOTAL DEPTH DRIVEN 36'
	back to 25' and set screen & developed		DEPTH DEVELOPED 25'
			PIPE LEFT IN PLACE 18'
	Note high Iron Content		TYPE SCREEN 1 1/4" Gal. Johnson 60 slot
			DEPTH SCREEN SET 20'-25'
			DEVELOPED & RATED AT
			75& G.P.M. 15" VAC.
			WATER SAMPLE
			DATE COLLECTED
			REMARKS

'd of pumping test to determine specific yield

for 2nd. mineral test

ed 75 g.p.m for 2 hr. from #2 observed ~~ft. in, drawdown in obs. ft. away at a depth of ft.~~

ed ____ g.p.m for ____ hr. from ____ observed ____ ft. ____ in, drawdown in obs. ____ ft. away at a depth of ____ ft.

Specific yield of ____ gallons per foot of drawdown

. driven by [redacted]

SIGNED _____

pton Pump Supply Inc.
WOBURN STREET
TON, MASS 01887
659-9111

APPENDIX B

EVALUATION OF GROUNDWATER INTERACTION WITH EAST DITCH SURFACE WATER AND SEDIMENT

Appendix B - Evaluation of Groundwater Interaction with East Ditch Surface Water and Sediment

Introduction

In its response to Appendix 6 Specific Comment 8, USEPA requested that Olin expand discussion of groundwater interaction with surface water and sediment to include East Ditch. The Final OU1/OU2 RI was based on surface water and sediment data collected when the Plant B groundwater extraction system (for LNAPL migration control) was operating. Operation of that system extracts groundwater in the immediate vicinity of Plant B but the full extent to which it captures groundwater has not been studied. The surface water and sediment chemical data in the OU1/OU2 RI Report therefore generally reflect the effects of discharge of shallow overburden groundwater from the site located outside the influence of Plant B. Based on groundwater potentiometric interpretations presented in the Draft OU3 RI Report (Amec Foster Wheeler, 2018b), shallow groundwater from both the eastern and western sides of East Ditch flow toward and parallel with the axis of the ditch. The base flows in East Ditch are not high and therefore it only captures a portion of shallow groundwater. Wells located along the east side of East Ditch (GW-402D and GW-403D) are not impacted by the OCSS. South of the confluence of South Ditch, overburden groundwater flows under East Ditch to the east. North of the Eames Street Bridge, surface water flows north and west. South of the bridge it flows east.

The nature and extent of chemicals detected in surface water and sediment was discussed at length in Sections 4.2.5.3 and 4.2.6.3 of the Final OU1/OU2 RI report, respectively. The RI and its associated ecological risk assessment documents, which included a Screening Level Ecological Risk Assessment (SLERA), concluded with USEPA concurrence and agreement that the East Ditch has little or no ecological habitat of value and that surface water quality posed no ecological concerns (USEPA, 2015). In addition, the Baseline Human Health Risk Assessment (BHHRA) conducted in support of the OU1/OU2 RI concluded that human health risk associated with potential exposures to surface water and sediment in the East Ditch were within or below CERCLA risk limits. The OU1/OU2 RI Report did not identify any substantial groundwater/sediment interaction that was resulting in on-going impacts to sediment within OU1/OU2.

Under normal historical operations, the water levels in the Plant B extraction wells (principally IW-11) were lower than East Ditch Surface water elevation which was intended to eliminate migration of sheen when the system was initially operated. The OU1/OU2 RI Report did not contemplate a hypothetical condition whereby groundwater from Plant B is no longer extracted, and to the extent it was captured is allowed to discharge to East Ditch. The evaluation described herein was conducted to provide that context and conservatively assumes constituents detected in

groundwater near the East Ditch discharge to surface water with little or no dilution. Ecological screening levels in this evaluation were updated from the SLERA or otherwise developed, to allow an interpretation of whether groundwater poses a risk to the East Ditch. The BHHRA was also re-evaluated under the assumption that groundwater discharges to the East Ditch to assess whether the conclusions of the original BHHRA would remain valid. This assessment finds the discharge of groundwater to the East Ditch is not considered to pose a potential hazard to human or ecological receptors potentially present in the East Ditch in the area of Plant B or immediately downstream within the East Ditch.

The subsequent subsections review the findings of the SLERA with respect to East Ditch wetland habitat and function, describe an approach for ecological screening, summarize the findings from the screening, summarize the re-evaluation of the BHHRA, and provide conclusions.

Previous Evaluation of East Ditch Habitat and Wetlands Function

The 2013 Screening Level Ecological Risk Assessment for East Ditch was included as Attachment 7 to the Baseline Ecological Risk Assessment, Operable Unit 1 & Operable Unit 2, Olin Chemical Superfund Site that was itself included as Appendix N to the Final Remedial Investigation Report, Operable Unit 1 & Operable Unit 2, Olin Chemical Superfund Site Wilmington, Massachusetts (AMEC Environment & Infrastructure, Inc., 2015). The East Ditch SLERA included an extensive description of the environmental setting of the East Ditch, a summary of the habitat assessment and wetlands function and values assessment that were conducted for the East Ditch (following methods approved by the State of Massachusetts), and a summary of the information collected for the East Ditch and surrounding area with respect to endangered or threatened species. The text below summarizes the SLERA information concerning environmental setting, habitat assessment and wetlands function and values, and endangered or threatened species.

Highlights of the East Ditch environmental setting are summarized below. The locations of the East Ditch, Plant B, and wells in the area are shown on the attached **Figure 2.2-12**, which has been reproduced from the Draft OU3 Remedial Investigation report.

- The East Ditch is a man-made channel engineered to convey surface water runoff along the MBTA railroad tracks. The upstream East Ditch and a portion of the downstream East Ditch run parallel to the railroad tracks at the base of the railroad embankment.
- The East Ditch runs straight to the south from the Eames Street overpass approximately 1500 feet to the confluence with the Lower South Ditch. The East Ditch continues to run south approximately 1,375 feet along the railroad tracks and enters an underground culvert located approximately 500 feet north of Anderson Station. The ditch runs southwest underground for a short distance and daylights immediately to the west of New Boston Street. The ditch runs approximately 200 feet south to the confluence with Landfill

Brook and the combined flow almost immediately enters an underground culvert and runs approximately 1,300 feet to the southeast where it daylights and flows south to the confluence with Hall's Brook and the combined flow runs to the east into the Hall's Brook Holding Area.

- The banks and channel of the East Ditch are formed by railroad ballast that consists of homogenous crushed stone (1 to 2 inch diameter) from the north down to the underground culvert north of Anderson Station. The 200-foot segment of the East Ditch along New Boston Street has rip-rap banks and channel. It was difficult to locate and collect samples of sediment in the East Ditch.
- The East Ditch throughout its course is narrow (ranging from approximately 2 – 4 feet wide and occasionally up to approximately 10 feet) and shallow (0.5 to 1.5 feet deep). The east bank is adjacent to the railroad and has little or no vegetation and the west bank has no canopy to provide cover or shade. No pools or riffles were observed in the East Ditch.

The findings of the Habitat Assessment conducted in 2013 (using the Rapid Bioassessment Protocols for Wadeable Streams and Rivers Habitat Assessment Field Sheets for Low Gradient Streams (USEPA, 1999)) are summarized below.

- Channel alteration was scored as poor (clearly an engineered feature)
- Channel sinuosity was scored as poor (straight and highly channelized)
- Sediment deposition score of marginal to poor (channel substrate and banks are ballast, absence of islands or pint bars formed by sediment deposition).
- Epifaunal (i.e., benthic invertebrate) substrate/available cover scored as marginal to poor.
- Pool substrate could not be scored (no pools observed) and pool variability was scored as poor.
- Channel flow status was characterized as poor to marginal.
- Eastern bank stability was scored as optimal, western bank stability scored as suboptimal (some evidence of erosion).
- The eastern bank of the ditch was scored as poor for vegetative cover and riparian vegetative zone width.
- The western bank was scored marginal for vegetative cover (herbs, shrubs, saplings). Vegetation provides no canopy cover for East Ditch.
- The western bank scored as poor for riparian zone width (15-20 feet).

The findings of the Wetland Functions and Values Assessment are summarized below.

- The East Ditch is an engineered surface water drainage channel that provides little or no habitat of value.
- The MBTA performs annual maintenance including mechanical removal of vegetation further limiting value of the habitat.
- Functional Wetlands Assessment concluded that none of the thirteen wetland functions were present at the East Ditch.

Research concerning presence of endangered, threatened or State-listed species is summarized below.

- Previous consultations with US Fish and Wildlife Service indicate no federally-listed and proposed, endangered or threatened species are known to occur in the vicinity of the Site.
- In 2003, AMEC reviewed files of the US Fish and Wildlife Service and confirmed there are no federally-listed rare, threatened, or endangered species know to occur at or in the vicinity of OU1 and OU2.
- In 2003 AMEC also confirmed with the Massachusetts Natural Heritage and Endangered Species Program (NHESP) there are no estimated habitats of State-listed species at or in the vicinity of OU1 and OU2.

Overall, the SLERA for the East Ditch indicates that the East Ditch in the vicinity of Plant B is a man-made, engineered drainage ditch with limited habitat for ecological receptors and has no functional wetland value. The substrate is stone railroad ballast and no fish have been observed in the ditch. There are limited ecological receptors present in the East Ditch.

Approach for Ecological Screening

Because East Ditch water quality adjacent to the Plant B area is unknown for a future scenario in which the Plant B groundwater collection and treatment system is no longer operating, this evaluation has conservatively assumed that current groundwater quality in the Plant B area is a worst-case estimation of future surface water quality in the East Ditch immediately adjacent to Plant B. The assumed worst-case conditions for surface water in the East Ditch have been evaluated by comparing the assumed surface water concentrations to ecological screening criteria.

The data set identified consists of groundwater data from monitoring wells located in the immediate vicinity of Plant B and to the east of Plant B. Using the groundwater data conservatively assumes that there would be no dilution in East Ditch surface water as the groundwater discharges to the ditch.

The wells included in this evaluation are: B-03, GW-101, GW-13, IW-6, and IW-10, which are the wells in the vicinity of Plant B that are closest to the East Ditch and that also provide spatial representation of groundwater concentrations to the north, east, and south of Plant B (see attached figure). These wells also have the most complete analytical data sets. In addition, the data set was limited to samples collected from 2010-present, to provide a data set that would approximate current conditions in groundwater and the East Ditch. Wells GW-100 and GW-102 were considered for this evaluation; however, they have not been sampled since 2010.

Data available for this evaluation included samples collected for the Draft OU3 Remedial Investigation (RI) Report at B-03, GW-101, and GW-13. In addition, each of the five wells is also sampled annually in November. Therefore, the data set totals 51 samples (6 RI samples and 45 annual samples). One duplicate sample was collected, and these results were considered along with the field sample results as indicated. Analytical data used in this evaluation are presented in **Table B-1**. **Table B-2** provides a statistical summary of the groundwater data set, including frequency of detection, minimum concentration detected, maximum concentration detected, location of maximum detected concentration, average of detected concentrations, and range of quantitation limits for non-detects.

Ecological screening criteria identified for evaluating the groundwater concentrations were the following:

- USEPA Freshwater Ambient Water Quality Criteria - Chronic Continuous Concentration (USEPA, 2019) (https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table)
- For ammonia, a CMC has been calculated, consistent with USEPA guidance, for surface water where salmonid fish species are absent.
- Buchman, 2008, Screening Quick Reference Tables (SQuiRTs from NOAA) (https://response.restoration.noaa.gov/environmental-restoration/environmental-assessment-tools/squirt-cards.html) Note that SQuiRTs were developed for screening purposes only; they do not represent official NOAA policy and do not constitute criteria or clean up levels.
    - SQuiRTs often cite other sources including:
        - Suter, G.W, & C.L. Tsao, 1997. Oak Ridge National Laboratory Tier II Secondary Chronic Values.
- USEPA Region 4 freshwater chronic values (USEPA, 2018a). Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment (https://www.epa.gov/sites/production/files/2018-03/documents/era_regional_supplemental_guidance_report-march-2018_update.pdf)
- USEPA Region 3 BTAG Screening Benchmarks for Freshwater (USEPA, 2006) (https://www.epa.gov/sites/production/files/2015-09/documents/r3_btag_fw_benchmarks_07-06.pdf)
- For the trimethylpentene compounds, screening levels were not available from the sources identified above. Therefore, consistent with the Baseline Ecological Risk Assessment for OU1 and OU2, screening values were derived estimated using USEPA's Ecological Structure Activity Relationships (ECOSAR) Database v.1.11 (USEPA, 2009)

Screening levels are identified in the attached **Tables B-1** and **B-2**. Concentrations of chemicals detected in groundwater were compared to each of the available ecological screening criteria.

The number of detected concentrations above each of the screening benchmarks is provided in **Table B-2**.

Findings

For most chemicals detected in groundwater, few concentrations are above the ecological screening criteria. The primary exceptions are bis(2-ethylhexyl)phthalate (BEHP) (21 of 51 sample results above lowest screening value), iron (28 of 51 sample results above the lowest screening value), and ammonia (39 of 51 sample results above the lowest screening value). Twenty sample results for 2,4,4-trimethyl-1-pentene and 18 sample results for 2,4,4-trimethyl-2-pentene in 51 groundwater samples are higher than the ECOSAR screening criteria.

BEHP

The SQuiRTs list three ecological screening values for BEHP: 32 µg/L for EPA Eco screening level, 16 µg/L for a Canadian screening level (avian), and 0.3 µg/L for Region V screening level. The Canadian value is not considered relevant for the purposes of this evaluation because it is for an avian receptor, and none are present in the East Ditch. The EPA Eco value was calculated using Great Lakes Water Quality Initiative Tier II methodology (40 CFR 9 et al.). The Region V screening levels are considered by USEPA to be archived values. Regardless, the 0.3 µg/L value was based on USEPA Ambient Water Quality for Phthalate Esters (EPA 440/5-80-067) (USEPA, 1980), which though issued in 1980 is still considered the most recent AWQC for BEHP. The 0.3 µg/L value was derived from a chronic value of 3 ug/L for an effect of significant reproductive impairment in *Daphnia magna*, which was adjusted with an uncertainty factor of 10.

The reporting limits for BEHP for 26 of the 30 results reported as non-detect range from 1.8 to 5.2 µg/L (with two samples having reporting limits of 25-26 and two having reporting limits of 50-52 µg/L) and the minimum detected value for BEHP is 0.42 µg/L; therefore, this screening criterion of 0.3 µg/L is below what can be detected using typical analytical methods for groundwater. However, if the chronic value of 3 µg/L is used without the application of the uncertainty factor, solely two detected values for BEHP (~10 percent of detects) are higher than 3 ug/L. In addition, the maximum detected value for BEHP of 5.5 µg/L is lower than the EPA Eco screening level of 32 µg/L, the Region 4 screening value of 8 µg/L, and the Region 3 BTAG screening level of 16 µg/L. Lastly, the highest concentrations of BEHP have typically been detected in well GW-101 (average detect 2.4 µg/L), and the average detected in IW-10, the nearest well to the south, is 0.98 µg/L. As such, it seems likely that the concentrations of BEHP present in GW-101 would be diluted via mixing with nearby groundwater to concentrations below 3 µg/L prior to reaching the East Ditch. Therefore, based on how the lowest screening value was developed, the alternate screening levels, and the pattern of detected concentrations in groundwater, it is concluded that the concentrations

of BEHP in groundwater in the vicinity of Plant B are unlikely to pose a hazard to potential ecological receptors in the East Ditch.

Ammonia

Consistent with the Aquatic Life Ambient Water Quality Criteria For Ammonia – Freshwater 2013 (USEPA, 2013), a Criterion Maximum Concentration (CMC) for ammonia in surface water at the East Ditch has been calculated as 36 mg/L. This water quality criterion was calculated using the procedures on page 42 of the 2013 USEPA document for site-specific situations where salmonid fish species are absent (the situation that exists for the East Ditch).

A second screening level for ammonia of 19 ug/L was obtained from the Region 3 BTAG freshwater screening values. Upon further inspection, it was found that this value is from the Canadian Council of Ministers of the Environment (CCME) and is applicable to un-ionized ammonia, which constitutes a very small percentage (less than 1% at neutral pH) of total ammonia in groundwater or surface water (Canadian Water Quality Guidelines for the Protection of Aquatic life, Ammonia, Canadian Council of Ministers of the Environment, 2010). This screening level is not applicable here, since the available ammonia analytical data are for total ammonia (not un-ionized).

Concentrations of ammonia above 36 mg/L are limited to well IW-10 in the vicinity of Plant B, where the average ammonia concentration is approximately 58 mg/L. The maximum detected concentration in other wells is 6 mg/L, with an average detected concentration of 1.1 mg/L. IW-10 is between wells GW-101 (to the north) and B-03 (to the southwest). Concentrations of ammonia in B-03 are typically detected around 0.3 mg/L and concentrations at GW-101 average about 2.4 mg/L. Based on the much lower concentrations of ammonia in these wells in the nearby vicinity, it seems likely that the concentrations of ammonia present in IW-10 would be diluted via mixing with nearby groundwater to concentrations below the freshwater criterion of 36 mg/L prior to reaching the East Ditch. Concentrations of ammonia in shallow overburden groundwater for the next 700 feet south of Plant B along East Ditch are also low based upon OU3 RI groundwater results. BEHP is not detected in shallow groundwater along this same distance south of Plant B. Upon discharge to the East Ditch, and during transport down the ditch, additional dilution in surface water would further reduce ammonia concentrations. These observations are consistent with the low concentrations of ammonia detected at EDSD/SW2 (0.26 to 0.92 mg/L) 200 feet downstream of Plant B and low concentrations detected historically and recently at ISCO3 (1.2 mg/L; May 22, 2018) located upstream of the confluence of South Ditch. Therefore, the concentrations of ammonia in groundwater are not considered to pose a potential hazard to potential ecological receptors in the East Ditch adjacent to Plant B or in downstream areas.

Iron

Forty-five of the groundwater samples included in the data set used in this evaluation were analyzed for dissolved iron, six were analyzed for total iron, and detected concentrations ranged from 17 to 28,000 µg/L, compared to the available screening levels of 1,000 and 300 µg/L. The screening level of 300 µg/L is the USEPA Secondary MCL for iron, which is related to taste and color and is not a health-based value. Therefore, it is not considered further in this evaluation.

The value of 1,000 µg/L as a screening level is documented in USEPA's 1976 "Quality Criteria for Water" (EPA 440-9-76-023), which states that, "based on field observations principally, a criterion of 1 mg/L iron for freshwater aquatic life is believe to be adequately protective" (USEPA, 1976). Therefore, the value was not based on any particular species or any particular health effects endpoint. The general effects of iron noted in the quality criteria document relate to its tendency to floc or precipitate, which can smother fish and settle to the bottom of water ways, affecting fish eggs and bottom-dwelling organisms. Because the East Ditch is an ephemeral water body and is not a suitable fish habitat, these effects would be less of a concern. Another study mentioned in the Quality Criteria for Water stated that an iron concentration of up to 10 mg/L was associated with a viable ecological community. The average detected concentration of iron in groundwater near Plant B is approximately 4.1 mg/L, which is well below this value. Iron floc has also not been observed in East Ditch. Based on the lack of specificity in the groundwater criterion, the lack of ecological receptors that would be most likely to be affected by iron, and potential dilution of groundwater from Plant B to the East Ditch, the concentrations of iron are not considered to pose a potential hazard to potential ecological receptors in the East Ditch.

Trimethylpentenes

Concentrations of trimethylpentenes above the ECOSAR screening levels are limited to two wells: IW-6 and GW-101. The average concentration of 2,4,4-trimethyl-1-pentene in IW-6 is 971 µg/L and in GW-101 is 182 µg/L. The average concentration of 2,4,4-trimethyl-2-pentene in IW-6 is 176 µg/L and in GW-101 is 46.3 µg/L. Wells GW-101 and IW-6 are near to each other on the east side of Plant B. The wells to the north (GW-13) and south (IW-10 and B-03) have much lower concentrations of trimethylpentenes. The maximum and average detected concentration of 2,4,4-trimethyl-1-pentene in these three other wells are 11 and 3.85 µg/L, respectively. The maximum and average detected concentration of 2,4,4-trimethyl-2-pentene in these three other wells are 8.6 and 2.69 µg/L, respectively. Given the localized nature of the elevated trimethylpentene concentrations, the potential for dilution prior to reaching the East Ditch and upon discharge into surface water, the concentrations of trimethylpentenes in groundwater are not considered to pose a potential hazard to potential ecological receptors in the East Ditch. In addition, as reported in

the November 2018 USEPA Regional Screening Levels tables (USEPA, 2018b), trimethylpentenes are highly volatile compounds (vapor pressure = 71 mm Hg) with high dimensionless Henry's Law Constants (H = 30). A higher Henry's law Constant indicates a greater tendency to leave water and move into air. As a point of reference, the volatile organic compound toluene has vapor pressure = 28 mm Hg and a dimensionless Henry's Law Constant = 0.27. This information indicates that rapid volatilization loss of trimethylpentenes from surface water would be expected, indicating that this evaluation is conservative and likely overestimates future surface water concentrations. This is consistent with detection of low concentrations of trimethylpentenes in East Ditch surface water in 2010 and 2011 (0.0044 and 0.0039 mg/L) at EDSD/SW2 and lack of detections downstream at EDSD/SW5 and ED/SD/SW7.

Re-Evaluation of the OU1/OU2 BHHRA for the East Ditch

In the OU1/OU2 BHHRA, the East Ditch was characterized as a shallow stormwater drainage ditch that flows along the eastern side of the Massachusetts Bay Transportation Authority (MBTA) railway right-of-way. Given the location and nature of the East Ditch, the only exposure scenario that was considered was a trespasser who might have the potential for very limited direct contact (ingestion and dermal contact) with surface water and sediment. Such trespassers would be trespassing on an active rail line property, which would pose a significant safety risk. The trespasser receptor included older children/adolescents and adults who may access the East Ditch for walking or some type of teenage activity.

A railroad maintenance worker was considered as a potential receptor; however, because the periodic clearing and excavation of the East Ditch is done mechanically from a rail-mounted excavator, no complete exposure pathways were identified for this receptor. The calculated cancer risk for a current and future trespasser in the OU1/OU2 BHHRA who was assumed to be exposed to sediment and surface water in the East Ditch was 7×10^{-5} and the non-cancer screening hazard index (HI) was 0.5. The cancer risk was within the CERCLA acceptable cancer risk range of 10^{-6} to 10^{-4}, and the non-cancer screening HI was below 1, indicating that risks were within or below acceptable limits.

For the purposes of this evaluation, where it is assumed that the Plant B treatment system is no longer operating, the cancer risk and non-cancer hazard for the trespasser receptor for exposure to surface water were re-calculated using the groundwater data evaluated herein, specifically for the chemicals identified above: BEHP, ammonia, iron, and trimethylpentenes. For other chemicals evaluated in the original BHHRA for the East Ditch, the surface water exposure point concentrations (EPCs) were retained, as were the sediment EPCs. The exposure parameters used in the OU1/OU2 BHHRA for a trespasser were also retained. EPCs for BEHP, ammonia, iron, and trimethylpentenes were calculated as the 95th percentile upper confidence limit (UCL) on the mean

of the groundwater data set using USEPA's ProUCL software version 5.1.002 (USEPA, 2016). These EPCs were then used in the risk calculation spreadsheets from the OU1/OU2 BHHRA for a trespasser potentially present in the East Ditch to recalculate the human health risks. The calculated cancer risk for this updated evaluation is 7×10^{-5} and the non-cancer screening HI is 0.6, indicating that the human health risks for a scenario where the Plant B treatment system is no longer operating are also within or below CERCLA risk limits. Therefore, exposure to sediment and surface water in the East Ditch is not anticipated to pose a potential risk to human health, consistent with the conclusions of the OU1/OU2 BHHRA.

Conclusions

The East Ditch in the vicinity of Plant B is a man-made, engineered drainage ditch with limited, low value habitat for ecological receptors and has no functional wetland value. The substrate is stone railroad ballast and no fish have been observed in the ditch. There are limited ecological receptors present in the East Ditch. In addition, the sole potential human receptor identified for the East Ditch is a trespasser who may be exposed to sediment and surface water via ingestion and dermal contact. A railroad maintenance worker in the MBTA right-of-way would not be anticipated to be exposed to media in the East Ditch because maintenance of the East Ditch is conducted using a rail-mounted excavator.

Since surface water quality in the East Ditch is unknown for the future scenario where the Plant B groundwater collection and treatment system is no longer operating, concentrations of chemicals detected in groundwater in the vicinity of Plant B were compared to ecological screening criteria from several sources. This conservative approach assumes no dilution of detected parameters in the groundwater as it flows toward the East Ditch and no dilution as the groundwater discharges to the surface water of the East Ditch. Concentrations of most of the detected parameters in groundwater samples were below ecological screening levels. Some concentrations of BEHP, ammonia, iron, and trimethylpentenes were above one or more available screening levels. Based on an evaluation of the East Ditch habitat, how these criteria were derived and the overall pattern of the concentrations of these constituents, if the Plant B groundwater collection and treatment system was no longer in operation, the discharge of groundwater to the East Ditch is not considered to pose a potential hazard to ecological receptors in the East Ditch in the area of Plant B or immediately downstream within the East Ditch. Further, the non-cancer and cancer risks calculated for a trespasser in the East Ditch using groundwater data identified herein are within or below CERCLA risk limits. Therefore, exposure to sediment and surface water in the East Ditch is not anticipated to pose a potential risk to human health, consistent with the conclusions of the OU1/OU2 BHHRA.

References

AMEC Environment & Infrastructure, Inc., 2015. Final Remedial Investigation Report, Operable Unit 1 & Operable Unit 2, Olin Chemical Superfund Site Wilmington, Massachusetts.

Buchman, Michael F. 2008. Screening Quick Reference Tables (SQuiRTs). Technical Report. National Ocean Service, Office of Response and Restoration. National Oceanic and Atmospheric Administration. https://repository.library.noaa.gov/view/noaa/9327

Canadian Council of Ministers of the Environment (CCME), 2010. Canadian water quality guidelines for the protection of aquatic life: Ammonia. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg. http://ceqg-rcqe.ccme.ca/download/en/141

Suter, G.W, & C.L. Tsao, 1997. Oak Ridge National Laboratory Tier II Secondary Chronic Values. In: Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota. U.S. Department of Energy, Office of Environmental Management. ES/ER/TM-96/R2 https://rais.ornl.gov/documents/tm96r2.pdf

USEPA, 1976. USEPA Quality Criteria for Water. Office of Water and Hazardous Materials, USEPA, Washington, D.C. EPA 440-9-76-023. July 26, 1976.

USEPA, 1980. USEPA Ambient Water Quality for Phthalate Esters. Office of Water, Regulations and Standards, Criteria and Standards Division, USEPA, Washington, D.C. EPA 440/5-80-067. October 1980.

USEPA, 1999. Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers. Habitat Assessment Field Sheets for Low Gradient Streams. Office of Water, USEPA, Washington, D.C. EPA 841-B-99-002. July 1999.

USEPA, 2006. EPA Region 3 BTAG Freshwater Screening Benchmarks. July 2006. https://www.epa.gov/sites/production/files/2015-09/documents/r3_btag_fw_benchmarks_07-06.pdf

USEPA, 2009. Ecological Structure Activity Relationships (ECOSAR) Database v.1.11. https://www.epa.gov/tsca-screening-tools/ecological-structure-activity-relationships-ecosar-predictive-model

USEPA, 2013. Aquatic Life Ambient Water Quality Criteria For Ammonia Freshwater – 2013. https://www.epa.gov/sites/production/files/2015-08/documents/aquatic-life-ambient-water-quality-criteria-for-ammonia-freshwater-2013.pdf

USEPA, 2015. Letter from USEPA to Olin Corporation regarding "Review and Conditional Approval; Draft Final Remedial Investigation report and Risk Assessment Report; Operable Units 1 and 2 dated April 10, 2014"; July 2, 2015.

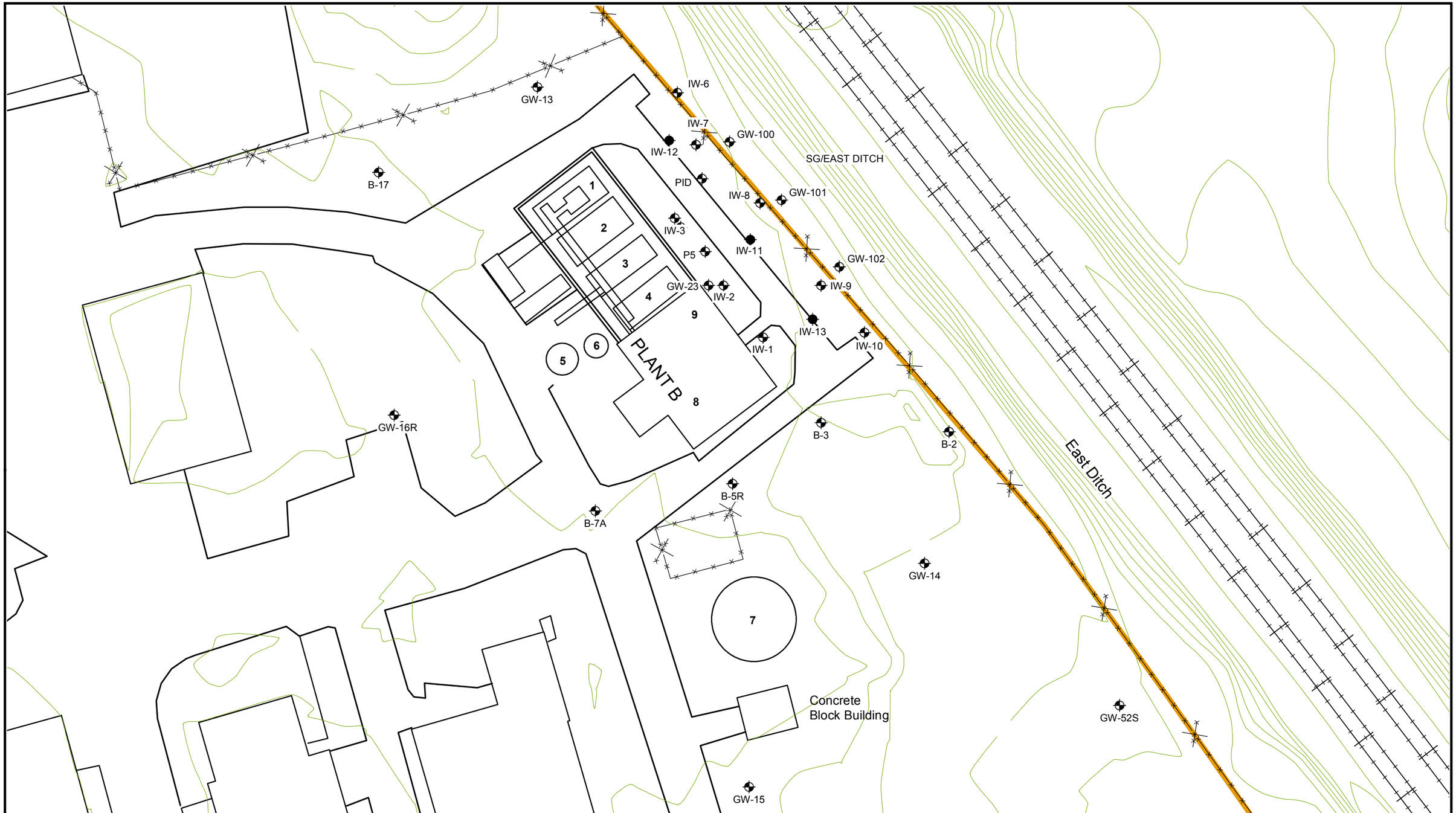
USEPA, 2016. "Software for Calculating Upper Confidence Limits. ProUCL Version 5.1" Technical Support Center for Monitoring and Site Characterization. https://www.epa.gov/land-research/proucl-software

USEPA, 2018a. Regional Ecological Risk Assessment (ERA) Supplemental Guidance. USEPA Region 4 Superfund Division's Scientific Support Section. March 2018. https://www.epa.gov/sites/production/files/2018-03/documents/era_regional_supplemental_guidance_report-march-2018_update.pdf

USEPA, 2018b. USEPA Regional Screening Levels. November 2018. https://www.epa.gov/risk/regional-screening-levels-rsls

United States Environmental Protection Agency (USEPA), 2019. National Recommended Water Quality Criteria - Aquatic Life Criteria Table. Last updated March 13, 2019. https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table

FIGURES AND TABLES



Tank #1 - Receives gravity overflow from Tank 2
and allows for further settling
Tank #2 - Caustic addition and initial iron drop-out
Tank #3 & #4 - Overnight holding tank for treated water
Tank #5 - Pre-carbon hold tank
Tank #6 - Residence tank
Tank #7 - Raw water (pH adjusted)
Tank #8 - Pre-carbon transfer
Tank #9 - Day discharge to NPDES Outfall 002

Legend

- Monitoring Well
- Recovery Well
- Elevation Contours

amec foster wheeler

Amec Foster Wheeler
Environment & Infrastructure, Inc.
271 Mill Rd
Chelmsford, MA 01824

N

0 15 30 60 Feet

Figure 2.2-12
Plant B Monitoring Program
Sampling Locations

OU3 Remedial Investigation
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: EFG 03/14/18 | Checked/Date: JBR 03/14/18

Document: P:\old_Wakefield_Data\projects\OLIN\Wilmington\GIS\MapDocuments\Interim Response Work Plan\Olin_PlantB_11X17_LS.mxd PDF: P:\old_Wakefield_Data\projects\OLIN\Wilmington\GIS\Figures\Figure 3 - Plant B Monitoring Program Sampling Locations.pdf

Table B-1
Groundwater Analytical Data for Plant B near the East Ditch
Olin Wilmington
Wilmington, MA

					Media	GW		GW		GW		GW		GW		GW		GW		GW		GW		GW		GW	
					Location	B-03		B-03		B-03		B-03		B-03		B-03		B-03		B-03		B-03		B-03		GW-101	
					Sample Date	5/10/2010		10/11/2010		11/18/2010		11/9/2011		11/14/2012		11/19/2013		11/20/2013		11/5/2014		11/5/2015		11/5/2015		12/6/2016		11/14/2017		11/28/2018		5/12/2010	
					Sample ID	OC-B-03-XXX		OC-B-03-XXX		OC-B-03		OC-B-03		OC-B-03		OC-B-03		OC-B-03		OC-B-03		OC-B-03		OC-DUP-3 GW		OC-B-03		OC-B-03		OC-B-03		OC-GW-101-XXX	
					Qc Code	FS		FS		FS		FS		FS		FS		FS		FS		FS		FD		FS		FS		FS		FS	
Parameter	**CASRN**	**CCC [1]**	**SQuiRTs [2]**	**Region IV [3]**	**BTAG [4]**	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
NDMA (ug/L)																																	
N-Nitrosodimethylamine	62-75-9	NA	NA	NA	117	0.0019	U	0.0019	UJ																							0.018	
VOCs (ug/L)																																	
1,1,2-Trichloro-1,2,2-Trifluoroethane	76-13-1	NA	NA	NA	NA	1	U	1	U																							2	U
2,4,4-Trimethyl-1-pentene	107-39-1	15*	NA	NA	NA	1	U	1.7		1	U	1	U	1	U			1	U	1	U	0.5	J	1	U	1	U	1	U	1	U	210	
2,4,4-Trimethyl-2-pentene	107-40-4	18*	NA	NA	NA	1	U	1	U	1	U	1	U	1	U			1	U	1	U	1	U	1	U	1	U	1	U	1	U	41	
Acetone	67-64-1	NA	1500	1700	1500	50	UJ	50	U																							100	UJ
Carbon disulfide	75-15-0	NA	0.92	15	0.92	10	U	10	U																							20	U
Chloromethane	74-87-3	NA	NA	NA	NA	2	U	2	U																							4	U
Tetrahydrofuran	109-99-9	NA	NA	11000	NA	10	U	10	U																							20	U
Trichloroethene	79-01-6	NA	21	220	21	1	U	1	U																							2	U
SVOCs (ug/L)																																	
Aniline	62-53-3	NA	2.2	4.1	2.2	4.8	UJ	4.5	UJ																							1	J
Biphenyl	92-52-4	NA	14	6.5	14	4.8	U	4.5	U																							0.79	J
Bis(2-Ethylhexyl)phthalate	117-81-7	NA	0.3	8	16	2.2	U	1.8	U	1.8	UJ	1.9	U	1.9	U	2.1	U			1.9	U	4.9	U	4.8	U	52	U	0.73	J	26	U	1.8	U
Carbazole	86-74-8	NA	NA	4	NA	4.8	U	4.5	U																							4.5	U
Diphenyl ether	101-84-8	NA	NA	NA	NA	4.8	U	4.5	U																							8.1	
Diphenylamine	122-39-4	NA	NA	NA	NA																											67	J
N-Nitrosodiphenylamine	86-30-6	NA	210	25	210	4.8	U	1.1	J	0.86	J	1.7	J	4.8	UJ	5.2	U			0.34	J	4.9	U	0.47	J	52	U	0.61	J	0.43	J	120	
Phenol	108-95-2	NA	180	160	4	4.8	UJ	4.5	UJ																							4.5	UJ
EPH/VPH (ug/L)																																	
Benzo(ghi)perylene	191-24-2	NA	7.64	0.012	NA																												
C11-C22 Aromatics Adjusted	HLA0108	NA	NA	NA	NA																											180	
Dibenz(a,h)anthracene	53-70-3	NA	NA	0.012	0																												
Indeno(1,2,3-cd)pyrene	193-39-5	NA	4.31	0.012	0																												
Benzene	71-43-2	NA	46	160	370					4	U	4	U	1	U			1	U	1	U	1	U	1	U	1	U	1	U	1	U		
C5-C8 Aliphatics	HLA0155	NA	NA	NA	NA					200	U	200	U	10	U			5	U	5	U	5	U	5	U	5	U	100	U	9.2		50	U
C9-C10 Aromatics	HLA0156	NA	NA	NA	NA					200	U	200	U	0.89	J			5	U			5	U	5	U							50	U
C9-C12 Aliphatics	HLA0154	NA	NA	NA	NA					200	U	200	U	10	U			5	U	5	U	5	U	5	U	5	U	85	J	2.6	J	50	U
Ethylbenzene	100-41-4	NA	7.3	61	90					4	U	4	U	1	U			0.35	J	1	U	1	U	1	U	1	U	1	U	1	U		
Methyl Tertbutyl Ether	1634-04-4	NA	10000	730	11070					4	U	4	U	1	U			1	U	1	U	1	U	1	U	1	U	3	U	1	U		
Toluene	108-88-3	NA	2	62	2					4	U	4	U	1	U			0.58	J	1	U	1	U	1	U	1	U	3	U	1	U		
Xylene, o	95-47-6	NA	350	NA	NA					4	U	4	U	1	U			0.32	J	1	U	1	U	1	U	1	U	2	U	1	U		
Xylenes (m&p)	179601-23	NA	1.8	NA	1.8					8	U	8	U	2	U			1.7	J	2	U	2	U	2	U	2	U	4	U	2	U		
Non Standard Analysis/Fuel Oils (ug/L)																																	
4-Nonylphenol (Tech.)	84852-15-3	6.6	NA	1	NA																											2.7	J
Total Metals (ug/L)																																	
Aluminum	7429-90-5	NA	87	87	87	300		89	J																							100	U
Antimony	7440-36-0	NA	30	190	30	6	U	1.5	J																							6	U
Arsenic	7440-38-2	150	190	150	5	1	U	1	U																							5.9	
Barium	7440-39-3	NA	3.9	220	4	15		12																								24	
Cadmium	7440-43-9	0.72	0.25	NA	0.25	1	U	0.14	J																							1	U
Calcium	7440-70-2	NA	NA	116000	116000	3200		7000																								20000	
Chromium, Hexavalent	18540-29-9	11	11	11	11																											1	U
Cobalt	7440-48-4	NA	3	19	23	10	U	10	U																							3.8	J
Copper	7440-50-8	NA	9	NA	9	4.9	J	10	U																							10	U
Iron	7439-89-6	1000	1000	1000	300	110		210																								2100	
Magnesium	7439-95-4	NA	NA	82000	82000	280	J	480																								2500	
Manganese	7439-96-5	NA	80	93	120	28		38																								200	
Nickel	7440-02-0	52	52	28.9	52	2.8	J	1.2	J																							3.8	J
Potassium	7440-09-7	NA	NA	53000	53000	4000	U	4000	U																							3500	J
Sodium	7440-23-5	NA	NA	680000	680000	1200	J	1700	J																							16000	
Vanadium	7440-62-2	NA	19	27	20	10	U	1.7	J																							10	U
Zinc	7440-66-6	120	120	NA	120	14	J	8.7	J																							50	U
Dissolved Metals (ug/L)																																	
Iron	7439-89-6	1000	1000	1000	300					100	U	17	J	50	U	50	U			50	U	31	J	31	J	50	U	450		310			
Inorganics & Wet Chem (ug/L)																																	
Nitrogen, as Ammonia	HLA0043	36000	NA	NA	19	170		120	U	210		340		20	U	20				570		340	J	200		400		300	U	270	U	1900	
Bromide	24959-67-9	NA	NA	NA	NA	100	U	100	U																							100	U
Chloride	16887-00-6	230000	NA	230000	230000	2000		1500																								19000	
Nitrate as N	14797-55-8	NA	NA	NA	NA	930		1400																								2900	
Sulfate	14808-79-8	NA	NA	NA	NA	3300		5300																								30000	

Notes

1. USEPA Freshwater Ambient Water Quality Criteria - Chronic Continuous Concentration
2. Suter, G.W, & C.L. Tsao, 1997. Oak Ridge National Laboratory Tier II Secondary Chronic Values. Cited in Buchman, 2008, Screening Quick Reference Tables
3. USEPA Region 4 freshwater chronic values. Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment
4. USEPA Region 3 BTAG Screening Benchmarks for Freshwater

An asterisk (*) indicates an ECOSAR based criterion (not an AWQC).
All concentrations are in ug/L (micrograms per liter)

Abbreviations:
U: not detected
J: estimated value
FS: field sample
FD: field duplicate

Table B-1
Groundwater Analytical Data for Plant B near the East Ditch
Olin Wilmington
Wilmington, MA

					Media	GW		GW		GW		GW		GW		GW		GW		GW		GW		GW		GW	
					Location	GW-101		GW-101		GW-101		GW-101		GW-101		GW-101		GW-101		GW-101		GW-13		GW-13		GW-13	
					Sample Date	10/11/2010		11/18/2010		11/9/2011		11/15/2012		11/20/2013		11/5/2014		11/5/2015		12/6/2016		11/14/2017		11/27/2018		5/10/2010		10/12/2010		11/18/2010		11/10/2011	
					Sample ID	OC-GW-101-XXX		OC-GW-101		OC-GW-101		OC-GW-101		OC-GW-101		OC-GW-101		OC-GW-101		OC-GW-101		OC-GW-101		OC-GW-101		OC-GW-13-XXX		OC-GW-13-XXX		OC-GW-13		OC-GW-13	
					Qc Code	FS		FS		FS		FS		FS		FS		FS		FS		FS		FS		FS		FS		FS		FS	
Parameter	**CASRN**	**CCC [1]**	**SQuiRTs [2]**	**Region IV [3]**	**BTAG [4]**	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
NDMA (ug/L)																																	
N-Nitrosodimethylamine	62-75-9	NA	NA	NA	117	0.0019	UJ																			0.0048		0.047	J				
VOCs (ug/L)																																	
1,1,2-Trichloro-1,2,2-Trifluoroethane	76-13-1	NA	NA	NA	NA	0.81	J																	10	U	1	U	1	U				
2,4,4-Trimethyl-1-pentene	107-39-1	15*	NA	NA	NA	110		160		81	J	39		260		92		100		170		150		630		1	U	5.4		1	U	1	U
2,4,4-Trimethyl-2-pentene	107-40-4	18*	NA	NA	NA	36		23		14		6.2	J	34		19	J	39	J	41		26		230		1	U	1.5		1	U	1	U
Acetone	67-64-1	NA	1500	1700	1500	50	U																	500	U	50	UJ	50	U				
Carbon disulfide	75-15-0	NA	0.92	15	0.92	1.6	J																	100	U	10	U	10	U				
Chloromethane	74-87-3	NA	NA	NA	NA	2	U																	20	U	2	U	2	U				
Tetrahydrofuran	109-99-9	NA	NA	11000	NA	10	U																	100	U	10	U	3.2	J				
Trichloroethene	79-01-6	NA	21	220	21	1	U																	10	U	1	U	1	U				
SVOCs (ug/L)																																	
Aniline	62-53-3	NA	2.2	4.1	2.2	0.68	J																	12		4.5	UJ	4.5	UJ				
Biphenyl	92-52-4	NA	14	6.5	14	4.5	U																	6.3	J	4.5	U	4.5	U				
Bis(2-Ethylhexyl)phthalate	117-81-7	NA	0.3	8	16	1	J	2.7	UJ	2.6		1.9	U	1.6	J	4.9	U	1.6	J	4.9	J	2.6	J	25	U	1.8	U	1.8	U	1.8	UJ	0.89	J
Carbazole	86-74-8	NA	NA	4	NA	4.5	U																	1.3	J	4.5	U	4.5	U				
Diphenyl ether	101-84-8	NA	NA	NA	NA	4.5																				4.5	U	2.4	J				
Diphenylamine	122-39-4	NA	NA	NA	NA	4.5	U																										
N-Nitrosodiphenylamine	86-30-6	NA	210	25	210	7.3		12		340		44	J	58		110		190		36	J	120		850		4.5	U	4.5	U	4.5	U	4.7	U
Phenol	108-95-2	NA	180	160	4	4.5	UJ																	5	U	4.5	UJ	4.5	UJ				
EPH/VPH (ug/L)																																	
Benzo(ghi)perylene	191-24-2	NA	7.64	0.012	NA																			2.8	J								
C11-C22 Aromatics Adjusted	HLA0108	NA	NA	NA	NA	91	U																	780									
Dibenz(a,h)anthracene	53-70-3	NA	NA	0.012	0																			10	U								
Indeno(1,2,3-cd)pyrene	193-39-5	NA	4.31	0.012	0																			10	U								
Benzene	71-43-2	NA	46	160	370			1	U	1	U	10	U	10	U	1	U	1	U	10	U	1	U	10	U					1	U	1	U
C5-C8 Aliphatics	HLA0155	NA	NA	NA	NA	170		190		370		65		170		110		84		250		300		1100						50	U	50	U
C9-C10 Aromatics	HLA0156	NA	NA	NA	NA	50	U	50	U	50	U	100	U	50	U			1.1	J											50	U	50	U
C9-C12 Aliphatics	HLA0154	NA	NA	NA	NA	50	U	50	U	50	U	10	U	50	U	2.9	J	5		50	U	110		48	J					50	U	50	U
Ethylbenzene	100-41-4	NA	7.3	61	90			1	U	1	U	10	U	10	U	1	U	1	U	10	U	1	U	10	U					1	U	1	U
Methyl Tertbutyl Ether	1634-04-4	NA	10000	730	11070			1	U	1	U	10	U	10	U	1	U	1.1		2.7	J	3	U	10	U					1	U	1	U
Toluene	108-88-3	NA	2	62	2			1	U	1	U	10	U	10	U	0.81	J	1.1		2.6	J	3	U	2.8	J					1	U	1	U
Xylene, o	95-47-6	NA	350	NA	NA			1	U	1	U	10	U	10	U	1	U	0.31	J	10	U	2	U	19						1	U	1	U
Xylenes (m&p)	179601-23	NA	1.8	NA	1.8			2	U	2	U	20	U	20	U	2	U	2	U	20	U	4	U	20	U					2	U	2	U
Non Standard Analysis/Fuel Oils (ug/L)																																	
4-Nonylphenol (Tech.)	84852-15-3	6.6	NA	1	NA	4.8	U																										
Total Metals (ug/L)																																	
Aluminum	7429-90-5	NA	87	87	87	100	U																			65	J	120					
Antimony	7440-36-0	NA	30	190	30	6	UJ																			6	U	6	U				
Arsenic	7440-38-2	150	190	150	5	18	J																			1	U	1	U				
Barium	7440-39-3	NA	3.9	220	4	150																				10		16					
Cadmium	7440-43-9	0.72	0.25	NA	0.25	1	U																			0.2	J	0.37	J				
Calcium	7440-70-2	NA	NA	116000	116000	64000																				2800		6900					
Chromium, Hexavalent	18540-29-9	11	11	11	11	0.71	J																										
Cobalt	7440-48-4	NA	3	19	23	12																				10	U	3.1	J				
Copper	7440-50-8	NA	9	NA	9	10	U																			4.4	J	10	U				
Iron	7439-89-6	1000	1000	1000	300	6000																				170		350					
Magnesium	7439-95-4	NA	NA	82000	82000	11000																				530		1200					
Manganese	7439-96-5	NA	80	93	120	540																				28		83					
Nickel	7440-02-0	52	52	28.9	52	7	J																			1.6	J	3.1	J				
Potassium	7440-09-7	NA	NA	53000	53000	5200																				4000	U	4000	U				
Sodium	7440-23-5	NA	NA	680000	680000	240000																				1900	J	5800					
Vanadium	7440-62-2	NA	19	27	20	10	UJ																			10	U	10	U				
Zinc	7440-66-6	120	120	NA	120	20	J																			93		130					
Dissolved Metals (ug/L)																																	
Iron	7439-89-6	1000	1000	1000	300			6300		7500		3900		6600		6800		5900		14000		8100		4600						100	U	70	J
Inorganics & Wet Chem (ug/L)																																	
Nitrogen, as Ammonia	HLA0043	36000	NA	NA	19	1700		950		1200		6000		4800		1900		1400		1900		2600		1600	J	200		330	U	100	U	190	
Bromide	24959-67-9	NA	NA	NA	NA	200																				100	U	100	U				
Chloride	16887-00-6	230000	NA	230000	230000	610000																				4500		13000					
Nitrate as N	14797-55-8	NA	NA	NA	NA	50	U																			57		50	U				
Sulfate	14808-79-8	NA	NA	NA	NA	32000																				5700		14000					

Notes

1. USEPA Freshwater Ambient Water Quality Criteria - Chronic Continuous Concentration
2. Suter, G.W, & C.L. Tsao, 1997. Oak Ridge National Laboratory Tier II Secondary Chronic Values. Cited in Buchman, 2008, Screening Quick Reference Tables
3. USEPA Region 4 freshwater chronic values. Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment
4. USEPA Region 3 BTAG Screening Benchmarks for Freshwater

An asterisk (*) indicates an ECOSAR based criterion (not an AWQC).
All concentrations are in ug/L (micrograms per liter)

Abbreviations:
U: not detected
J: estimated value
FS: field sample
FD: field duplicate

Table B-1
Groundwater Analytical Data for Plant B near the East Ditch
Olin Wilmington
Wilmington, MA

					Media	GW		GW		GW		GW		GW		GW		GW		GW		GW		GW		GW	
					Location	GW-13		GW-13		GW-13		GW-13		GW-13		GW-13		IW-10		IW-10		IW-10		IW-10		IW-10	
					Sample Date	11/14/2012		11/20/2013		11/5/2014		11/5/2015		12/6/2016		11/14/2017		11/28/2018		11/18/2010		11/9/2011		11/14/2012		11/19/2013		11/20/2013		11/5/2014		11/6/2015	
					Sample ID	OC-GW-13		OC-GW-13		OC-GW-13		OG-GW-13		OC-GW-13		OC-GW-13		OC-GW-13		OC-IW-10		OC-IW-10		OC-IW-10		OC-IW-10		OC-IW-10		OC-IW-10		OC-IW-10	
					Qc Code	FS		FS		FS		FS		FS		FS		FS		FS		FS		FS		FS		FS		FS		FS	
Parameter	**CASRN**	**CCC [1]**	**SQuiRTs [2]**	**Region IV [3]**	**BTAG [4]**	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
NDMA (ug/L)																																	
N-Nitrosodimethylamine	62-75-9	NA	NA	NA	117																												
VOCs (ug/L)																																	
1,1,2-Trichloro-1,2,2-Trifluoroethane	76-13-1	NA	NA	NA	NA																												
2,4,4-Trimethyl-1-pentene	107-39-1	15*	NA	NA	NA	1	U	1	U	4.5		11		7		2.1		1.1		1.7		2.4		1	U			3.3		0.96	J	7.6	
2,4,4-Trimethyl-2-pentene	107-40-4	18*	NA	NA	NA	0.79	J	1	U	1.7	J	3.8	J	3.1		0.55	J	1	U	0.73	J	0.96	J	2.1	J			2.9		0.75	J	8.6	J
Acetone	67-64-1	NA	1500	1700	1500																												
Carbon disulfide	75-15-0	NA	0.92	15	0.92																												
Chloromethane	74-87-3	NA	NA	NA	NA																												
Tetrahydrofuran	109-99-9	NA	NA	11000	NA																												
Trichloroethene	79-01-6	NA	21	220	21																												
SVOCs (ug/L)																																	
Aniline	62-53-3	NA	2.2	4.1	2.2																												
Biphenyl	92-52-4	NA	14	6.5	14																												
Bis(2-Ethylhexyl)phthalate	117-81-7	NA	0.3	8	16	2	U	2.1	U	1.9	U	2.2	J	5.2	U	0.42	J	0.55	J	1.8	UJ	0.91	J	2	U	2.1	U			1.9	U	0.44	J
Carbazole	86-74-8	NA	NA	4	NA																												
Diphenyl ether	101-84-8	NA	NA	NA	NA																												
Diphenylamine	122-39-4	NA	NA	NA	NA																												
N-Nitrosodiphenylamine	86-30-6	NA	210	25	210	5	UJ	5.2	U	4.8	U	4.9	U	5.2	U	5	U	5.3	U	4.5	U	4.7	U	5	UJ	0.41	J			4.8	U	4.8	U
Phenol	108-95-2	NA	180	160	4																												
EPH/VPH (ug/L)																																	
Benzo(ghi)perylene	191-24-2	NA	7.64	0.012	NA																												
C11-C22 Aromatics Adjusted	HLA0108	NA	NA	NA	NA																												
Dibenz(a,h)anthracene	53-70-3	NA	NA	0.012	0																												
Indeno(1,2,3-cd)pyrene	193-39-5	NA	4.31	0.012	0																												
Benzene	71-43-2	NA	46	160	370	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	10	U			10	U	1	U	1	U
C5-C8 Aliphatics	HLA0155	NA	NA	NA	NA	10		5	U	11		10		21		100	U	19		50	U	50	U	10	U			50	U	5	U	9.5	
C9-C10 Aromatics	HLA0156	NA	NA	NA	NA	10	U	5	U			5	U							50	U	50	U	100	U			50	U			0.54	J
C9-C12 Aliphatics	HLA0154	NA	NA	NA	NA	10	U	5	U	5	U	5	U	5	U	85	J	5	U	50	U	50	U	10	U			50	U	5	U	5	U
Ethylbenzene	100-41-4	NA	7.3	61	90	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	10	U			10	U	1	U	1	U
Methyl Tertbutyl Ether	1634-04-4	NA	10000	730	11070	1	U	1	U	1	U	1	U	1		3	U	1	U	1	U	1	U	10	U			10	U	1	U	1	U
Toluene	108-88-3	NA	2	62	2	1	U	1	U	1	U	1	U	1	U	3	U	1	U	1	U	1	U	10	U			10	U	1	U	1	U
Xylene, o	95-47-6	NA	350	NA	NA	1.5		1	U	1	U	1	U	1	U	2	U	0.28	J	1	U	1	U	10	U			10	U	1	U	1	U
Xylenes (m&p)	179601-23	NA	1.8	NA	1.8	2	U	2	U	2	U	2	U	2	U	4	U	2	U	2	U	2	U	20	U			20	U	2	U	2	U
Non Standard Analysis/Fuel Oils (ug/L)																																	
4-Nonylphenol (Tech.)	84852-15-3	6.6	NA	1	NA																												
Total Metals (ug/L)																																	
Aluminum	7429-90-5	NA	87	87	87																												
Antimony	7440-36-0	NA	30	190	30																												
Arsenic	7440-38-2	150	190	150	5																												
Barium	7440-39-3	NA	3.9	220	4																												
Cadmium	7440-43-9	0.72	0.25	NA	0.25																												
Calcium	7440-70-2	NA	NA	116000	116000																												
Chromium, Hexavalent	18540-29-9	11	11	11	11																												
Cobalt	7440-48-4	NA	3	19	23																												
Copper	7440-50-8	NA	9	NA	9																												
Iron	7439-89-6	1000	1000	1000	300																												
Magnesium	7439-95-4	NA	NA	82000	82000																												
Manganese	7439-96-5	NA	80	93	120																												
Nickel	7440-02-0	52	52	28.9	52																												
Potassium	7440-09-7	NA	NA	53000	53000																												
Sodium	7440-23-5	NA	NA	680000	680000																												
Vanadium	7440-62-2	NA	19	27	20																												
Zinc	7440-66-6	120	120	NA	120																												
Dissolved Metals (ug/L)																																	
Iron	7439-89-6	1000	1000	1000	300	45	J	50	U	130		180		680		4400		74		58	J	750		26	J	5000				710		100	
Inorganics & Wet Chem (ug/L)																																	
Nitrogen, as Ammonia	HLA0043	36000	NA	NA	19	20	U	20	U	200	U	110	J	110	J	240	U	210	U	56000		60000		68000		57000				48000		66000	
Bromide	24959-67-9	NA	NA	NA	NA																												
Chloride	16887-00-6	230000	NA	230000	230000																												
Nitrate as N	14797-55-8	NA	NA	NA	NA																												
Sulfate	14808-79-8	NA	NA	NA	NA																												

Notes

1. USEPA Freshwater Ambient Water Quality Criteria - Chronic Continuous Concentration
2. Suter, G.W, & C.L. Tsao, 1997. Oak Ridge National Laboratory Tier II Secondary Chronic Values. Cited in Buchman, 2008, Screening Quick Reference Tables
3. USEPA Region 4 freshwater chronic values. Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment
4. USEPA Region 3 BTAG Screening Benchmarks for Freshwater

An asterisk (*) indicates an ECOSAR based criterion (not an AWQC).
All concentrations are in ug/L (micrograms per liter)

Abbreviations:
U: not detected
J: estimated value
FS: field sample
FD: field duplicate

Table B-1
Groundwater Analytical Data for Plant B near the East Ditch
Olin Wilmington
Wilmington, MA

					Media	GW		GW		GW		GW		GW		GW		GW		GW		GW		GW	
					Location	IW-10		IW-10		IW-10		IW-6		IW-6		IW-6		IW-6		IW-6		IW-6		IW-6	
					Sample Date	12/6/2016		11/14/2017		11/27/2018		11/18/2010		11/9/2011		11/14/2012		11/20/2013		11/5/2014		11/5/2015		12/6/2016		11/14/2017		11/27/2018	
					Sample ID	OC-IW-10		OC-IW-10		OC-IW-10		OC-IW-6		OC-IW-6		OC-IW-6		OC-IW-6		OC-IW-6		OC-IW-6		OC-IW-6		OC-IW-6		OC-IW-6	
					Qc Code	FS		FS		FS		FS		FS		FS		FS		FS		FS		FS		FS		FS	
Parameter	**CASRN**	**CCC [1]**	**SQuiRTs [2]**	**Region IV [3]**	**BTAG [4]**	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
NDMA (ug/L)																													
N-Nitrosodimethylamine	62-75-9	NA	NA	NA	117																								
VOCs (ug/L)																													
1,1,2-Trichloro-1,2,2-Trifluoroethane	76-13-1	NA	NA	NA	NA					1	U																	1	U
2,4,4-Trimethyl-1-pentene	107-39-1	15*	NA	NA	NA	3.6		3.2		5.5		1100		250		900		1200		1400		940		1400		1100		450	
2,4,4-Trimethyl-2-pentene	107-40-4	18*	NA	NA	NA	4.1		2.4		6.4		130		20		140	J	200		270	J	210	J	350		170		93	
Acetone	67-64-1	NA	1500	1700	1500					50	U																	12	J
Carbon disulfide	75-15-0	NA	0.92	15	0.92					10	U																	10	U
Chloromethane	74-87-3	NA	NA	NA	NA					2	U																	0.79	J
Tetrahydrofuran	109-99-9	NA	NA	11000	NA					10	U																	10	U
Trichloroethene	79-01-6	NA	21	220	21					1	U																	0.54	J
SVOCs (ug/L)																													
Aniline	62-53-3	NA	2.2	4.1	2.2					5	U																	0.5	U
Biphenyl	92-52-4	NA	14	6.5	14					50	U																	5	U
Bis(2-Ethylhexyl)phthalate	117-81-7	NA	0.3	8	16	0.96	J	1.6	J	50	U	1.8	UJ	0.49	J	2	U	2	U	5.5		0.6	J	0.52	J	0.58	J	0.64	J
Carbazole	86-74-8	NA	NA	4	NA					50	U																	5	U
Diphenyl ether	101-84-8	NA	NA	NA	NA																								
Diphenylamine	122-39-4	NA	NA	NA	NA																								
N-Nitrosodiphenylamine	86-30-6	NA	210	25	210	1.2	J	1.3	J	50	U	0.73	J	0.73	J	0.51	J	0.69	J	0.92	J	4.9	U	0.87	J	1	J	0.28	J
Phenol	108-95-2	NA	180	160	4					13																		1	U
EPH/VPH (ug/L)																													
Benzo(ghi)perylene	191-24-2	NA	7.64	0.012	NA					9.8	J																	4.2	J
C11-C22 Aromatics Adjusted	HLA0108	NA	NA	NA	NA					540																		50	U
Dibenz(a,h)anthracene	53-70-3	NA	NA	0.012	0					5.8	J																	3.4	J
Indeno(1,2,3-cd)pyrene	193-39-5	NA	4.31	0.012	0					3	J																	10	U
Benzene	71-43-2	NA	46	160	370	1	U	1	U	1	U	1	U	1	U	100	U	20	U	2.5		2		10	U	1	U	10	U
C5-C8 Aliphatics	HLA0155	NA	NA	NA	NA	8.1		100	U	32		1600		790		1300		710		480		660		1900		1100		420	
C9-C10 Aromatics	HLA0156	NA	NA	NA	NA							50	U	50	U	1000	U	100	U			1.4	J						
C9-C12 Aliphatics	HLA0154	NA	NA	NA	NA	5	U	100	U	5	U	50	U	50	U	10	U	55	J	50		33		50	U	350	U	180	
Ethylbenzene	100-41-4	NA	7.3	61	90	1	U	1	U	1	U	1	U	1	U	100	U	20	U	3.3		1.1		10	U	1	U	10	U
Methyl Tertbutyl Ether	1634-04-4	NA	10000	730	11070	1	U	3	U	1	U	1	U	1	U	100	U	20	U	4.9	B	3.7		8.7	J	3	U	10	U
Toluene	108-88-3	NA	2	62	2	1	U	3	U	1	U	1	U	1	U	100	U	20	U	23		9.5		3	J	1.4	J	10	U
Xylene, o	95-47-6	NA	350	NA	NA	1	U	2	U	0.62	J	13		1	U	100	U	20	U	3.5		3.3		10	U	2	U	7.8	J
Xylenes (m&p)	179601-23	NA	1.8	NA	1.8	2	U	4	U	2	U	2	U	2	U	200	U	40	U	2	U	2	U	20	U	4	U	20	U
Non Standard Analysis/Fuel Oils (ug/L)																													
4-Nonylphenol (Tech.)	84852-15-3	6.6	NA	1	NA																								
Total Metals (ug/L)																													
Aluminum	7429-90-5	NA	87	87	87																								
Antimony	7440-36-0	NA	30	190	30																								
Arsenic	7440-38-2	150	190	150	5																								
Barium	7440-39-3	NA	3.9	220	4																								
Cadmium	7440-43-9	0.72	0.25	NA	0.25																								
Calcium	7440-70-2	NA	NA	116000	116000																								
Chromium, Hexavalent	18540-29-9	11	11	11	11																								
Cobalt	7440-48-4	NA	3	19	23																								
Copper	7440-50-8	NA	9	NA	9																								
Iron	7439-89-6	1000	1000	1000	300																								
Magnesium	7439-95-4	NA	NA	82000	82000																								
Manganese	7439-96-5	NA	80	93	120																								
Nickel	7440-02-0	52	52	28.9	52																								
Potassium	7440-09-7	NA	NA	53000	53000																								
Sodium	7440-23-5	NA	NA	680000	680000																								
Vanadium	7440-62-2	NA	19	27	20																								
Zinc	7440-66-6	120	120	NA	120																								
Dissolved Metals (ug/L)																													
Iron	7439-89-6	1000	1000	1000	300	250		230		290		8000		3100		8000		5300		9200		6000		16000		11000		28000	
Inorganics & Wet Chem (ug/L)																													
Nitrogen, as Ammonia	HLA0043	36000	NA	NA	19	79000		52000		37000		610		200		490		500		670	J	590		650		850		1200	U
Bromide	24959-67-9	NA	NA	NA	NA																								
Chloride	16887-00-6	230000	NA	230000	230000																								
Nitrate as N	14797-55-8	NA	NA	NA	NA																								
Sulfate	14808-79-8	NA	NA	NA	NA																								

Notes

1. USEPA Freshwater Ambient Water Quality Criteria - Chronic Continuous Concentration
2. Suter, G.W, & C.L. Tsao, 1997. Oak Ridge National Laboratory Tier II Secondary Chronic Values. Cited in Buchman, 2008, Screening Quick Reference Tables
3. USEPA Region 4 freshwater chronic values. Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment
4. USEPA Region 3 BTAG Screening Benchmarks for Freshwater

An asterisk (*) indicates an ECOSAR based criterion (not an AWQC).
All concentrations are in ug/L (micrograms per liter)

Abbreviations:
U: not detected
J: estimated value
FS: field sample
FD: field duplicate

Prepared by: KS 4/29/2019
Checked by: JPK 5/2/2019

Table B-2
Statistical Summar of Groundwater Data and Comparison to Ecological Screening Criteria
Olin Wilmington
Wilmington, MA

	Parameter	fraction	CASRN	Units	Frequency of Detection		Minimum Detect		Maximum Detect		Ave of Detects	Loc of max hit	Count of NDs	Min ND	Max ND
Method Class					# Detcts	# Samples		Qualifier		Qualifier					
NDMA only	N-Nitrosodimethylamine	N	62-75-9	ug/L	3	6	0.0048		0.047	J	0.02	GW-13	3	0.0019	0.0019
VOCs	1,1,2-Trichloro-1,2,2-Trifluoroethane	N	76-13-1	ug/L	1	9	0.81	J	0.81	J	0.81	GW-101	8	1	10
VOCs	2,4,4-Trimethyl-1-pentene	N	107-39-1	ug/L	36	51	0.5	J	1400		300.1	IW-6	15	1	1
VOCs	2,4,4-Trimethyl-2-pentene	N	107-40-4	ug/L	35	51	0.55	J	350		60.93	IW-6	16	1	1
VOCs	Acetone	N	67-64-1	ug/L	1	9	12	J	12	J	12	IW-6	8	50	500
VOCs	Carbon disulfide	N	75-15-0	ug/L	1	9	1.6	J	1.6	J	1.6	GW-101	8	10	100
VOCs	Chloromethane	N	74-87-3	ug/L	1	9	0.79	J	0.79	J	0.79	IW-6	8	2	20
VOCs	Tetrahydrofuran	N	109-99-9	ug/L	1	9	3.2	J	3.2	J	3.2	GW-13	8	10	100
VOCs	Trichloroethene	N	79-01-6	ug/L	1	9	0.54	J	0.54	J	0.54	IW-6	8	1	10
SVOCs	Aniline	N	62-53-3	ug/L	3	9	0.68	J	12		4.56	GW-101	6	0.5	5
SVOCs	Biphenyl	N	92-52-4	ug/L	2	9	0.79	J	6.3	J	3.55	GW-101	7	4.5	50
SVOCs	Bis(2-Ethylhexyl)phthalate	N	117-81-7	ug/L	21	51	0.42	J	5.5		1.49	IW-6	30	1.8	52
SVOCs	Carbazole	N	86-74-8	ug/L	1	9	1.3	J	1.3	J	1.3	GW-101	8	4.5	50
SVOCs	Diphenyl ether	N	101-84-8	ug/L	3	6	2.4	J	8.1		5	GW-101	3	4.5	4.8
SVOCs	Diphenylamine	N	122-39-4	ug/L	1	2	67	J	67	J	67	GW-101	1	4.5	4.5
SVOCs	N-Nitrosodiphenylamine	N	86-30-6	ug/L	29	51	0.28	J	850		65.57	GW-101	22	4.5	52
SVOCs	Phenol	N	108-95-2	ug/L	1	9	13		13		13	IW-10	8	1	5
EPH	Benzo(ghi)perylene	N	191-24-2	ug/L	3	3	2.8	J	9.8	J	5.6	IW-10	0	NA	NA
EPH	C11-C22 Aromatics Adusted	N	HLA0108	ug/L	3	5	180		780		500	GW-101	2	50	91
EPH	Dibenz(a,h)anthracene	N	53-70-3	ug/L	2	3	3.4	J	5.8	J	4.6	IW-10	1	10	10
EPH	Indeno(1,2,3-cd)pyrene	N	193-39-5	ug/L	1	3	3	J	3	J	3	IW-10	2	10	10
VPH	Benzene	N	71-43-2	ug/L	2	45	2		2.5		2.25	IW-6	43	1	100
VPH	C5-C8 Aliphatics	N	HLA0155	ug/L	28	47	8.1		1900		424.96	IW-6	19	5	200
VPH	C9-C10 Aromatics	N	HLA0156	ug/L	4	27	0.54	J	1.4	J	0.98	IW-6	23	5	1000
VPH	C9-C12 Aliphatics	N	HLA0154	ug/L	11	47	2.6	J	180		59.68	IW-6	36	5	350
VPH	Ethylbenzene	N	100-41-4	ug/L	3	45	0.35	J	3.3		1.58	IW-6	42	1	100
VPH	Methyl Tertbutyl Ether	N	1634-04-4	ug/L	6	45	1		8.7	J	3.68	IW-6	39	1	100
VPH	Toluene	N	108-88-3	ug/L	9	45	0.58	J	23		4.98	IW-6	36	1	100
VPH	Xylene, o	N	95-47-6	ug/L	10	45	0.28	J	19		4.96	GW-101	35	1	100
VPH	Xylenes (m&p)	N	179601-23-1	ug/L	1	45	1.7	J	1.7	J	1.7	IW-10	44	2	200
Other	4-Nonylphenol (Tech.)	N	84852-15-3	ug/L	1	2	2.7	J	2.7	J	2.7	GW-101	1	4.8	4.8
Metals	Aluminum	T	7429-90-5	ug/L	4	6	65	J	300		143.5	B-03	2	100	100
Metals	Antimony	T	7440-36-0	ug/L	1	6	1.5	J	1.5	J	1.5	B-03	5	6	6
Metals	Arsenic	T	7440-38-2	ug/L	2	6	5.9		18	J	11.95	GW-101	4	1	1
Metals	Barium	T	7440-39-3	ug/L	6	6	10		150		37.83	GW-101	0	NA	NA
Metals	Cadmium	T	7440-43-9	ug/L	3	7	0.14	J	0.37	J	0.237	GW-101	3	1	1
Metals	Calcium	T	7440-70-2	ug/L	6	6	2800		64000		17316.67	GW-101	0	NA	NA
Metals	Chromium, Hexavalent	T	18540-29-9	ug/L	1	2	0.71	J	0.71	J	0.71	GW-101	1	1	1
Metals	Cobalt	T	7440-48-4	ug/L	3	6	3.1	J	12		6.3	GW-101	3	10	10
Metals	Copper	T	7440-50-8	ug/L	2	6	4.4	J	4.9	J	4.65	B-03	4	10	10
Metals	Iron	T	7439-89-6	ug/L	6	6	110		6000		1490	GW-101	0	NA	NA
Metals	Iron	D	7439-89-6	ug/L	38	45	17	J	28000		4528.97	IW-6	7	50	100
Metals	Magnesium	T	7439-95-4	ug/L	6	6	280	J	11000		2665	GW-101	0	NA	NA
Metals	Manganese	T	7439-96-5	ug/L	6	6	28		540		152.83	GW-101	0	NA	NA
Metals	Nickel	T	7440-02-0	ug/L	6	6	1.2	J	7	J	3.25	GW-101	0	NA	NA
Metals	Potassium	T	7440-09-7	ug/L	2	6	3500	J	5200		4350	GW-101	4	4000	4000
Metals	Sodium	T	7440-23-5	ug/L	6	6	1200	J	240000		44433.33	GW-101	0	NA	NA
Metals	Vanadium	T	7440-62-2	ug/L	1	6	1.7	J	1.7	J	1.7	B-03	5	10	10
Metals	Zinc	T	7440-66-6	ug/L	5	6	8.7	J	130		53.14	GW-13	1	50	50
Inorganics	Nitrogen, as Ammonia	T	HLA0043	ug/L	39	51	20		79000		14258.97	IW-10	12	20	1200
Inorganics	Bromide	T	24959-67-9	ug/L	1	6	200		200		200	GW-101	5	100	100
Inorganics	Chloride	T	16887-00-6	ug/L	6	6	1500		610000		108333.33	GW-101	0	NA	NA
Inorganics	Nitrate as N	T	14797-55-8	ug/L	4	6	57		2900		1321.75	GW-101	2	50	50
Inorganics	Sulfate	T	14808-79-8	ug/L	6	6	3300		32000		15050	GW-101	0	NA	NA

NOTE:
For samples with a duplicate, results were resolved as follows:
for sample sets with two detections, average the two hits,
use a detect if one is ND and the other is a detect, or
use the lower of the RLs if both are ND

Table B-2
Statistical Summary of Groundwater Data and Comparison to Ecological Screening Criteria
Olin Wilmington
Wilmington, MA

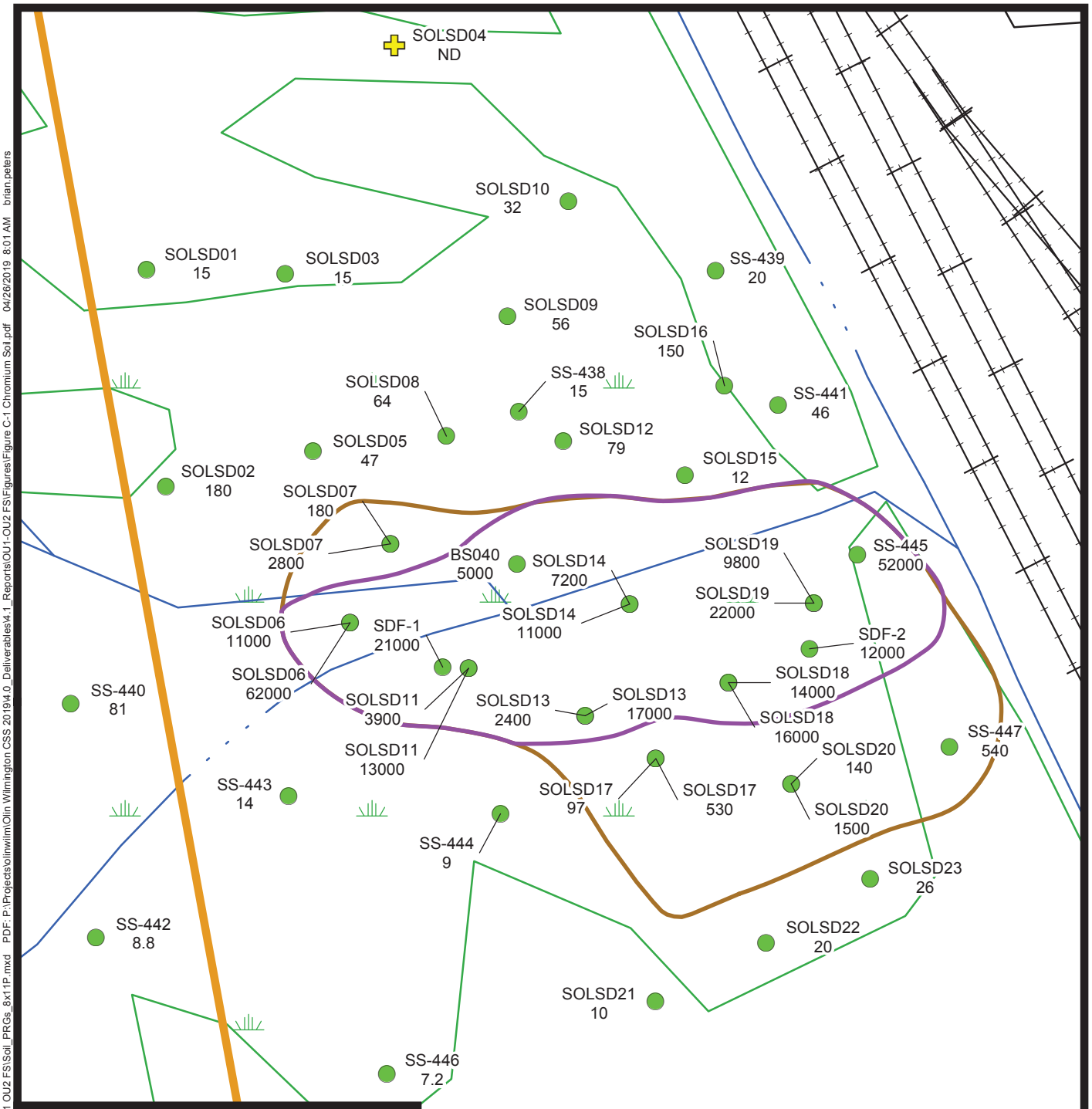
	Parameter	fraction	CASRN	Screening_Value_CCC	# Exceed	Screening_Value_SQuiRTs	# Exceed	Screening_Value_RegionIV	# Exceed	Screening_Value_BTAG	# Exceed
Method Class											
NDMA only	N-Nitrosodimethylamine	N	62-75-9	NA	--	NA	--	NA	--	117	0
VOCs	1,1,2-Trichloro-1,2,2-Trifluoroethane	N	76-13-1	NA	--	NA	--	NA	--	NA	--
VOCs	2,4,4-Trimethyl-1-pentene	N	107-39-1	15*	20	NA	--	NA	--	NA	--
VOCs	2,4,4-Trimethyl-2-pentene	N	107-40-4	18*	18	NA	--	NA	--	NA	--
VOCs	Acetone	N	67-64-1	NA	--	1500	0	1700	0	1500	0
VOCs	Carbon disulfide	N	75-15-0	NA	--	0.92	1	15	0	0.92	1
VOCs	Chloromethane	N	74-87-3	NA	--	NA	--	NA	--	NA	--
VOCs	Tetrahydrofuran	N	109-99-9	NA	--	NA	--	11000	0	NA	--
VOCs	Trichloroethene	N	79-01-6	NA	--	21	0	220	0	21	0
SVOCs	Aniline	N	62-53-3	NA	--	2.2	1	4.1	1	2.2	1
SVOCs	Biphenyl	N	92-52-4	NA	--	14	0	6.5	0	14	0
SVOCs	Bis(2-Ethylhexyl)phthalate	N	117-81-7	NA	--	0.3	21	8	0	16	0
SVOCs	Carbazole	N	86-74-8	NA	--	NA	--	4	0	NA	--
SVOCs	Diphenyl ether	N	101-84-8	NA	--	NA	--	NA	--	NA	--
SVOCs	Diphenylamine	N	122-39-4	NA	--	NA	--	NA	--	NA	--
SVOCs	N-Nitrosodiphenylamine	N	86-30-6	NA	--	210	2	25	9	210	2
SVOCs	Phenol	N	108-95-2	NA	--	180	0	160	0	4	1
EPH	Benzo(ghi)perylene	N	191-24-2	NA	--	7.64	1	0.012	3	NA	--
EPH	C11-C22 Aromatics Adusted	N	HLA0108	NA	--	NA	--	NA	--	NA	--
EPH	Dibenz(a,h)anthracene	N	53-70-3	NA	--	NA	--	0.012	2	NA	--
EPH	Indeno(1,2,3-cd)pyrene	N	193-39-5	NA	--	4.31	0	0.012	1	NA	--
VPH	Benzene	N	71-43-2	NA	--	46	0	160	0	370	0
VPH	C5-C8 Aliphatics	N	HLA0155	NA	--	NA	--	NA	--	NA	--
VPH	C9-C10 Aromatics	N	HLA0156	NA	--	NA	--	NA	--	NA	--
VPH	C9-C12 Aliphatics	N	HLA0154	NA	--	NA	--	NA	--	NA	--
VPH	Ethylbenzene	N	100-41-4	NA	--	7.3	0	61	0	90	0
VPH	Methyl Tertbutyl Ether	N	1634-04-4	NA	--	10000	0	730	0	11070	0
VPH	Toluene	N	108-88-3	NA	--	2	5	62	0	2	5
VPH	Xylene, o	N	95-47-6	NA	--	350	0	NA	--	NA	--
VPH	Xylenes (m&p)	N	179601-23-1	NA	--	1.8	0	NA	--	1.8	0
Other	4-Nonylphenol (Tech.)	N	84852-15-3	6.6	0	NA	--	1	1	NA	--
Metals	Aluminum	T	7429-90-5	NA	--	87	3	87	3	87	3
Metals	Antimony	T	7440-36-0	NA	--	30	0	190	0	30	0
Metals	Arsenic	T	7440-38-2	150	0	190	0	150	0	5	2
Metals	Barium	T	7440-39-3	NA	--	3.9	6	220	0	4	6
Metals	Cadmium	T	7440-43-9	0.72	0	0.25	1	NA	--	0.25	1
Metals	Calcium	T	7440-70-2	NA	--	NA	--	116000	0	116000	0
Metals	Chromium, Hexavalent	T	18540-29-9	11	0	11	0	11	0	11	0
Metals	Cobalt	T	7440-48-4	NA	--	3	3	19	0	23	0
Metals	Copper	T	7440-50-8	NA	--	9	0	NA	--	9	0
Metals	Iron	T	7439-89-6	1000	2	1000	2	1000	2	300	3
Metals	Iron	D	7439-89-6	1000	20	1000	20	1000	20	300	25
Metals	Magnesium	T	7439-95-4	NA	--	NA	--	82000	0	82000	0
Metals	Manganese	T	7439-96-5	NA	--	80	3	93	2	120	2
Metals	Nickel	T	7440-02-0	52	0	52	0	28.9	0	52	0
Metals	Potassium	T	7440-09-7	NA	--	NA	--	53000	0	53000	0
Metals	Sodium	T	7440-23-5	NA	--	NA	--	680000	0	680000	0
Metals	Vanadium	T	7440-62-2	NA	--	19	0	27	0	20	0
Metals	Zinc	T	7440-66-6	120	1	120	1	NA	--	120	1
Inorganics	Nitrogen, as Ammonia	T	HLA0043	36000	9	NA	--	NA	--	19	39
Inorganics	Bromide	T	24959-67-9	NA	--	NA	--	NA	--	NA	--
Inorganics	Chloride	T	16887-00-6	230000	1	NA	--	230000	1	230000	1
Inorganics	Nitrate as N	T	14797-55-8	NA	--	NA	--	NA	--	NA	--
Inorganics	Sulfate	T	14808-79-8	NA	--	NA	--	NA	--	NA	--

Prepared by: KS 4/29/2019
Checked by: JPK 5/2/2019

NOTE:
An asterisk (*) indicates an ECOSAR based criterion (not an AWQC).
For samples with a duplicate, results were resolved as follows:
for sample sets with two detections, average the two hits,
use a detect if one is ND and the other is a detect, or
use the lower of the RLs if both are ND

APPENDIX C

SOIL AND SEDIMENT EXCEEDING PRGS



Legend

- Analyte Detected Below Industrial RSL
- Analyte Detected Above Industrial RSL
- 2.5 Detected Analyte Concentration (mg/kg)
- Analyte Not Detected
- Area Exceeding Chromium PRG of 310 mg/kg
- Area Exceeding Chromium PRG of 3,100 mg/kg
- 51 Eames St. Property Boundary
- Railroad
- Structures
- Surface Water
- Wetland Boundary

N

0 15 30 Feet

Notes:
1. Industrial RSL (USEPA) for Chromium = 1,500,000 mg/kg.
2. < - Not Detected, value shown is reporting limit
3. Samples collected as part of the RI have IDs SS-4XX, SB-4XX, SS-5XX, or SB-5XXX. All other samples were collected previous to the RI.

Prepared/Date: BRP 04/26/19
Checked/Date: APP 04/26/19

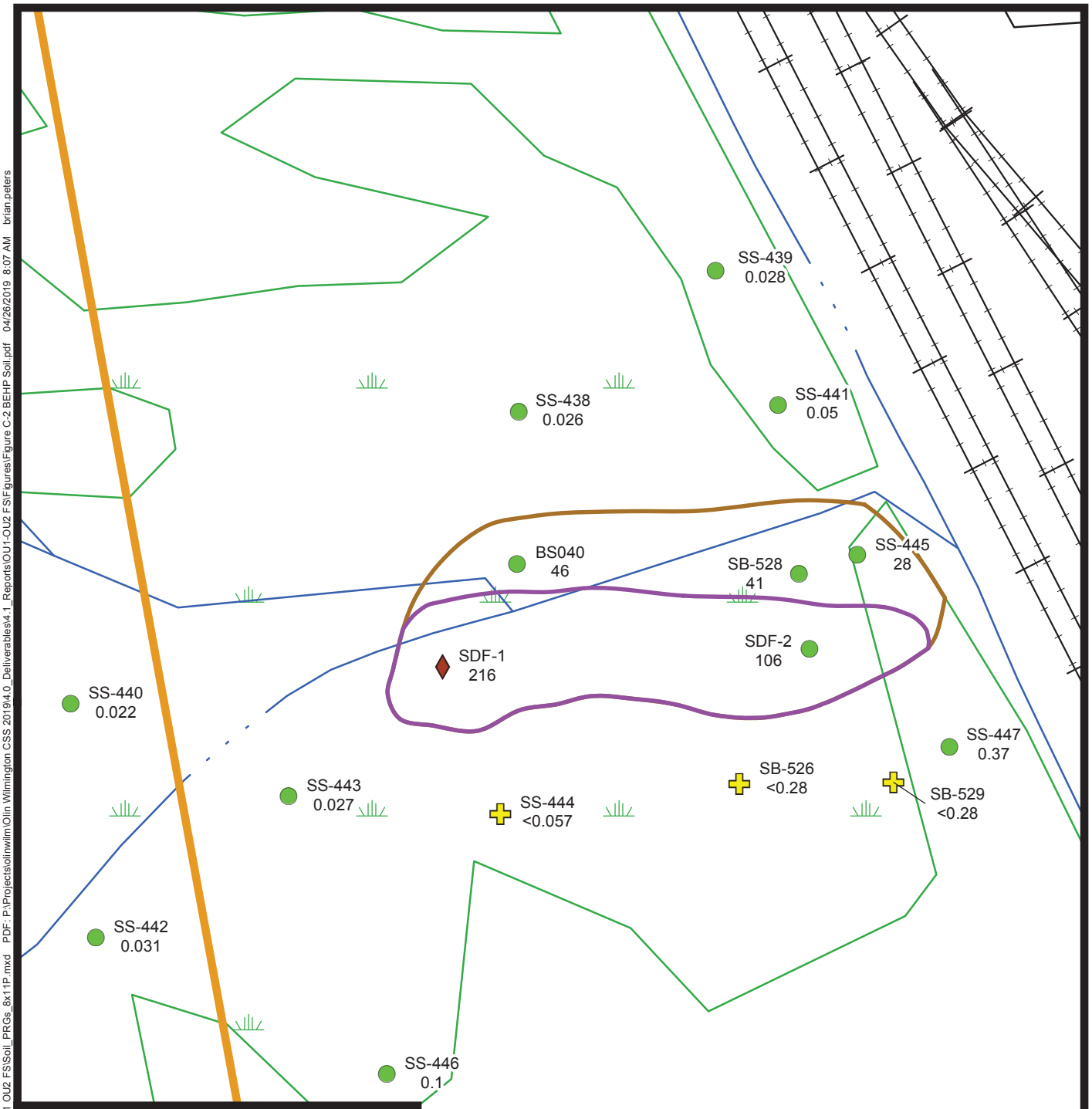
wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

Figure C-1
Areas Exceeding Soil PRGs for Chromium

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Document: P:\Projects\olinwilm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\Soil_PRGs_8x11P.mxd PDF: P:\Projects\olinwilm\Olin Wilmington CSS 201994.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure C-1 Chromium Soil.pdf 04/26/2019 8:01 AM brian.peters



Legend

- Analyte Detected Below Industrial RSL
- Analyte Detected Above Industrial RSL
- 2.5 Detected Analyte Concentration (mg/kg)
- Analyte Not Detected
- Area Exceeding BEHP PRG of 9.6 mg/kg
- Area Exceeding BEHP PRG of 96 mg/kg
- 51 Eames St. Property Boundary
- Railroad
- Structures
- Surface Water
- Wetland Boundary

N

0 15 30 Feet

Notes:
1. Industrial RSL (USEPA) for BEHP = 120 mg/kg.
2. < - Not Detected, value shown is reporting limit
3. Samples collected as part of the RI have IDs SS-4XX, SB-4XX, SS-5XX, or SB-5XXX. All other samples were collected previous to the RI.
4. BEHP = Bis(2-ethylhexyl)phthalate

Prepared/Date: BRP 04/26/19
Checked/Date: APP 04/26/19

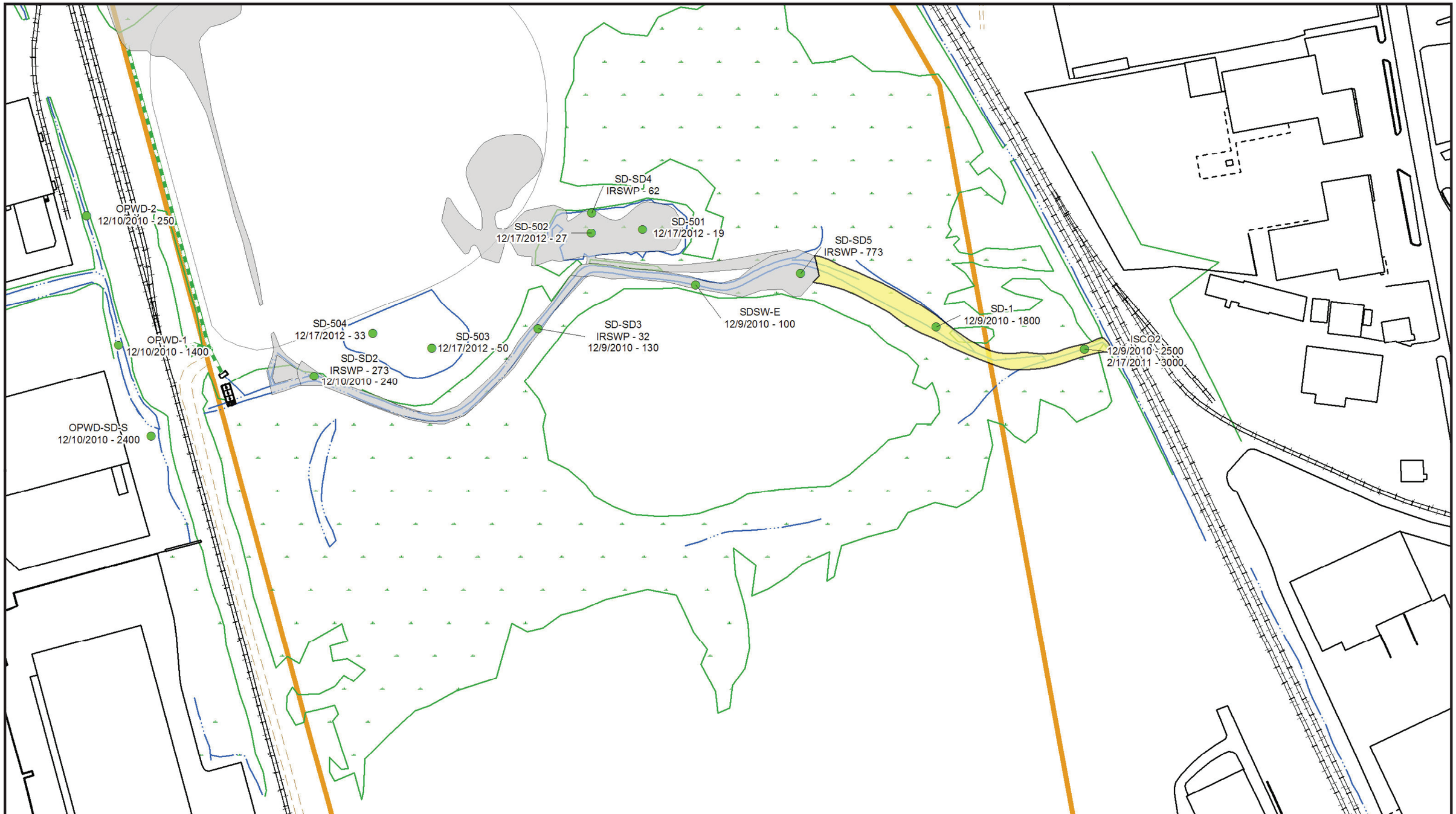
wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

Figure C-2
Areas Exceeding Soil PRGs for Bis(2-ethylhexyl)phthalate

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Document: P:\Projects\olinwilm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\Soil_PRGs_8x11P.mxd PDF: P:\Projects\olinwilm\Olin Wilmington CSS 2019\4.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure C-2 BEHP Soil.pdf 04/26/2019 8:07 AM brian.peters



Legend

- Sediment Sample Location
- 2.5 Detected Analyte Concentration (mg/kg)
- Inferred Area Exceeding Sediment PRGs of 111 and 1110 mg/kg
- Previous Sediment Excavation Areas
- 51 Eames St. Property Boundary
- Culvert
- Railroad
- Paved Road
- Unpaved Road
- Structures
- Surface Water
- Wetland Boundary

Notes:
1. IRSWP - Annual sediment sample location. Value shown is arithmetic mean for samples collected Oct 2010 to Jan 2013.

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

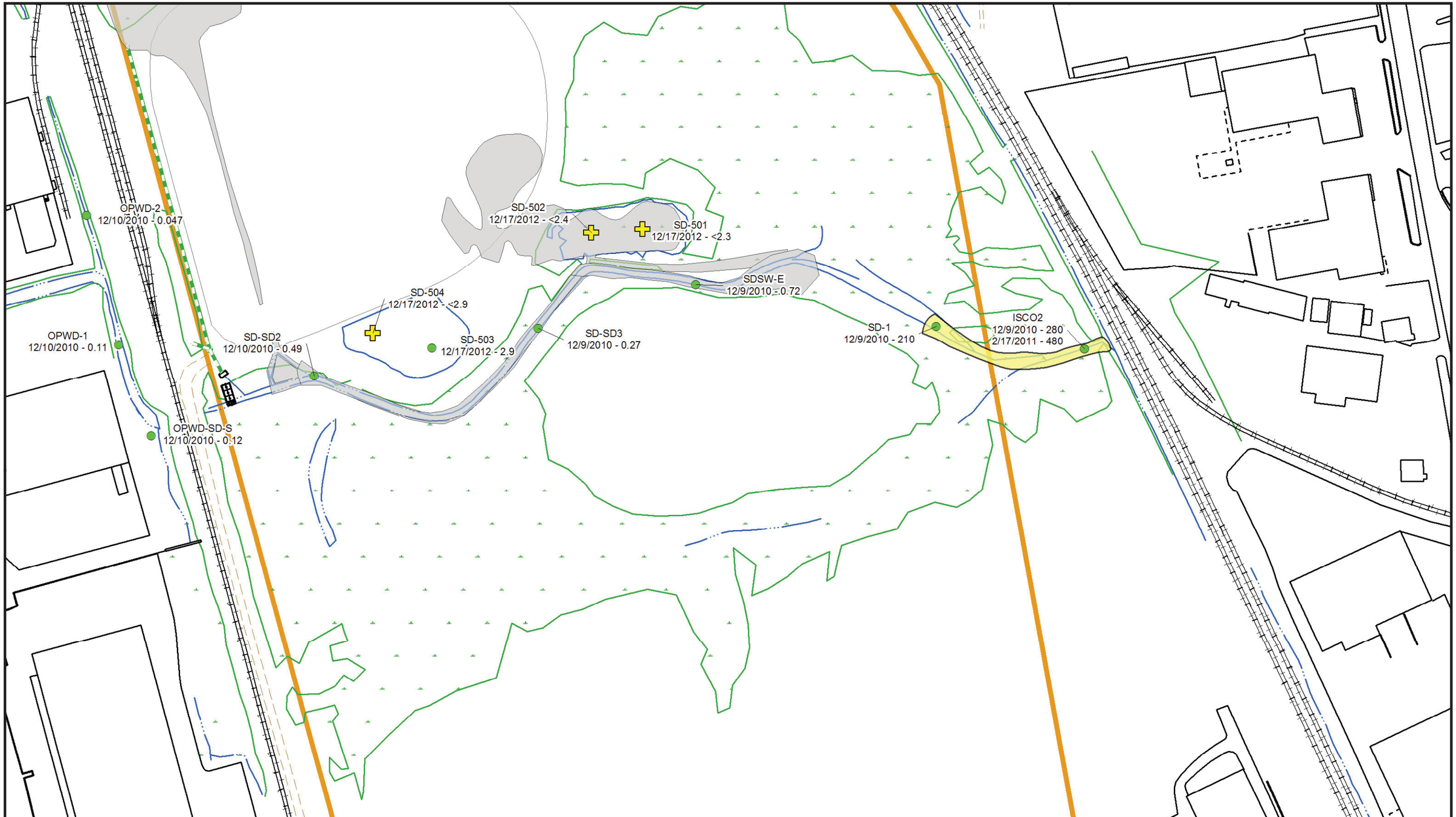
0 60 120 240 Feet

Figure C-3
Areas Exceeding Sediment PRGs for Chromium

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/26/19 | Checked/Date: APP 04/26/19

Document: P:\Projects\olinwilm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\Sediment_Distributions_11x17LS.mxd PDF: P:\Projects\olinwilm\Olin Wilmington CSS 2019\4.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure C-3 Chromium Sediment.pdf 04/26/2019 8:13 AM brian.peters



Legend

- Sediment Sample Location
- Analyte Not Detected
- 2.5 Detected Analyte Concentration (mg/kg)
- Inferred Area Exceeding Sediment PRG of 67
- Previous Sediment Excavation Areas
- 51 Eames St. Property Boundary
- Culvert
- Railroad
- Paved Road
- Unpaved Road
- Structures
- Surface Water
- Wetland Boundary

Notes:
1. No BEHP sediment PRG Exceedances at HQ=10
2. BEHP = Bis(2-ethylhexyl)phthalate

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 60 120 240 Feet

Figure C-4
Areas Exceeding Sediment PRGs for BEHP

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/26/19 | Checked/Date: APP 04/26/19

Document: P:\Projects\olinwilm\Olin Wilmington CERCLA\GIS\MapDocuments\OU1 OU2 FS\Sediment_Distributions_11x17LS.mxd PDF: P:\Projects\olinwilm\Olin Wilmington CSS 2019\4.0_Deliverables\4.1_Reports\OU1-OU2 FS\Figures\Figure C-4 BEHP Sediment.pdf 04/26/2019 8:35 AM brian.peters