ARKEMA EARLY ACTION
EE/CA WORK PLAN

Work Plan Addendum

DRAFT

Prepared for
Legacy Site Services, LLC
468 Thomas Jones Way
Exton, PA 19341

Prepared by

integral consulting inc.

319 SW Washington Street
Suite 1150
Portland, OR 97204

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ACRONYMS AND ABBREVIATIONS

For definitions of acronyms and abbreviations used in this addendum, refer to the list presented in the EPA/Parametrix Work Plan (Parametrix 2007).

PREFACE TO THE WORK PLAN ADDENDUM

This document is an addendum (Work Plan Addendum) to the May 11, 2007 *Arkema Early Action EE/CA Work Plan* prepared by Parametrix for the U.S. Environmental Protection Agency (EPA) (EPA/Parametrix Work Plan; Parametrix 2007). This addendum modifies and updates the May 11, 2007 work plan pursuant to additional information and findings that EPA and Legacy Site Services LLC (LSS), agent for Arkema Inc., have exchanged and agreed upon between May 2007 and the date of this Work Plan Addendum. Final agreements were memorialized in comment summary tables transmitted from LSS to EPA on February 19, 2008 as part of LSS' formal dispute documentation and as modified by the May 23, 2008 Final Decision on Disputes from Dan Opalski, Director of Office of Environmental Cleanup (Opalski Decision; USEPA 2008), regarding disputed issues.

The final EE/CA Work Plan (Final Work Plan) for the Site includes the combination of the following:

1. this Work Plan Addendum
2. EPA/Parametrix Work Plan (May 11, 2007).

Where there are differences between the Work Plan Addendum and the EPA/Parametrix Work Plan, the Work Plan Addendum text, tables, and figures supersede the EPA/Parametrix Work Plan. Neither of the two documents listed above should be considered stand-alone documents.

PRINCIPAL THREAT MATERIAL LANGUAGE IN THE EPA/PARAMETRIX WORK PLAN

EPA and Arkema agree that the term "Principal Threat Material" or "PTM" should be removed from the May 2007 Work Plan as unnecessary for articulating the basis for taking a removal action at the Arkema site. EPA and Arkema were not able to come to agreement as to what concentrations and chemicals at the site constitute Principal Threat Material, but EPA and Arkema have agreed on the RAA boundary in which the EE/CA analysis will be conducted, and agree that a non-time critical removal action in that RAA boundary will address a significant amount of high concentration sediment and will significantly reduce risk to human health and the environment. Principal Threat Material and/or PTM is no longer deemed relevant to the discussion of the screening level values in chapters 6 and 7 of the May 2007 Work Plan. EPA and Arkema agree to remove the term "Principal Threat Material" in relation to the screening level values (e.g., 1 x PEC and 1,000 x bioaccumulation SLV). The screening level values will remain in the Work Plan, including both the 1 x PEC and 1000 x bioaccumulation SLV, for purposes of evaluating dredging and judging the effectiveness of the removal action in the EE/CA.

WORK PLAN ADDENDUM FORMAT AND CONTENT

This Work Plan Addendum is structured using the same report outline as the EPA/Parametrix Work Plan. This report format is used to facilitate the use of this Work Plan Addendum with the EPA/Parametrix Work Plan, such that the reader can quickly identify a section or part of the EPA/Parametrix Work Plan that has been modified or superseded.

One consequence of this format is that certain sections of this Work Plan Addendum did not require modification and are so designated. This Work Plan Addendum format was deemed favorable to other alternatives because this format facilitates cross-referencing these two components of the Final Work Plan. To facilitate the review of modifications that resulted from agreements between LSS and EPA on the 126 comments, each Work Plan Addendum response is preceded by the comment number and the page number from the EPA/Parametrix Work Plan that identifies the location being modified. The comment resolution tables are also provided in Appendix D to this Work Plan Addendum.

In addition to the modifications to the EPA/Parametrix Work Plan, this Work Plan Addendum also incorporates a field sampling plan (FSP) and quality assurance project plan (QAPP) that provide the proposed scope of field investigations and analytical program to complete the engineering evaluation/cost analysis (EE/CA) site characterization. The FSP and QAPP are included as appendices A and B to this Work Plan Addendum, respectively, but will be submitted to EPA separately.

EXECUTIVE SUMMARY

The Executive Summary of the EPA/Parametrix Work Plan no longer applies to the Final EE/CA Work Plan. Revisions to the EPA/Parametrix Work Plan are documented in this Work Plan Addendum and thereby supersede the original EPA/Parametrix Work Plan. The Final EE/CA Work Plan consists of the EPA/Parametrix Work Plan as amended by the Work Plan Addendum as well as the FSP and QAPP, presented as addendum appendices A and B.

COMMENT 1—RESPONSIVNESS TO EPA'S COMMENTS ON THE JULY 2006 REVISED WORK PLAN

In LSS' opinion, the EPA/Parametrix Work Plan was non-responsive to a total of 46 government team comments provided in EPA's September 21, 2006 work plan disapproval letter (USEPA 2006a). Because EPA did not address these comments in the EPA/Parametrix Work Plan, LSS requested that EPA retract the "non-responsiveness" determination made in EPA's September 21, 2006 letter for each of these comments. EPA responded to LSS' request in a letter dated November 7, 2007 (USEPA 2007b), and LSS responded to EPA's letter on November 16, 2007 (LSS 2007b), continuing to request that EPA retract its determination that Arkema's Revised Work Plan was not responsive to these 46 comments. Ultimately, EPA and LSS agreed to disagree on whether these comments were adequately addressed in Arkema's Revised Work Plan, which ultimately does not affect the agreements reached that are documented in this Work Plan Addendum.

1 INTRODUCTION

LSS is Arkema's agent, not Arkema's successor.

The Final EE/CA Work Plan includes a FSP in addition to the QAPP and Health and Safety Plan (HASP).

1.1 PROJECT BACKGROUND

No changes to this section are required.

1.2 REMOVAL ACTION OBJECTIVES

No changes to this section are required.

1.3 REGULATORY FRAMEWORK

No changes to this section are required.

1.4 WORK PLAN ORGANIZATION

No changes to this section are required.

2 REMOVAL ACTION AREA CHARACTERISTICS

2.1 PHYSICAL AND ECOLOGICAL SETTING

Comment 2, Page 2-1, Fourth paragraph

The Site is generally secure; however, there is evidence of trespassers using the beach areas. Based on evidence of occasional beach use by trespassers, both trespassers and transients will be included as potential human receptors in the preliminary conceptual site model. The recreational user exposure scenario, therefore, has been replaced with the trespasser scenario.

Comment 63, Page 2-1

No text changes are required as a result of this comment. A description and analysis of upland groundwater data have been presented in other reports (ERM 2005; Integral 2003 and 2006).

Comment 64, Page 2-2, Section 2.1.2, First paragraph

The Willamette River merges with the Columbia River at Columbia RM 103, not Willamette River RM 103.

2.2 SITE HISTORY

No changes to this section are required.

2.3 CURRENT AND FUTURE FACILITY OPERATIONS

Comment 68, Page 2-10, Paragraph 3

In 2006, the operation of *in situ* groundwater interim remedial measures (IRMs) was discontinued in the upland portion of the Site due to the requirement for establishing a groundwater hydraulic control-based approach utilizing a slurry wall, and pump-and-treat system in advance of the removal action to meet the EE/CA schedule. The *ex situ* groundwater and treatment system was selected in lieu of *in situ* groundwater efforts in order to achieve EPA-directed source control efforts in accordance with the in-water EE/CA schedule. Prior to this transition, Arkema completed several IRMs to address chemicals in groundwater. In 2000 and 2001, Arkema completed two phases of excavation and disposal to remove surface and subsurface soil with elevated DDT concentrations from the former manufacturing process residue pond and trench. Air sparging and soil vapor extraction (AS/SVE) techniques were employed to address residual chlorobenzene in groundwater in the upland portion of the Site. The system operated between December 2004 and June 2006. Calcium polysulfide was injected

into groundwater in the Chlorate Plant area to reduce hexavalent chromium to a trivalent state and immobilize it in groundwater. The full-scale program implemented in June and November 2005 was monitored through April 2006 (Integral 2006). Bench-scale treatability studies of *in situ* treatments for perchlorate in groundwater were conducted between December 2003 and March 2006. Based on these studies, an active (groundwater and nutrient recirculation system), enhanced *in situ* bioremediation was recommended for the perchlorate plume (Integral 2006). A groundwater focused feasibility study (FFS) that evaluates and selects a preferred groundwater IRM was submitted to the Oregon Department of Environmental Quality (DEQ) in May 2008.

Comment 69, Section 2.3, Page 2-10

Integral Consulting Inc. (Integral) submitted a stormwater IRM FFS for the Site to DEQ on behalf of LSS on July 3, 2008 (Integral 2008a). The stormwater IRM FFS was prepared in conjunction with the Arkema Site Remedial Investigation and Feasibility Study (RI/FS) that is being conducted under the Oregon DEQ Voluntary Cleanup Program. The purpose of the FFS is to identify a source control action that mitigates the migration of constituents of potential concern (COPCs) in stormwater at the Site to the Willamette River. The implementation of the stormwater source control IRM will be coordinated with any sediment remediation conducted as part of the non-time critical removal action (NTCRA). Data from the IRM FFS may supplement other available data to complete data gaps and site characterization. Four rounds of stormwater and catch basin samples were collected as part of the IRM FSS between October 16, 2006 and June 5, 2007 as reported in *Stormwater Interim Remedial Measures Field Sampling and Data Report* (Integral 2007) and used and analyzed in *Stormwater Interim Remedial Measures Focused Feasibility Study Report* (Integral 2008a).

2.4 CULTURAL RESOURCES

No changes to this section are required.

3 REVIEW OF EXISTING DATA

3.1 SUMMARY OF PREVIOUS INVESTIGATIONS

Comment 70, Pages 3-1 through 3-13

A total of 29 additional field sampling, data, or site characterization reports have been completed by the Lower Willamette Group (LWG) and data from these reports are available to be incorporated into the EE/CA analysis as needed. Some of the reports may contain data that fill data gaps at the Site. The following is a list of additional reports that were not included in the EPA/Parametrix Work Plan (the date submitted to EPA precedes the date of the report) and reports that were submitted after the EPA/Parametrix Work Plan was completed:

1. 2008-06-13: Round 3B Upland Stormwater Sampling Field Sampling Report
2. 2008-05-16: Stormwater Loading Calculation Methods
3. 2008-04-21: Round 3B Bioassay Testing Data Report
4. 2008-03-21: Round 3B Comprehensive Sediment and Bioassay Testing Field Sampling Report
5. 2008-02-29: Round 3 Pre-breeding White Sturgeon (*Acipenser transmontanus*) Tissue Data Report
6. 2008-02-15: Round 3B Fish and Invertebrate Tissue and Collocated Surface Sediment Field Sampling Report
7. 2008-01: Round 3A Sediment Trap Sampling, Quarter 4 Field Report
8. 2007-11-30: Round 3A Upland Stormwater Sampling Field Sampling Report
9. 2007-10-20: Treatability Study Literature Survey Technical Memorandum
10. 2007-10-15: Round 3A Winter 2007 High-flow Surface Water Data Report
11. 2007-10-01: Round 2 Mussel and Lamprey Ammocoete Tissue Data Report
12. 2007-10: Round 3A Sediment Trap Sampling, Quarter 3 Field Report
13. 2007-08-24: Round 3 Lamprey (*Lampetra* sp.) Tissue Data Report
14. 2007-08-07: Round 2 Groundwater Pathway Assessment, Transition Zone Water Site Characterization Summary Report
15. 2007-07: Round 3A Sediment Trap Sampling, Quarter 2 Field Report
16. 2007-07: Draft Chemical Fate and Transport Model Development and Data Gaps Identification Report
17. 2007-05-21: Round 3A Low-flow and Stormwater-impacted Surface Water Data Report

18. 2007-05-01: Round 3 Sampling for Pre-breeding White Sturgeon (*Acipenser transmontanus*) Tissue Field Sampling Report
19. 2007-04-30: Round 3A Winter 2007 High-flow Surface Water Event Field Sampling Report
20. 2007-04-16: Round 3A Sediment Trap Sampling, Quarter 1 Field Report
21. 2007-04-09: Round 3A Upstream & Downstream Sediment Field Sampling Report
22. 2007-04-06: Round 3 Lamprey (*Lampetra* sp.) Phase 1 Toxicity Testing Report
23. 2007-02-21: Comprehensive Round 2 Site Characterization Summary and Data Gaps Analysis Report
24. 2007-01-15: Round 3A Fall 2006 Stormwater Surface Water Event Field Sampling Report
25. 2006-12-15: Round 3 Sampling for Lamprey (*Lampetra* sp.) Tissue, Field Sampling Report
26. 2006-12-08: Phase 2 Recalibration Results: Hydrodynamic Sedimentation Modeling for Lower Willamette River
27. 2006-12-08: Round 3A Summer 2006 Low-Flow Surface Water Event Field Sampling Report
28. 2006-10-20: Round 3A January 2006 High-Flow Surface Water Data Report
29. 2006-09-01: Round 2 Benthic Tissue and Sediment Data Report.

In addition to LWG data reports for the Willamette River, LSS has completed 14 reports and analyses that may apply to the EE/CA evaluation. These reports include the following:

1. 2008-07-03: Stormwater Interim Remedial Measures Focused Feasibility Study Report.
2. 2008-05-15: Draft Focused Feasibility Study – Groundwater Source Control IRM, which included the following reports as appendices:
    - Groundwater Modeling Report, Arkema Chemicals Facility, Portland, Oregon
    - DRAFT Slurry Materials Testing Report
    - Groundwater Barrier Wall Geotechnical Engineering Analysis Report
3. 2008-05-16: Draft Human Health Risk Assessment, Arkema Site: Upland Areas
4. 2008-03-11: Groundwater Source Control Evaluation, Addendum 1
5. 2008-02-13: Draft Arkema Upland Level II Screening Ecological Risk Assessment
6. 2008-04-10: Treatment of Groundwater from the Arkema Facility in Portland, Oregon: Bench Scale Treatability Study
7. 2008-01-02: Summary of Remedial Technology Alternatives, Groundwater Source Control Interim Remedial Measure Focused Feasibility Study, Arkema Inc., Portland, Oregon

8. 2007-12-09: Draft Groundwater Modeling Report
9. 2007-11-02: Stormwater Interim Remedial Measures Field Sampling and Data Report
10. 2007-10-30: Sitewide Groundwater Monitoring Report – April 2007 Monitoring Event
11. 2007-04-17: Draft Groundwater Source Control Evaluation, Arkema Portland Facility
12. 2006-12-12: Scoping Technical Memorandum, Groundwater Source Control Interim Remedial Measure
13. 2006-10-13: Upland Groundwater Dioxin/Furan Sampling - REVISED, Technical Memorandum, Arkema Inc., Portland Facility
14. 2006-07-06: Additional Performance Monitoring, Hexavalent Chromium Reduction Interim Remedial Measure (IRM), Arkema Inc., Portland Facility

Comment 71, Page 3-1

Monitoring data were first collected at the Site in 1996, and a number of sampling efforts have been conducted in the Willamette River and on its banks adjacent to the Site since 1996. There is no environmental data prior to 1996.

Comment 76, Page 3-3, Footnote 4

Riverbank soil is defined as the area between mean high water and ordinary high water. Beach sediment is defined as the area between mean low water and mean high water. Willamette River sediment is defined as material below mean low water.

Comment 77, Section 3.1.6, Pages 3-3 through 3-20

Sediment groundwater is groundwater that is located in river sediments below the mean high water line. Upland groundwater is groundwater that is located in soils above the mean high water line.

3.2 GEOLOGIC AND HYDROGEOLOGIC DATA

Comment 85, Section 3.2.1.3, Page 3-16, Figure 2-4

Fill history was presented previously in Table 2-3 and Figure 2-4 of the Revised Draft EE/CA Work Plan (Integral 2006). No additional information on fill history has become available. Table 2-3 and Figure 2-4 are reproduced here in the Work Plan Addendum.

Comment 86, Section 3.2.1.3, Page 3-16, Bullet 5

Columbia River Basalt is the name of a geologic group and should be capitalized.

Comment 90, Page 3-20, Figures 3-11 and 3-12

Figures 3-11 and 3-12 referenced in the EPA/Parametrix Work Plan do not exist.

3.3 ENGINEERING AND PHYSICAL PARAMETERS

No changes to this section are required.

3.4 HABITAT CHARACTERISTCS

No changes to this section are required.

4 PRELIMINARY CONCEPTUAL SITE MODEL

4.1 SOURCES

Comment 99, Section 4.1.3, Page 4-4, Paragraph 3

Monochlorobenzene (MCB) dense, nonaqueous phase liquid (DNAPL) likely contributes to the continued presence of dissolved-phase MCB in groundwater observed in upland soils and sediments.

Comment 101

An updated and complete version of Table 4-1 originally included in the LSS Revised Work Plan will be included in the EE/CA report.

Comment 102, Section 4.1.4, Page 4-5, Paragraph 1

Sources and possible release mechanisms of chemicals of interest (COIs) beyond the primary source list, which were identified during the data screening, are described in Section 4.1.4 of the EPA/Parametrix Work Plan. Information regarding the possible sources of these chemicals to the in-water portion of the Site is provided where available. COI-containing matrices being evaluated for the EE/CA include riverbank soil, beach sediment, river sediment, groundwater, surface water, and transition zone water (TZW).

Comment 104, Section 4.1.5, Page 4-8

The adequacy of upland hydraulic control will be evaluated as part of the Upland Source Control Measures being conducted under the Voluntary Agreement with DEQ. The EE/CA will monitor these source control measures and provided comments as necessary to that process.

Comment 97, Figure 4-3

EPA and LSS agree that a value of 3.6 μg/l will be used to map out the conceptual interpretation of the perchlorate groundwater plume outlined in Figure 4-3 of the EPA/Parametrix Work Plan.

4.2 TRANSPORT PATHWAYS

Comment 106, Pages 4-9 through 4-11

See comment 69 (Section 2.3) for a discussion of recent stormwater data collected as part of the Stormwater IRM FFS.

Comment 108, Section 4.2.3, Page 4-10

Integral evaluated the 2004 stormwater loading calculations presented in the *Groundwater and Stormwater Loading Estimates Technical Memorandum* (Attachment B to the EPA/Parametrix Work Plan). Integral identified some errors in the calculations that affect the loading estimates. The percent impervious values were incorrectly calculated for drainage areas 001 and 002; therefore, the loading estimates for Outfalls 001 and 002 presented in the EPA/Parametrix Work Plan were slightly low due to this miscalculation. The EPA/Parametrix Work Plan also overestimated select 4,4′-DDD and 4,4′-DDE average concentrations in Outfalls 003 and 004 due to a transcription error. The stormwater samples collected in 2004 are not representative of the Site's current physical condition; demolition and decommissioning activities were not yet complete at the time of sampling. For this reason, the loading estimates presented in the Stormwater IRM FFS (Integral 2008a) are included in this Work Plan Addendum as tables 2-2 and 4-5. The 2007 estimates are based on the most recent available data and are considered representative estimates for stormwater loading of the sum of 2,4' and 4,4'-DDD, -DDE, -DDT (DDx) at the Site.

Comment 110, Section 4.3, Page 4-12, Paragraph 1

Riverbank soil is defined in this Work Plan as the area between mean high water and ordinary high water. Riparian soil is defined as the area between mean high water and the top of bank.

Comments 112/113, Pages 3-1 to 5-7

Additional upland groundwater data are available. In April 2007, a Site-wide groundwater sampling event was conducted for a total of 92 wells, including 3 well clusters on Lots 1 and 2 that had not been sampled previously. The *Groundwater Source Control Evaluation – Addendum 1* submitted by Integral to DEQ on March 11, 2008 presents the JSCS screening results for the April 2007 monitoring event (Integral 2008b). *The Sitewide Groundwater Monitoring Report* submitted by ERM-West, Inc. to DEQ in October 2007 presents the results for the April 2007 monitoring event (ERM 2007).

Comment 5, Section 4.2.3, Page 4-10, Paragraph 3

Stormwater loading estimates for 2007 are presented in Table 4-5 of the Work Plan Addendum. The loading estimates were calculated using the Simple Method (Schueler 1987) and data from four rounds of stormwater samples were collected between October 16, 2006 and June 5, 2007 as reported in the *Stormwater Interim Remedial Measures Field Sampling and Data Report* (Integral 2007) and evaluated in the *Stormwater IRM FSS Report* (Integral 2008a).

4.3 EXPOSURE PATHWAYS AND POTENTIAL RECEPTOR POPULATIONS

Comment 6, Page 4-12, Paragraph 2

Air is not an exposure media that will be evaluated or addressed in the EE/CA.

Comment 7, Page 4-13, Bullet 1

In EPA's February 27, 2006 letter to Larry Patterson (USEPA 2006b), EPA agreed that the maximum contaminant level (MCL) and the primary remediation goal (PRG) will be considered at this time for screening purposes only. EPA further agreed that the use of MCL and PRG as applicable or relevant and appropriate requirements (ARARs) may result at later stages of the EE/CA. MCLs and Region 9 tap water PRGs are not relevant to on-site worker exposure limits, because Willamette River surface water in the vicinity of the Site has not been and is not expected to be used as a washing and/or drinking source for on-site workers.

Comment 8, Page 4-15, Paragraph 5

The Site and surrounding areas are zoned for industrial land use. Because existing land zoning precludes residential uses, there are currently no residents living on or adjacent to the Site. Based on the absence of residents living on or around the Site, the EE/CA will not evaluate on-site residential exposure. The Willamette River is a potential future drinking water source; thus, exposure to surface water through ingestion, dermal contact, or volatilization of contaminants is a potential future exposure mechanism. Surface water will be evaluated quantitatively by comparing contaminant concentrations to drinking water screening levels.

5 COMPARISON TO JOINT SOURCE CONTROL STRATEGY CRITERIA AND OTHER SCREENING-LEVEL VALUES

5.1 SELECTION OF SLVS

Comment 9, Page 5-1, Paragraph 1

EPA and LSS will agree to remove the term "Principal Threat Material" in relation to the screening level values (SLVs) (e.g., 1 x PEC and 1,000 x bioaccumulation SLV). The SLVs will remain in the Final Work Plan, including both the 1 x probable-effect concentration (PEC) and 1,000 x bioaccumulation SLVs, for the purpose of evaluating dredging and judging the effectiveness of the removal action in the EE/CA.

Comment 10, Page 5-2, Bullet 1

EPA and LSS agree that LWG sediment quality benchmarks can be included in future EE/CA evaluation and screening processes subsequent to EPA acceptance.

Comment 11, Page 5-2, Bullet 2

EPA and LSS agree that the foundation for any SLV selected for general evaluation of the Site will be the *Guidance for Assessing Bioaccumulative Chemicals of Concern in Sediment* (DEQ 2007, updated). This document represents the most recent DEQ guidance on the subject.

5.2 SOLID-PHASE MEDIA

Comment 12, Section 5.2.1, Page 5-3, Bullet 5

The Arkema EE/CA process can use Portland Harbor-specific SLVs if EPA approves such harbor-specific SLV values developed during the RI/FS process.

Comment 13, Section 5.2.1, Page 5-4, Paragraph 2

Sediment SLV in tables 5-3a through 5-3h may be superseded by harbor-specific values pending completion of the Portland Harbor RI report and approval by EPA; however, EPA does not agree to the use of the PEC for total DDT of 572 μg/kg (MacDonald et al. 2000) for sediment screening.

Comment 14, Section 5.2.1, Page 5-3, Bullet 5

Section 5.2.1 of the EPA/Parametrix Work Plan cites DEQ (2006a) and DEQ (2007) as supporting references for bioaccumulative SLVs listed in tables 5-3a through 5-3h. Replace the DEQ (2006a) and DEQ (2007) citations with DEQ (2007 updated). Replace all values in tables 5-3a through 5-3h that are dependent on DEQ (2006a) and DEQ (2007) with the updated values presented in DEQ (2007 updated).

5.3 AQUEOUS-PHASE MEDIA

No changes to this section are required.

5.4 TISSUE DATA SUMMARY

Comment 15, Section 5.4.1,Pages 5-6 and 5-7, Paragraph 2

FC017 is a point sampling location where an LWG Round 2A clam sample was collected.

Sample FZ0609 is an LWG Round 1 sampling area from RM 6 to 9 where black crappie, brown bullhead, and carp samples were collected.

5.5 BENTHIC TOXICITY STUDIES

Comment 16, Page 5-8

Benthic toxicity testing is not proposed in this EE/CA Work Plan. If toxicity testing is needed at a later date, the available information will be reviewed and used as a foundation to design a program based on current guidance. Analyte tables in the EPA/Parametrix Work Plan will be revised and included in the FSP.

6 PRINCIPAL THREAT MATERIAL

6.1 PRINCIPAL THREAT MATERIAL

Comment 18, Section 6.1.1, Page 6-2

The use of the term "Principal Threat Material" or "PTM" is removed, as it is no longer considered relevant to the discussion of SLVs in Section 6. The comparisons of existing chemical data with human health and ecological SLVs presented in Section 5 will be used for the purpose of evaluating dredging and judging the effectiveness of the removal action in the EE/CA. The basis for taking a removal action at the Site will be grounded upon the relevant and appropriate application of the screening processes presented in Section 5 and in accordance with relevant and appropriate CERCLA NTCRA Guidance and not any designation of "Principal Threat Material." Also, as proposed in EPA's August 28, 2007 letter (USEPA 2007a), the preliminary RAA boundary (as shown in Appendix A to the Administrative Order on Consent) will constitute the outer boundary within which further EE/CA analysis and dredging evaluations will be conducted, including additional site characterization for data gaps. In the letter, EPA further acknowledged that sediment outside of the preliminary RAA boundary, particularly in front of Lots 1 and 2, may exceed the SLVs; but that material remaining outside of the RAA will not be subject to the EE/CA removal action. The latter material instead will be subject to future action in accordance with the Portland Harbor Record of Decision. In a letter dated September 28, 2007 (LSS 2007a), LSS concurred with this agreement. EPA also accepts that the mass-to-volume relationship is a valuable tool for considering the implementability of technologies for a removal action. EPA and LSS subsequently agreed in principle to focus the boundary of the EE/CA removal action further, except that EPA has proposed using a 5 mg/kg concentration limit as the focused RAA boundary and LSS has proposed using the 90 percent + mass-to-volume breakpoint as the focused RAA boundary. The Opalski Decision, determined that the removal action alternative evaluation should consider a range of options within the 5 mg/kg focused RAA boundary.

Comments 19/20, Section 6.1.2, Page 6-2

The proposed Principal Threat Material discussion presented in Section 6.1.2 of the EPA/Parametrix Work Plan is removed, as it is no longer relevant. Analyses of the implications of dredging to a range of concentrations will be presented in the EE/CA. The range of concentrations considered will include SLVs as well as the approximate ±90 percent breakpoint (10 ppm DDx concentration) suggested by LSS' mass-based analysis. Materials designated as "PTM" in the EPA/Parametrix Work Plan are no longer relevant or appropriate and therefore have no bearing on the dredge scenarios considered.

Comment 114, Section 6.1.1, Page 6-2, Paragraph 2

The last paragraph in Section 6.1.1 of the EPA/Parametrix Work Plan should read as follows: "Principal threats, as defined in the National Contingency Plan are characterized by high concentrations of toxic compounds, liquids, or other highly mobile source materials or contaminated media that pose significant risk of exposure or that are composed of media containing contaminants several orders of magnitude above health-based levels."

Comment 115, Section 6.1.3.1, Page 6-3

The EPA/Parametrix Work Plan develops a two-dimensional analysis of chemical data by dividing the analysis area into 50 ft x 50 ft square grid cells. The process that EPA used to develop the grid cells in the EPA/Parametrix Work Plan is unknown.

Comment 21, Section 6.1.3.1, Page 6-3, Footnote 34

Footnote 16 is removed, as it is no longer relevant based on the agreement between EPA and LSS to discontinue the use of "PTM" language.

Comment 116, Section 6.1.3.1, Page 6-5, Bullet 2

The EPA/Parametrix Work Plan does not clarify the process used to incorporate samples with multiple dilutions into the screening process.

6.2 DATA SCREENING RESULTS

Comment 22, Page 6-6, Paragraph 4

References made in the first sentence of this paragraph and throughout the text to TEC and PEC screening levels in the context of "acute effects" are not correct. Consensus based TEC and PEC values are derived from a wide range of studies that include both chronic and acute toxicity tests as well as benthic community analysis. Consequently, threshold effect concentration (TEC) and PEC values represent a range of available chronic and acute exposure data available from laboratory and field studies.

Comment 23, Page 6-7, Paragraph 1

A similar pattern of exceedances is found when only detections are used to calculate exceedances (Figure 6-1b). Due to very high concentrations of some chemicals, some samples had to be diluted as part of laboratory quality assurance/quality control protocol. Sample dilution raised respective detection limits (DLs) substantially for other chemicals. This procedure could result in double counting those chemicals in the re-analysis that did not require dilution in the original sample. Because sample dilution raises DLs, some of the

chemicals that were detected in the original sample may be reported as not detected at higher concentrations in the re-analysis. In future analyses, only the "D" qualified chemicals will be reported in a re-analysis and the detection limits from the original analysis will be applied to those chemicals that were not "D" qualified.

Comment 117, Page 6-7, Paragraph 7

The first sentence in paragraph 7, page 6-7 in Section 6.2 of the EPA/Parametrix Work Plan is not relevant to the discussion of data screening results because it makes relative comparisons among dioxin/furan TCDD TEQ, total TCDD TEQ, total endrin, and DDx. The scale for individual substance comparisons should be created using meaningful comparisons to chemical benchmarks, contaminant distributions, and patterns of chemical concentrations across the Site and in Portland Harbor. Table 6-1 presents comparisons between maximum detections and SLV exceedance magnitudes.

Comment 24, Page 6-8, Paragraph 1

Region 9 PRGs for some substances are on the order of 10^6 times greater than the bioaccumulative SLVs. Because Region 9 PRGs are higher than SLVs, the area of Region 9 exceedance is much less than the 1,000x bioaccumulative SLV area.

Comment 25, Page 6-8, Paragraph 1

Aqueous media are not the focus of the EE/CA, but they are included in the analysis because of the potential threat of recontamination of sediments. Possible recontamination mechanisms include chemical migration through groundwater from upland sources, chemical migration from upstream sources, and transport and deposition of particles from upstream surface water sources.

6.3 REMOVAL ACTION AREA DELINEATION CRITERIA

Comment 26, Page 6-9, Bullets 1, 2, and 3

The RAA will be defined at the end of the EE/CA. The purpose of the EE/CA is to refine and better define removal action specifications. The data available at the time of the EE/CA report will be used to define specific details such as dredging boundaries, overdredge depths, and hydraulic containment structure boundaries.

6.4 EVALUATION OF RECONTAMINATION POTENTIAL

Comment 28, Page 6-9, Paragraph 3

Replace the word "acute" with the word "toxic" in the sentence that states "In the third screen, emphasis was placed on chemicals present in concentrations that might represent an acute threat to ecological receptors (i.e., benthic invertebrates)." The word "acute" implies short-term exposure durations to relatively high concentrations. However, the sediment quality values used in the third screen are based broadly on many studies that include a wide range of exposure durations, as well as benthic community data that represent chronic exposure.

Comment 118, Page 6-9

The various mechanisms for recontamination potential will be evaluated as part of the remedy selection for the RAA and will be incorporated into a monitoring program to verify the effectiveness of the removal action and to document any recontamination via sources external to the RAA and the Site.

Comment 31, Section 6.4.1, Page 6-12, Paragraph 1

EPA and LSS agree that ongoing sediment transport may be a source of recontamination potential for certain COIs from additional sources within Portland Harbor.

Comment 32, Section 6.4.1, Page 6-12, Paragraph 4

As stated in the Opalski Decision, it is not necessary to identify lindane as a COI at this time. Data collection and reporting in the EE/CA process will continue to include analyses for a suite of pesticides that will include lindane with appropriate consideration of detection limits so as to improve interpretation of the lindane-related data set. Analyte tables in the EPA/Parametrix Work Plan will be revised and included in the FSP.

Comment 33, Section 6.4.1, Page 6-14, Paragraph 4

The citation of AMEC (2005) in Section 6.4.1 concerning TCDD equivalents is deleted from the EPA/Parametrix Work Plan.

Comment 34, Section 6.4.2, Page 6-15, Paragraph 4

In groundwater, DDx concentrations occur mostly in the range between 0.2 and 20 μg/L. Similar but somewhat lower concentrations of DDx are reported in TZW. The lowest SLV for DDx in sediments is about 0.04 μg/kg. The preliminary, non-quantitative evaluation that indicated that these concentration ranges are sufficient to cause recontamination of sediments will be further refined as the EE/CA proceeds.

It should also be noted that these report values of DDx in groundwater in many cases are obtained from Geoprobe or similar sampling methods which by their nature are highly turbid and therefore the resulting reported values for COIs such as pesticides/DDx and metals are biased high and do not represent dissolved phase concentrations. Any and all groundwater and/or TZW collected as part of the EE/CA Site characterization will be collected using appropriate sampling methods to evaluate dissolved phase concentrations of DDx.

7 REMOVAL ACTION EVALUATION APPROACH

The removal action evaluation approach will consider a range of options within the 5 mg/kg focused RAA boundary (USEPA 2008). EPA and LSS agree that a range of removal action technologies may be reviewed to include dredging (mechanical and hydraulic dredging) with and without hydraulic containment, capping, and on-site (upland and confined disposal facility [CDF]) and off-site disposal.

Comments 35 and 36, Page 7-1

A number of removal action evaluations that were excluded previously in the EPA/Parametrix Work Plan can now be considered in the EE/CA. These evaluations include mechanical dredging with hydraulic containment, on-site upland disposal, and localized capping. A discussion of each method is presented in the subsections below. In addition, pursuant to the Opalski Decision, the EE/CA alternatives analysis will consider constraints such as the feasible limits of conventional dredging techniques, as well as other appropriate factors, in evaluating various extents of dredging (USEPA 2008). EPA, in its August 28, 2007 letter, concurs that an environmental dredge bucket has the potential to limit water quality impacts when compared to a conventional clamshell bucket. However, based on existing information about the amount of debris in Site sediment, it is expected that the environmental dredge would perform no better than the conventional clamshell bucket. EPA maintains that an environmental dredge bucket can be analyzed, but it would have to be analyzed in the context of Site conditions and assessed with the same hydraulic control requirements as for a conventional clamshell bucket (USEPA 2007a).

7.1 DREDGING TECHNOLOGIES

Comment 37, Page 7-2, Paragraph 2

Some mechanical dredge buckets are now designed to be entirely sealed to reduce sediment loss and resuspension in the water column, reducing water quality impacts and residuals during dredging. The EPA/Parametrix Work Plan based the decision to exclude a mechanical dredging evaluation on the poor performance of conventional clamshell buckets. Mechanical dredging using environmental dredge buckets with hydraulic containment is a viable option that can be considered in the EE/CA. Also note that Section 7.1 of the EPA/Parametrix Work Plan concludes that the use of hydraulic dredging may significantly reduce the necessity of containment structures. Future dredging projects should re-evaluate this alternative, including the use of pilot tests or other means to more fully evaluate the alternative.

7.2 DREDGED MATERIAL HANDLING TECHNOLOGIES

Comment 38, Section 7.2.3, Page 7-5

Based on the Opalski Decision, the use of an on-site CDF can be evaluated and presented as a disposal option in the EE/CA.

7.3 POST-DREDGING CAPPING

Comment 36, Page 7-5

A majority of the mass of DDx is located in subsurface sediments between Docks 1 and 2. DDx has a high affinity for particles and does not readily migrate with groundwater accept for cosolvency with solvents such as MCB. Based on the location of the DDx mass and the chemical sorption properties of DDx, localized isolation capping is a viable option that can be considered in the EE/CA.

Comment 121, Page 7-5, Bullet 1

The EPA/Parametrix reference to "thin-layer caps" is replaced by "thin-layer placement" to reflect EPA Sediment Guidance.

7.4 HYDRAULIC CONTAINMENT

No changes to this section are required.

8 DATA GAP ANALYSIS AND PROPOSED REMOVAL ACTION CHARACTERIZATION ACTIVITIES

8.1 DATA GAPS

Comment 122, Section 8.1.3, Page 8-4, Paragraph 3

The need for additional sedimentation data will be determined after the remedy option is selected in the EE/CA.

Comment 123, Section 8.1.4.1, Page 8-4, Paragraph 2

Analysis of dioxin-like polychlorinated biphenyls (PCBs) will not be required as part of the EE/CA process. However, both chlorinated dioxins/furans and dioxin-like PCBs will be analyzed in the sediments off of the Site after the removal action is completed. Chlorinated dioxin/furan and dioxin-like PCB data analyzed as part of the post-removal action monitoring will be used to assess the effectiveness of the removal action and to compare the remaining sediment concentrations to the remediation goals developed for the Portland Harbor RI/FS.

8.2 REMOVAL ACTION CHARACTERIZATION ACTIVITIES

Comments 40/42, Section 8.2.1.2, Page 8-11

EPA and LSS agree that the sediment sampling proposal can consider all of the information being used to evaluate data gaps. LSS will propose the additional sampling locations based on remaining data gaps and baseline characterization needs. The revised FSP (Appendix A) will include the rationale for the final sample locations. The revised FSP will also include a figure that illustrates the revised preliminary RAA boundary agreed upon by EPA and LSS, as well as final sample locations and types.

Comment 43, Section 8.2.1.2, Page 8-12, Bullet 2

Technical discussion between EPA and LSS and further review of the available information from the Site indicates that elevated levels of chloride are not expected in most areas of the in-water Site. Consequently chemical analysis for surface sediment samples will not include chloride.

Comment 125, Section 8.2.1.2, Page 8-12

EPA no longer believes that surface sediment bioassays are necessary to evaluate practical limits of the RAA. Analyte tables in the EPA/Parametrix Work Plan will be revised and included in the FSP.

Comment 44, Section 8.2.1.2, Page 8-13, Paragraph 1

Dioxin/furan surface sampling will be needed at certain stations. The revised FSP will include the rationale for the analytical strategy at each sample location where dioxin/furan analysis is proposed. Analyte tables in the EPA/Parametrix Work Plan will be revised and included in the FSP.

Comment 45, Section 8.2.1.2, Page 8-15, Paragraph 2

Rationale for sampling at sediment stations WS/WB-82, 83 and 84 will be revisited and provided in the revised FSP. The rationale provided in the FSP will be accompanied by a figure depicting the final locations of all sediment sampling stations.

Comment 46, Section 8.2.1.2, Page 8-15, Paragraph 6

All sediment borings that are logged for lithology will also be visually examined for bioturbation. A visual inspection will provide an adequate determination of bioturbation depth, so beryllium-7 analysis of sediment samples is unnecessary. The depth of bioturbation will have no effect on defining the RAA boundary and no effect on dredging analysis.

Comment 47, Section 8.2.1.2, Page 8-15, Paragraph 6

The rationale for subsurface sediment sample density and location will be revisited and provided in the FSP. The rationale provided in the FSP will be accompanied by a figure depicting the final locations of all subsurface sediment sampling locations.

Comment 48, Section 8.2.1.3, Page 8-17, Paragraph 2

The primary surface water baseline conditions that need to be established in the EE/CA are contaminant concentrations in water and recontamination potential. The surface water and stormwater program currently being conducted as part of the LWG RI will be adequate for evaluating these baseline surface water conditions for the EE/CA evaluation. No sampling is specified in this Final Work Plan. Additional baseline surface water sampling will be proposed as part of the removal action design.

Comments 49, 51, 52, 53, Section 8.2.2.1, Page 8-19

Section 8.2.2.1 provides a detailed rationale, sampling strategy and analytical strategy for measuring SVOCs, pesticides, PCB Aroclors and PCB congeners in aquatic biota. Biota sampling for the EE/CA will be needed for several objectives, including but not limited to 1) identifying baseline conditions in biota before the removal action; 2) assessing the impacts of the removal action on biota contaminant levels; and 3) assessing the effectiveness of the removal. However, the extent of biota sampling needed to meet these objectives is dependent

upon several factors, including the boundary of the RAA, the methods used for removal, and the design of the final removal action, which cannot be accurately predicted at the EE/CA work plan stage. Therefore, the FSP/QAPP for the removal area characterization will discuss the biota sampling objectives but otherwise will defer biota sampling until after EE/CA design. The pre-remedial biota sampling will include appropriate target species such as crayfish, clams, smallmouth bass, and sculpin; surrogate species or passive surrogate sampling devices (e.g., semipermeable membrane devices [SPMDs]) will also be evaluated in the study design to assure a cost-effective monitoring approach that will yield sufficient numbers of samples that will accurately represent sediment-biota relationships needed to verify sediment remediation effectiveness.

Comment 50, Section 8.2.2.1, Page 8-19

LSS has agreed to share any data generated for the EE/CA with LWG. EPA has agreed that no specific sampling in support of the Portland Harbor RI/FS will be required.

Comments 54-60, Attachment B

Two-dimensional kriging will remain in the Final Work Plan; however, three-dimensional kriging can also be used to identify data gaps, further define the RAA, estimate mass of DDx and volume of sediment within the RAA, and refine and focus the EE/CA site characterization. The methods and software used in the three-dimensional modeling and spatial analysis of total DDx contamination in sediment at the Site is described further below. In addition, a summary of the methods and results of the Environmental Visualization System (EVS) data gap analysis tool that was used to focus on the uncertainty in the three-dimensional kriged model of DDx mass in sediments at the Site is described below.

Three-dimensional Kriging Methodology

C Tech's EVS-Pro and ESRI's ArcGIS software was used for the modeling and spatial analysis of total DDx contamination in sediment at the Site. Sediment data consisted of 229 surface and subsurface sample points of DDx concentrations converted to a mass-per-volume relationship (mg/m^3). This data was converted to a groundwater chemistry file (.gwc) for input to the 3D Krig module in EVS. In the 3D Krig module, the data was processed using a Log10 base. The "adaptive," "proportional," and "favor max values" gridding options were all selected.

The geologic model domain was developed using 4,700 elevation points from the combined datasets of multibeam bathymetric sonar and surface LiDAR. The combined data was converted to a geology multi file (.gmf). The file was used as input for the 3D Krig Geology module in EVS. The extent of the model was constrained horizontally by the study area boundary and vertically by the mask geology module that references the .gmf file.

The model developed for the DDx mass removal approach used kriging to interpolate the DDx sediment data at the Site. Kriging is a geostatistical method that minimizes the estimated variance of a predicted point with the weighted average of its neighbors. Kriging uses a semivariogram graph, which plots one-half of the square of differences between samples versus distance. The semivariogram describes the weighting factors applied for the kriging interpolation. Unlike inverse distance weighting, another interpolation method, kriging provides a measure of the error and associated confidence and uncertainty in the estimates at each point in the model.

For the DDx mass removal analysis, EVS software kriging algorithms were used to estimate DDx masses and concentrations in the analysis area. Sample stations with chemical results for DDx have 100 percent confidence in the three-dimensional kriging. DDx concentrations at every other location in the analysis area are predicted by the kriging algorithm. The kriging algorithm computes the standard deviation from the semivariogram for each estimated value in the analysis area. This standard deviation allows the assessment of the confidence and uncertainty of the estimated values within the analysis area.

Several EVS subsetting modules were applied to the three-dimensional Krig surface to enhance visualization and interpretation. These modules consist of *Slice*, *Cut*, and *Isovolume*. Isovolumes were defined at several concentration levels to identify the spatial distribution and estimate mass and volume of DDx in sediment.

Isovolumes were exported from EVS as three-dimensional shapefiles as the basis for calculating dredge prisms in ArcMap to estimate volumes of sediment that would need to be removed for specific clean-up levels. A spatial join was performed using 10 ft x 10 ft cells and the Isovolume shapefile. The spatial join extracted the maximum depth elevation of contamination within a given cell. The contamination depth per cell was rounded down to the nearest foot. The difference in surface elevation and depth was multiplied by the cell area to determine the volume of sediment per cell. The individual cell volumes were totaled to provide the volume per concentration level.

EVS Pro's Drill Guide functionality was used to statistically determine, from the Krig dataset, the optimal locations for additional sediment sampling as described below.

Data Gap Analysis

The EVS data gap analysis tool will be used to focus on the uncertainty in the three-dimensional kriged model of DDx (i.e., sum of total DDT, total DDD, and total DDE) mass in sediments at the Site. This tool can be used to supplement other data gaps analyses that are conducted to identify key data needs for data collection for the Site EE/CA.

The objective of this analysis is to identify data gaps by identifying areas of higher uncertainty in the 3D kriged model that are located in the areas near the "breakpoint" in the DDx mass

removal analysis for the Site sediments. The target sample locations identified in this analysis will be used in conjunction with other data gaps analyses to identify potential target locations for further EE/CA investigation.

A process called "Drill Guide" in the EVS software can be utilized to identify areas of high uncertainty. Drill Guide identifies trends in the kriged sediment data to determine the optimal locations for additional sampling. The Drill Guide can be used to focus on specific areas of the Site.

The Drill Guide will be run on two-dimensional kriged data using the highest total DDx concentration from each sample station[1]. The highest concentration is used because the data gaps associated with the higher concentrations of DDx are of greatest interest for the mass removal approach analysis. For this analysis, the Drill Guide will be used to analyze uncertainty associated with each of two specified target concentrations (5 and 10 mg/kg) that bracket the breakpoint in the total DDx mass data. The Drill Guide will be set to identify 20 locations for each of these target concentrations where the predicted concentration confidence is low.

The results of the drill guide analysis will be shown in conjunction with the mass removal boundaries that bracket the DDx sediment mass removal breakpoint (i.e., 5 and 10 mg/kg DDx) and also the existing sediment sample stations. This analysis will identify potential target areas for additional investigation, but not the specific number of boreholes or sample points that will be required to complete the EE/CA investigation. The results of this analysis will be presented in the FSP.

[1] The EVS software developers recommend the 2D analysis because of the complexities of examining uncertainty in three dimensions. There is no differentiation between surface and subsurface samples in this 2D analysis and both surface and subsurface samples are equally weighted. As a result, the 2D model will yield similar results to the 3D model with the exception that the 3D model will also in some cases identify multiple sample depths at a single sample station that have higher uncertainty. The latter aspect of the 3D analysis is not lost, however, because it is assumed that the 2D drill guide will be used to identify borings that will be advanced to depth (i.e., bedrock or equivalent depths).

9 PROJECT SCHEDULE

Removal action activities are on schedule and will be completed within the timeline provided in the Statement of Work (SOW) and in accordance with the AOC. Addendum Figure 9-1 updates the current project schedule, as modified by the Opalski Decision.

10 PROJECT TEAM AND RESPONSIBILITIES

No changes to this section are required.

11 REFERENCES

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FIGURES

Estimated Acid Plant Area RiverBank Fill

Proposed 1977, 1984, and 1993 dredge areas

Approximate location of former DDT pond and trench

Estimated location of 1956 dredging activities

Dock #2

Dock #1

Salt Dock

Estimated fill area from the 1956 dredging activities

Ordinary Highwater Line Based On Elevation of 20.46' NAVD88.

Acid Plant Area

Outfall 004

Outfall 003

Outfall 002

Outfall 001

RHONE POULENC

Railroad Bridge

Approximate Location of Former Process Discharge Pipe

Old Caustic Tank Farm

Former Salt Storage Area

Warehouse No. 2

CITY OF PORTLAND

RHONE POULENC

Approximate Top of Bank

Former Ammonia Plant Area

Former Chlorate Plant Barge Loading Overhead Pipeline

Acid Plant Area

Former brine mud pile and pond area

Warehouse No. 1

Boiler Room

Former location of asbestos trenches

Lot 2

Lot 3

Lot 1

New Caustic Tank Farm

Chlorate Plant Area

Former Asbestos Ponds

Lot 4

Former DDT Process Building

Saltzman Creek

BPA Substation Annex

BPA Main Substation

Old Chlorine cell room (1946-1971)

New Chlorine Cell room (1962-2001)

CB-001-01
CB-001-02
CB-001-03
CB-001-04
CB-001-05
CB-001-06
CB-001-07
CB-002-01
CB-002-02
CB-003-02
CB-003-03
CB-003-05
CB-003-06
CB-003-07
CB-004-01
CB-004-02
CB-004-03

REVISED DRAFT

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This document is currently under review by US EPA and its federal, state, and tribal partners, and is subject to change in whole or in part.

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integral consulting inc.

200 100 0 200 Feet

Ordinary High Water
Top of Bank
E-Sewer-L
Storm Drain
Overhead Pipeline
12ft_Contour
Navigation Channel
Bridges
Property Lines
Outfalls
Catch Basins
Estimated Fill Area
Proposed 1977, 1984, and 1993 dredge areas
Estimated Dredged Area

Figure 2-4
Arkema EE/CA
Dredge & Fill and Historical Uses of Site

7/22/2008 Revision

PRELIMINARY DRAFT SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**EFFECTIVE DATE OF AOC**	1 day	Mon 6/27/05	Mon 6/27/05
2	**EE/CA WORK PLAN**	**1211 days**	**Tue 6/28/05**	**Mon 10/20/08**
3	Draft EE/CA Work Plan	91 days	Tue 6/28/05	Mon 9/26/05
4	Agency Review EE/CA Work Plan	36 days	Tue 9/27/05	Tue 11/1/05
5	Agency Comments and Dispute Resolution	129 days	Wed 11/2/05	Fri 3/10/06
6	Revised Work Plan and Interim Deliverables	126 days	Sat 3/11/06	Fri 7/14/06
7	Agency Review EE/CA Work Plan	68 days	Sat 7/15/06	Wed 9/20/06
8	Agency Comments and Dispute Resolution	69 days	Thu 9/21/06	Tue 11/28/06
9	EPA Dispute Finding	1 day	Wed 11/29/06	Wed 11/29/06
10	EPA Work Plan	232 days	Fri 9/22/06	Fri 5/11/07
11	Review, Comments, Meetings, and Informal Dispute Resolution	283 days	Sat 5/12/07	Mon 2/18/08
12	Formal Dispute	95 days	Tue 2/19/08	Fri 5/23/08
13	Work Plan Addendum	60 days	Sat 5/24/08	Tue 7/22/08
14	FSP, QAPP, HASP	90 days	Sat 5/24/08	Thu 8/21/08
15	EPA Review and Approval of EE/CA Work Plan	60 days	Fri 8/22/08	Mon 10/20/08
16	**ADDITIONAL SITE CHARACTERIZATION**	**140 days**	**Tue 10/21/08**	**Mon 3/9/09**
17	Field Mobilization	20 days	Tue 10/21/08	Sun 11/9/08
18	Field Sampling	60 days	Mon 11/10/08	Thu 1/8/09
19	Laboratory Analysis and Validation	120 days	Mon 11/10/08	Mon 3/9/09
20	**REMOVAL ACTION CHARACTERIZATION REPORT**	**243 days**	**Tue 10/21/08**	**Sat 6/20/09**
21	Draft Removal Action Characterization Report	152 days	Tue 10/21/08	Sat 3/21/09
22	Agency Review of Removal Action Characterization Report	30 days	Sun 3/22/09	Mon 4/20/09
23	Final Removal Action Characterization Report	30 days	Tue 4/21/09	Wed 5/20/09
24	EPA Approval of Removal Action Characterization Report	31 days	Thu 5/21/09	Sat 6/20/09
25	**EE/CA REPORT**	**331 days**	**Sun 6/21/09**	**Mon 5/17/10**
26	Technical Briefing on Proposed Remedial Alternatives	30 days	Sun 6/21/09	Mon 7/20/09
27	First Draft EE/CA	90 days	Tue 7/21/09	Sun 10/18/09
28	Agency Review of Draft EE/CA	30 days	Mon 10/19/09	Tue 11/17/09
29	Second Draft (Public Review) EE/CA	60 days	Wed 11/18/09	Sat 1/16/10
30	Public Review of Second Draft EE/CA	30 days	Sun 1/17/10	Mon 2/15/10
31	Final EE/CA	61 days	Tue 2/16/10	Sat 4/17/10
32	EPA Approval of EE/CA	30 days	Sun 4/18/10	Mon 5/17/10
33	**BIOLOGICAL ASSESSMENT AND 404 MEMORANDUM**	**392 days**	**Tue 7/21/09**	**Mon 8/16/10**
42	**EPA ISSUANCE OF THE ACTION MEMORANDUM**	61 days	Tue 8/17/10	Sat 10/16/10
43	**PROJECT DESIGN DOCUMENTS**	**315 days**	**Sun 10/17/10**	**Sat 8/27/11**
50	**SELECTION OF CONTRACTOR(S)**	**88 days**	**Sun 8/28/11**	**Wed 11/23/11**
56	**REMOVAL ACTION WORK PLAN**	**136 days**	**Thu 11/24/11**	**Sat 4/7/12**
57	Draft Removal Action Work Plan	60 days	Thu 11/24/11	Sun 1/22/12
58	Agency Review of Draft Removal Action Work Plan	30 days	Mon 1/23/12	Tue 2/21/12
59	Final Removal Action Work Plan	32 days	Wed 2/22/12	Sat 3/24/12
60	EPA Approval of Removal Action Work Plan	14 days	Sun 3/25/12	Sat 4/7/12
61	**IMPLEMENTATION OF REMOVAL ACTION**	**152 days**	**Sun 4/8/12**	**Thu 9/6/12**
62	Notification of Removal Action Start	30 days	Sun 4/8/12	Mon 5/7/12
63	Removal Action	122 days	Tue 5/8/12	Thu 9/6/12
64	Removal Action Completion	0 days	Thu 9/6/12	Thu 9/6/12
65	**UPLAND SOURCE CONTROL EVALUATION AND IRM's**	**1373 days**	**Sun 1/6/08**	**Sun 10/9/11**
66	Stormwater Source Control Focused Feasibility Study	180 days	Sun 1/6/08	Thu 7/3/08
67	Agency Review of Stormwater Focused Feasibility Study	45 days	Fri 7/4/08	Sun 8/17/08
68	Stormwater Source Control IRM and Report	540 days	Mon 8/18/08	Mon 2/8/10
69	Agency Review and Approval of Stormwater Source Control IRM Report	45 days	Tue 2/9/10	Thu 3/25/10
70	Groundwater Source Control Focused Feasibility Study	100 days	Thu 2/7/08	Fri 5/16/08
71	Agency Review of Groundwater Focused Feasibility Study	77 days	Sat 5/17/08	Fri 8/1/08
72	Groundwater Source Control IRM and Report	1134 days	Sat 8/2/08	Fri 9/9/11
73	Agency Review and Approval of Groundwater Source Control IRM Report	30 days	Sat 9/10/11	Sun 10/9/11

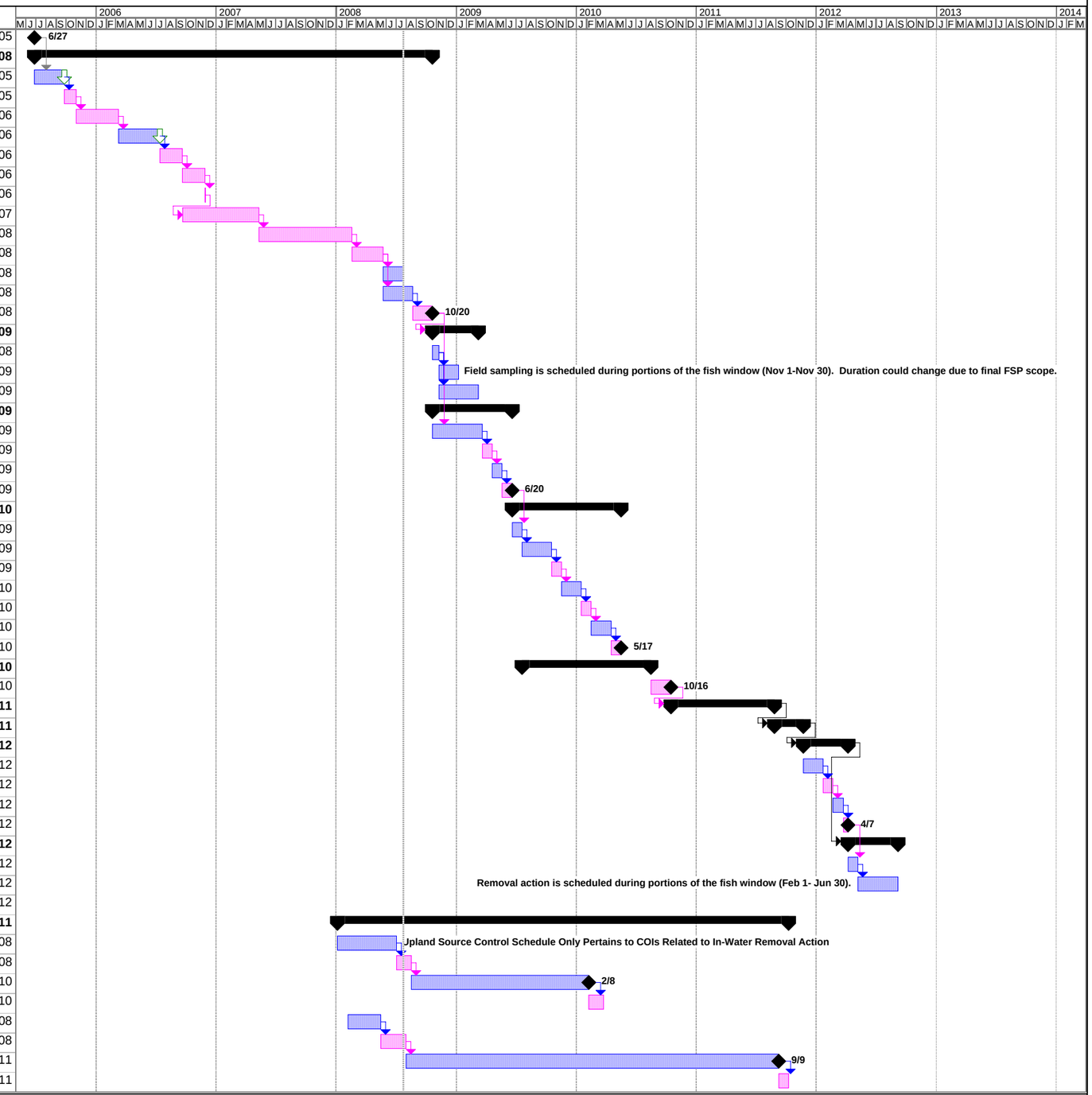

Figure 9-1. Project Schedule

Task | Split | Milestone | Summary | Deadline

Note: Dates and duration of tasks shaded in red are dependent on timing of agency review.

PRELIMINARY DRAFT SCHEDULE

18 Field Sampling
Field sampling is scheduled during portions of the fish window (Nov 1-Nov 30). Duration could change due to final FSP scope.

63 Removal Action
Removal action is scheduled during portions of the fish window (Feb 1- Jun 30).

66 Stormwater Source Control Focused Feasibility Study
Upland Source Control Schedule Only Pertains to COIs Related to In-Water Removal Action

Note: Dates and duration of tasks shaded in red are dependent on timing of agency review.

TABLES

Addendum Table 2-2. Average Annual Stormwater Discharge by Drainage Area

Description	Area (square feet)	Area (acres)	Pervious Area (%)	Impervious Area (%)	Fraction of Precipitation That Produces Runoff[a]	Runoff Coefficient[b]	Discharge[c] (gallons/yr)
Lots 3 and 4 Drainage Basins							
Drainage to Outfall 001	796,000	18.3	30%	70%	0.9	0.68	10,900,000
Drainage to Outfall 002	75,000	1.7	0%	100%	0.9	0.95	1,400,000
Drainage to Outfall 003	347,000	8.0	43%	57%	0.9	0.56	4,000,000
Drainage to Outfall 004 (including from Lot 2)	528,000	12.1	88%	12%	0.9	0.16	1,700,000
Lots 3 & 4[d]					0.9		
Lot 3	75,000	1.7	100%	0	0.9	0.05	100,000
Lot 4	75,000	1.7	100%	0	0.9	0.05	100,000
Lot 1 - Total	267,000	6.1	100%	0	0.9	0.05	300,000
Lot 2 (minus drainage to Outfall 004)	208,000	4.8	100%	0	0.9	0.05	200,000
Total Area:	2,371,000	54.4					

Total Point Source Discharge from Outfalls 1, 2, 3, and 4:	18,000,000	=	96%
Total Non-Point Source Discharge:	700,000	=	4%
Total Discharge:	18,700,000		

Notes:

[a] Default value.

[b] Runoff Coefficient utilizing "The Simple Method", *Urban Stormwater Hydrology, A Guide to Engineering Calculations*. CRC Press. 1993. Rv = 0.05 + 0.009x(percent impervious).

[c] Discharge = Area (Acres) x Fraction of Precipitation producing runoff x Runoff Coefficient x 27153.4 (Unit Conversion Factor)

[d] Area within Lots 3 & 4 that is outside of the current drainage to Outfalls 001, 002, 003, and 004 and discharge as non-point source to the Willamette River.

[e] A small amount of stormwater from Lot 1 flows to Lot 3 and ultimately to the Willamette River through Outfall 004 (Figure 2-5).

[f] Approximatley 3.5 acres of runoff from Lot 2 flows to Lot 3 and ultimately to the Willamette River through Outfall 004. This acerage is counted in the drainage to Outfall 004.

Source:

Integral. 2008. DRAFT Stormwater Interim Remedial Measures Focused Feasibility Study Report, Arkema Portland Site. Prepared for Legacy Site Services LLC, Exton, PA. Integral Consulting Inc., Portland, OR.

Addendum Table 4-5. Stormwater COPC Loading from Lots 3 and 4.

COPC	Outfall 001 (mg/L)	Outfall 002 (mg/L)	Outfall 003 (mg/L)	Outfall 004 (mg/L)
4,4'-DDD				
02/15/07	3.74E-05	4.29E-05	5.92E-05 U	6.34E-05
03/02/07	4.48E-05 J	5.40E-05 J	3.33E-05 J	5.45E-05 J
03/19/07	5.92E-05 U	5.92E-05 U	2.78E-05 U	4.09E-05 U
06/05/07	3.33E-05 J	3.33E-05 J	NS	NS
Average Concentration[a]	4.51E-05	4.00E-05	0.00E+00 [b]	4.61E-05
Annual Discharge Quantity (gal)	10,900,000	1,400,000	4,000,000	1,700,000
Average Annual Mass (lb)	4.10E-03	4.67E-04	0.00E+00	6.54E-04
Total Loading (lbs):	0.0052			
4,4'-DDE				
02/15/07	1.48E-04	2.29E-04	2.28E-04	8.43E-05 U
03/02/07	2.16E-04	2.49E-04	9.28E-05	1.34E-04
03/19/07	2.28E-04	2.28E-04	2.40E-04 J	1.57E-04
06/05/07	9.28E-05 J	9.28E-05 J	NS	NS
Average Concentration[a]	1.71E-04	2.00E-04	1.87E-04	1.11E-04
Annual Discharge Quantity (gal)	10,900,000	1,400,000	4,000,000	1,700,000
Average Annual Mass (lb)	1.56E-02	2.33E-03	6.24E-03	1.58E-03
Total Loading (lbs):	0.0257			

Addendum Table 4-5. Stormwater COPC Loading from Lots 3 and 4.

COPC	Outfall 001 (mg/L)	Outfall 002 (mg/L)	Outfall 003 (mg/L)	Outfall 004 (mg/L)
4,4'-DDT				
02/15/07	1.32E-04 J	3.73E-04 J	1.57E-04	8.43E-05
03/02/07	1.61E-04 J	4.78E-04 J	1.80E-04 J	1.22E-04 J
03/19/07	1.57E-04	1.57E-04	2.14E-04 J	1.27E-04
06/05/07	1.80E-04 J	1.80E-04 J	NS	NS
Average Concentration[a]	1.58E-04	2.97E-04	1.84E-04	1.11E-04
Annual Discharge Quantity (gal)	10,900,000	1,400,000	4,000,000	1,700,000
Average Annual Mass (lb)	1.43E-02	3.47E-03	6.13E-03	1.58E-03
Total Loading (lbs):	0.0262			
Total DDx Loading (lbs):	0.0572			

Notes:

[a] Averages were calculated using 1/2 the detection limit for undetected constituents. If all concentrations were below detection limits, averages were not calculated.

[b] If analyte was not detected in a given area, average concentration was assumed to be zero.

U - undetected at detection limit shown
J - estimated concentration
NA - not applicable
NS - not sampled

Source:

Integral. 2008. DRAFT Stormwater Interim Remedial Measures Focused Feasibility Study Report, Arkema Portland Site. Prepared for Legacy Site Services LLC, Exton, PA. Integral Consulting Inc., Portland, OR.

Table 2-3. Chronology of Fill and Dredge Events at Arkema.

Year	Location	Description
1953	Northern vacant portion of the property	In 1953, the Port of Portland in cooperation with the USACE disposed of dredged materials from the Willamette River onto what is currently Lots 1 and 2 (Elf Atochem 2000).
After 1953	Along riverbank	Fill was placed in the Acid Plant area bordering the Willamette River after DDT manufacturing ceased. It appears that the bank adjacent to the Acid Plant area has been filled out toward the Willamette River approximately 200 ft since the 1950s (CH2M Hill 1997). Fill thickness ranges from a few feet in the former DDT manufacturing area to approximately 25 ft along the riverbank (Integral 2004a). The sources of the fill material included the City of Portland, private excavation contractors, and Elf Atochem (ERM 2005d). Fill materials included clean soil, asphalt, concrete, metal piping, and miscellaneous materials from spent chlorine cells (ERM 2005d).
1956	Salt Dock	Two areas were dredged to accommodate dock construction. The dredged material was placed behind an earthen berm, which extended from Dock 1 to the upstream end of the property, to form the base of the eastern half of the current salt pads.[a] Some dredged materials from the navigation channel may have also been placed on the property by others (Elf Atochem 2000).
1977	Dock 1 and Salt Dock[b]	Three areas were apparently dredged. A letter from Pennwalt Corporation to USACE requested permission to complete the dredging with a clamshell to an elevation of -30 ft (datum unknown). The permit application (No. 2607) indicates that the dredging was to be conducted between May 15 and June 15, 1977. According to a letter from Pennwalt to the USACE, dated April 19, 1977, approximately 1,000 cy of material was supposed to be dredged by clamshell derrick, loaded onto flat-decked barges, and removed from the site for disposal behind a protective berm that is located above the high water mark at the Brand S disposal site (Pennwalt 1977). There is no documentation or confirmation that dredging took place.
1984	Dock 1 and Salt Dock[b]	Joint permit application No. 5565 to USACE and Oregon DSL to repeat dredging apparently conducted in 1977. This permit application was approved in a letter from the USACE to Pennwalt Corporation dated September 15, 1984 (USACE 1984). Dredging was to be completed to elevation -30 ft MSL and application was for 500 cubic yards (cy). There is no confirmation that dredging was initiated and completed, but application states that the dredging was to be conducted from September 17-20, 1984.

Table 2-3. Chronology of Fill and Dredge Events at Arkema.

Year	Location	Description
1993	Dock 1 and Salt Dock[b]	Dredging permit application No. 93-54 was granted in a letter from the USACE on January 19, 1994 (USACE 1994). The application was for maintenance dredging of 500 cy of sand and silt. The dredging spoils were to be disposed of in the Ross Island Lagoon. This permit application was submitted because of the company name change from Pennwalt Corporation to Elf Atochem North America. The estimated start date on the application was June 1993; the completion date was listed as "ongoing." There is no confirmation that dredging was initiated or completed.
1999	Dock 1 and Salt Dock	Dredging permit application No. 99-651 was denied in 1999 due to concerns about pesticide contamination. On February 6, 2002, the permit was withdrawn by ATOFINA Chemicals, Inc. because the Portland plant was shut down.

Notes:

[a] 1956: Approximate dredge areas were as follows: an area 175 ft x 1200 ft was dredged to -35 ft, extending from Dock 1 to the south end of the current No. 3 Salt Pad (the southernmost pad). A second area within the channel, 575 ft x 1225 ft , was dredged to -50 ft (datum unknown) [Source: Arkema].

[b] 1977, 1984, and 1993: Proposed dredge areas: (1) area 200 ft long and 30 ft wide at northern end of Dock 1; (2) area 150 ft long and 25 ft wide towards the middle of Dock 1; (3) area 150 ft long and 25 ft wide along the Salt Dock (Figure 2-1) [Source: USACE permit applications].