LOWER FOX RIVER REMEDIAL DESIGN
60 PERCENT DESIGN REPORT
FOR 2009 REMEDIAL ACTIONS

VOLUME 1 OF 2

Prepared for

Appleton Papers Inc.

Georgia-Pacific Consumer Products LP

NCR Corporation

For Submittal to

Wisconsin Department of Natural Resources

U.S. Environmental Protection Agency

Prepared by

Anchor Environmental, L.L.C.

Tetra Tech EC, Inc.

J. F. Brennan Co, Inc.

Boskalis Dolman

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Anchor	Anchor Environmental, L.L.C.
AOC	Administrative Order on Consent
A/OT	Agencies/Oversight Team
ARAR	applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
BDTTRA	Best Demonstrated Treatment Technology Reasonable Achievable
BMP	best management practice
BOD	biochemical oxygen demand
BODR	Basis of Design Report
CBR	California bearing ratio
CDF	confined disposal facility
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
cm	centimeter
CQAPP	Construction Quality Assurance Project Plan
cy	cubic yards
DOC	depth of contamination
DOT	Department of Transportation
DRET	Dredging Elutriate Test
ERDC	Engineer Research and Development Center
fps	feet per second
FIK	full indicator kriging
Fort James	Fort James Operating Company, Inc.
GAC	granulated activated carbon
GIS	geographic information system
GP	Georgia-Pacific Consumer Products LP
gpm	gallons per minute
GPS	global positioning system
HASP	Health and Safety Plan
HDPE	high-density polyethylene
HMI	human-machine interface
hp	horsepower
h:v	horizontal to vertical

IGLD	International Great Lakes Datum
J.F. Brennan	J.F. Brennan and Company
kHz	kilohertz
LDD	Land Development Desktop (by AutoDesk)
LGAC	liquid-phase granulated activated carbon
LOS	level of significance
LTMP	Long-Term Monitoring Plan
mg/L	milligrams per liter
MNR	monitored natural recovery
NAD	North American Datum
NAVD	North American Vertical Datum
NCR	NCR Corporation
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OMMP	Operations, Maintenance and Monitoring Plan
OU	Operable Unit
PCB	polychlorinated biphenyl
PLC	programmable logic controller
PND Engineers	Peratrovich, Nottingham & Drage Engineers Inc.
ppm	part per million
psi	pounds per square inch
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RA	remedial action
RAL	remedial action level
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RD Respondents	Fort James Operating Company, Inc. and NCR Corporation
Response Agencies	USEPA and WDNR
RM	river mile

ROD	Record of Decision
rpm	revolutions per minute
RTK	Real Time Kinematic
SAP	Sampling and Analysis Plan
SDR	Standard Dimension Ratio
Shaw	Shaw Environmental and Infrastructure, Inc.
SHPO	State Historic Preservation Officer
SMU	Sediment Management Unit
SOW	Statement of Work
SPT	Standard Penetration Test
SWAC	surface weighted average concentration
SWPPP	Stormwater Pollution Prevention Plan
Tetra Tech	Tetra Tech EC, Inc.
TIN	triangulated irregular network
TSCA	Toxic Substances Control Act
TSS	total suspended solids
µg	microgram (or micron)
µg/m^3	micrograms per cubic meter
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VFD	variable frequency drive
WDOT	Wisconsin Department of Transportation
WDNR	Wisconsin Department of Natural Resources
WPDES	Wisconsin Pollutant Discharge Elimination System
WRDA	Water Resources Development Act
WTM	Wisconsin Traverse Mercator
WTM I	WTM I Company
WTP	wastewater treatment plant
ZID	zone of initial dilution

1 INTRODUCTION

This document presents Volume 1 of the 60 Percent Design Report for the remediation of polychlorinated biphenyls (PCBs) in Operable Units (OUs) 2 to 5 of the Lower Fox River and Green Bay Site (Site; Figure 1-1). This Volume 1 submittal presents the remedial design (RD) of construction activities scheduled for implementation in 2009, including remedial action (RA) in OU 2, upper OU 3, a portion of upper OU 4, and associated material processing and staging facilities. The accompanying Volume 2 of this 60 Percent Design Report presents the RD for remaining activities within OUs 2 to 5 to be performed in 2010 and beyond. Included in the Volume 2 document are summaries of sampling, analysis, and engineering evaluations completed to date that form the basis for the overall RD in OUs 2 to 5.

The PCB cleanup remedy for the Lower Fox River was originally set forth in Records of Decision (RODs) for OUs 2 to 5 issued in December 2002 and June 2003 by the United States Environmental Protection Agency (USEPA) and the Wisconsin Department of Natural Resources (WDNR) under the authority of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended, 42 U.S.C. §§ 9601-9675. The RD requirements for OUs 2 to 5 were originally set forth in the Administrative Order on Consent (AOC) and associated Statement of Work (SOW) for OUs 2 to 5 (USEPA 2004), executed in March 2004 by Fort James Operating Company, Inc.[1] (Fort James) and NCR Corporation (NCR) (collectively the "RD Respondents") in cooperation with the USEPA and WDNR (collectively the "Response Agencies"). USEPA and WDNR are overseeing the RD process, and design documents prepared by the RD Respondents are subject to review and approval by USEPA and WDNR.

In order to support detailed RD analyses consistent with the RODs, intensive data collection was performed beginning in 2004, resulting in collection and analysis of approximately 10,200 sediment samples from 1,900 locations at the Site through 2007. The resulting sampling density varied across OUs 2 to 5, averaging approximately one core per 1.3 acres within the 2,200-acre sampling area. Much of that new information was compiled and analyzed in the Basis of Design Report (BODR) for OUs 2 to 5 (Shaw and Anchor 2006), approved by USEPA and WDNR in July 2006. The BODR concluded that approximately 1,170 acres of OUs 2 to 5

[1] In January 2007, Fort James Operating Company, Inc was converted to Georgia-Pacific Consumer Products LP.

exceeded the 1.0 part per million (ppm) PCB remedial action level (RAL) specified in the RODs, representing approximately 7.56 million cubic yards (cy) of in situ sediment. In June 2007, a ROD Amendment was issued by USEPA and WDNR that made changes to parts of the remedy described in the original RODs in response to the new information analyzed in the BODR, and also from experience with prior remediation activities at the Site (USEPA and WDNR 2007). Brief summaries of site characteristics and the OUs 2 to 5 remedy (including ROD Amendment requirements) are provided in Sections 1.2 and 1.3, respectively. A more complete summary is provided in the accompanying 60 Percent Design Report Volume 2 submittal. Design of RAs in OU 1 is being addressed under a separate agreement between USEPA, WDNR, and the WTM I Company (WTM I).

The October 30, 2007 revised AOC and the Administrative Order for Remedial Action (2007 RD AOC) between the RD Respondents and the Response Agencies modified the previous SOW and AOC to ensure consistency with the 2007 ROD Amendment. On November 30, 2007, the RD Respondents submitted to the Response Agencies the Preliminary (30 Percent) Design for OUs 2 to 5. The 30 Percent RD submittal included summaries of RD analyses completed to date, along with engineering design plans, cross-sections, and drawings that described the design of the 2007 ROD Amendment remedy in more detail. On February 1, 2008, the Response Agencies approved the 30 Percent Design Report with modifications.

Throughout the RD process, the Response Agencies and RD Respondents have collaboratively sought to resolve key technical and implementation issues through the timely use of workgroups and other communications (e.g., technical memoranda). Many of the technical memoranda and data collected during each phase of the RD have been included with the design deliverable for that phase of the work (e.g., technical memoranda produced during the 30 Percent Design Phase were included with the 30 Percent Design). At the recommendation of the Response Agencies, each successive RD deliverable has not duplicated technical memoranda, data, and other information that were previously included in, or attached to, an earlier design deliverable. Rather, a "RD Design Anthology" is currently being developed that will include all information that forms the basis of the design, including the project analytical database, technical memoranda documenting key parts of the RD, and each RD submittal (e.g., BODR, 30 Percent Design, 60 Percent Design, etc.). The intent is to continually update the Design Anthology as the RD progresses, in order to maintain a complete set of RD documents.

The RD Respondents currently plan to submit the Design Anthology, including RD information through the 60 Percent Design phase, in July 2008.

This 60 Percent Design submittal builds on the BODR, the ROD Amendment, the 30 Percent Design, and follow-on collaborative workgroup efforts. Since submittal of the 30 Percent Design Report, the team of Tetra Tech EC, Inc. (Tetra Tech), J.F. Brennan and Company (J.F. Brennan), and Boskalis Dolman (collectively "the Tetra Tech Team") have been selected to perform the RA for OUs 2 to 5. The equipment and methods proposed by the Tetra Tech Team have been included in this 60 Percent Design Report.

The requirements for the 60 Percent Design submittal are more specifically described in the RD Work Plan approved by the Response Agencies on June 28, 2004, and the RD Work Plan Addendum Schedule approved by the Response Agencies on April 29, 2008. This 60 Percent Design Report has also been developed in accordance with the Response Agencies' *Requirements for the 60 Percent Design Report* provided on April 29, 2008 (USEPA 2008). Consistent with these requirements, the 60 Percent Design Report is being presented in two volumes. This Volume 1 submittal presents the RD of actions that will be performed in 2009, while Volume 2 describes those activities that will occur in 2010 and beyond. This Volume 1 submittal includes the following:

- Determination of specific technologies for sediment dredging, dewatering, transportation, and disposal of dredged sediments and associated wastewaters to be performed in 2009
- Design assumptions, parameters, and specifications, including design restrictions, process performance criteria, appropriate unit processes for the treatment train, and expected removal or treatment efficiencies during 2009
- Detailed plans, cross-sections, drawings, sketches, and design calculations for specific elements of the 2009 RA
- Selected siting/locations of 2009 processes and construction activities
- Draft construction schedule for the implementation of the 2009 RA
- Draft Construction Quality Assurance Project Plan (CQAPP), including verification plans and contingency plans to be implemented in 2009
- Draft 2009 Health and Safety Plan (HASP)

The RD Work Plan approved by the Response Agencies in 2004 originally called for Agency review and approval of a comprehensive 60 Percent Design Report, followed by subsequent design submittals and approvals of Pre-Final (90 Percent) and Final (100 Percent) Design Reports to allow further development and refinement of the RD for OUs 2 to 5. However, in order to facilitate initiation of full-scale RA at the start of the 2009 in-water construction season pursuant to the Administrative Order for RA, USEPA Docket Number V-W-08-C-885 (the "Order"; USEPA 2007), the Response Agencies are considering providing approval of this Volume 1 submittal (2009 actions) following a more streamlined RD submittal process and schedule. Subject to Response Agency approval of this streamlining option, the RD Respondents will address Response Agency comments on this 60 Percent Design Report Volume 1 in the Final Design Volume 1 submittal (and 2009 RA Work Plan), currently targeted to be submitted for Agency review on December 30, 2008. Follow-on Agency comments on the 60 Percent Design Report Volume 2 (2010 and later actions) would be addressed through sequential submittal of the 90 Percent Design Volume 2 and Final Design Volume 2 Reports, as provided in the current AOC schedule. In the event that the Response Agencies do not approve the RD documentation streamlining approach outlined above, the RD Respondents will sequentially submit the Pre-Final (90 Percent) and Final (100 Percent) Design Reports for Volumes 1 and 2 in accordance with the approved RD Work Plan. The Response Agencies will make their determinations on appropriate streamlining opportunities based on their review of the completeness and level of detail provided in the overall 60 Percent Design submittal. Consistent with the RD Work Plan Addendum Schedule approved by the Response Agencies on April 29, 2008, the Final Design Report Volume 2 and Long-Term Monitoring Plan (LTMP) are currently targeted for Response Agency approval by May 2009, at which point the requirements of the 2007 RD AOC will have been met. Follow-on RA activities will occur under the Order.

1.1 Site Description

The Lower Fox River Site defined by the Response Agencies extends 39 miles from the outlet of Lake Winnebago to the mouth of the river where it discharges into Green Bay (Figure 1-1). The Lower Fox River is the most industrialized river in Wisconsin. Since the mid 1800s, water quality has been degraded by expanding industries and communities discharging sewage and industrial wastes into the river as well as by agricultural activity

(USEPA and WDNR 2003). PCBs were discovered in the Lower Fox River in the 1970s. As set forth in the RODs, PCBs are the focus of current RD efforts.

The Lower Fox River is divided into five OUs:

- OU 1 is also known as Little Lake Butte des Morts. The Neenah and Menasha Dams control the pool elevation of Lake Winnebago and the discharge to the upstream end of OU 1 at river mile (RM) 39. RD and RA activities in OU 1 are being addressed under a separate SOW and Consent Order.
- OU 2 extends from the Appleton Locks at RM 31.9 to the Little Rapids Dam at RM 13.1. This unit contains the majority of locks and dams in the Lower Fox River system and the greatest elevation drop and gradient. Sediments have a very patchy distribution in this reach with extensive intervening bedrock exposures. The OUs 1 to 2 ROD calls for active remediation in Deposit DD only, while monitored natural recovery (MNR) is the selected remedy for the remainder of OU 2.
- OU 3 extends from the Little Rapids Dam to the De Pere Dam at RM 7.1. Soft sediment covers most of this unit.
- OU 4 extends from the De Pere Dam to the river mouth at Green Bay. This OU contains a federal navigation channel, the northern portion of which is currently maintained by the U.S. Army Corps of Engineers (USACE). The area around OU 4 is highly urbanized, and includes the City of Green Bay.
- OU 5 begins at the river mouth, and includes the entire bay of Green Bay, which is approximately 119 miles long and is an average of 23 miles wide (USEPA and WDNR 2003). The OUs 3 to 5 ROD specified MNR as the selected remedy for OU 5, with the exception of dredging and capping near the river mouth.

1.2 Site Characteristics

The new data and analyses presented in the BODR (Shaw and Anchor 2006) and summarized in the ROD Amendment (USEPA and WDNR 2007) demonstrated that:

- PCBs are not uniformly spread throughout OUs 2 to 5, but instead vary both vertically in the sediment column and laterally throughout the Site. To accommodate this spatial variation in the PCB deposits, a combination of RAs has been designed including dredging, capping, dredge-and-cap, and sand covering. In addition to the RD sampling conducted to date and described in the accompanying

60 Percent Design Report Volume 2 submittal, additional sampling is planned for summer 2008 under the Order to further refine the delineation of PCBs above the 1.0 ppm RAL and refine remediation footprints within certain of the 2009 RA areas.

- A 20-acre area with PCB concentrations in near-surface sediments as high as 3,000 ppm (the highest known PCB concentrations in the Lower Fox River) was found just downstream and west of the De Pere Dam. This area was addressed as part of the separate Phase 1 remediation project, with approximately 132,000 cy of PCB-contaminated sediment removed during 2007, including approximately 26,000 cy of sediment subject to handling and disposal in accordance with the Toxic Substances Control Act (TSCA). The Phase 1 Project reduced the overall surface weighted average PCB concentration (SWAC) in OU 4 by approximately 14 percent (from 3.16 ppm to 2.72 ppm; Anchor and Foth 2008).
- PCB-contaminated sediment was found at depths up to 13 feet below the river bottom in mid-channel stretches of OU 4. PCB concentrations in these mid-channel areas tend to increase with increasing sediment depth. To remove the more highly-contaminated PCB deposits in these areas, less contaminated overlying sediment (i.e., overburden) would also have to be removed and disposed.
- Approximately 210 acres out of a total 1,170 acres of the PCB contaminated sediment (roughly 18 percent by area and 0.5 percent of the PCB mass) are found in deposits that are less than 6 inches thick with PCB concentrations between 1.0 and 2.0 ppm.
- While recent experience in OU 1 demonstrated dredging to the 1.0 ppm RAL is possible, experience with dredging at other sediment cleanup sites, including within the Phase 1 Project area, has shown that dredging equipment often cannot completely remove contaminated sediment from dredged areas. Thus, varying levels of residual contaminant concentrations often remain after dredging is completed. It is anticipated that these dredge residuals may exceed the RAL and/or SWAC goals established by the RODs and ROD Amendment. Dredging alone would thus likely not achieve the PCB concentration (RAL and SWAC) goals in some areas.
- Dredging cannot be used to remove contaminated sediment in some areas near shoreline facilities and in-water structures because removal of the sediment could undermine and destabilize those facilities and structures either in the short- or long-term.

1.3 Summary of OUs 2 to 5 Remedy

The ROD Amendment requires RA for all sediment with PCB concentrations exceeding the 1.0 ppm RAL. Consistent with the ROD Amendment, the OUs 2 to 5 remedy described in this 60 Percent Design Report includes the following elements:

- **Performance Standards.** The ROD Amendment requires remediation of all contaminated sediment exceeding the 1.0 ppm RAL in OUs 2 to 5, excluding exceptional areas, either by the removal, engineered capping, or sand cover approaches discussed below. The ROD Amendment also establishes two standards that will be used to judge the completion of construction of the OUs 2 to 5 remedy in each OU: 1) a RAL performance standard; and 2) a SWAC goal. Construction of the remedy in an OU is deemed complete if the RAL performance standard is met throughout the OU. If the RAL performance standard is not met at the completion of construction, then the remedy is deemed complete if the SWAC meets the goal for the OU. However, the construction of the remedy is not deemed complete based on the SWAC goal unless all sediment exceeding the RAL is addressed using the remedial approaches outlined below.
- **Staging Areas**. Material processing and staging facilities are required for sediment dewatering, sediment handling, water treatment, and cap/cover material staging. On May 1, 2008, the Response Agencies provided provisional acceptance of the former Shell property in OU 4 (currently owned by Georgia-Pacific Consumer Products LP [GP]) for site operations use pursuant to the Order. The Response Agencies also determined that permanent buildout of the former Shell property to a total of 27.3 acres of land, including construction of an improved bulkhead wall, is necessary to accomplish onshore remedial activities pursuant to the Order. Short-term access to the former Shell property has been secured. Long-term use of the former Shell property will be secured by the Respondents to the Order. In addition, a secondary staging area in OU 2 adjacent to the Little Rapids Dam has been identified by the Tetra Tech Team to support capping operations in OUs 2 and 3. Ongoing site preparation work at the staging areas includes topographic surveying, physical and geotechnical characterization, and constructing necessary onshore facilities. Docking facilities for dredging and loading/offloading equipment and ancillary equipment will be constructed in 2008 as part of site preparation at the

former Shell property under the Order. Preparation for RA will also include obtaining needed access agreements and landfill disposal agreements.

- **Sediment Removal**. Sediment with PCB concentrations exceeding the 1.0 ppm RAL are targeted for removal in parts of OU 2 (Deposit DD), OU 3, and OU 4. In areas targeted for sediment removal without subsequent (post-2009) placement of an engineered cap, sediment removal will be performed to a neatline elevation intended to remove sediment exceeding 1.0 ppm PCBs while appropriately balancing the likelihood of removing non-target sediments or leaving undisturbed residuals behind (as determined using sampling data and geostatistical data interpolation). As discussed below, further sampling will be performed in 2008 within specific dredging-only areas of upper OU 3 (and potentially also in other areas of the Site) to refine the neatline dredging plan. Sediment removal will primarily be conducted using hydraulic dredging methods (e.g., swinging ladder cutterhead dredges), although in certain circumstances (such as in areas that cannot be accessed by hydraulic dredging equipment) some sediment may be removed by mechanical dredging, transported by barge to the sediment processing facility at the former Shell property staging area, and mechanically unloaded on the north end of the former Shell property near the head of the Leicht slip (which will not interfere with bulkhead wall construction). For hydraulic dredging, in-water pipelines or other transportation methods will carry the dredged sediment from the dredge to the staging area.
- **Sediment Desanding**. The sand fraction of sediment that is removed from OUs 2 to 5 will be separated from the finer-grained dredge material, washed or otherwise treated as practicable, and beneficially reused to the extent feasible. Consistent with WDNR's April 18, 2008 *Guidance for the Reuse of Sand Separated from Fox River PCB Sediment*, approval of beneficial use of separated sand will be performed by WDNR under a Wisconsin Statute 289.43 low hazard exemption, and evaluated on a case-by-case basis to ensure that the beneficial reuse will meet NR 500 performance standards. Pilot testing of the sand separation process will be performed in 2008 under the Order to characterize expected PCB concentrations and to support evaluation of appropriate beneficial reuse alternatives. Pilot testing results, which are currently underway, will be summarized in a data report to be provided to the Response Agencies in summer 2008. Full-scale production analysis of separated

sand will also be required for the final suitability determination. Based on preliminary RD evaluations and as described in WDNR's April 18, 2008 guidance, potential uses for the separated sand that are currently being evaluated include:

- Fill behind the former Shell property bulkhead wall
- Road bed fill (e.g., Highway 41 expansion)
- Mine reclamation fill
- Landfill beneficial use (e.g., capping or drainage material at the Renard or Bayport confined disposal facilities [CDFs])
- Concrete or asphalt raw material
- Regional restoration projects

Ongoing value engineering evaluations by the Tetra Tech Team are also exploring possible amendments and other design options for the separated sand relative to NR 500 performance standards. WDNR approval of specific beneficial uses of separated sand will be performed on a case-by-case basis during RA implementation.

- **Sediment Dewatering and Disposal**. Contaminated sediment to be dredged from OUs 2 to 5 will be processed through several stages to enable efficient and effective mechanical dewatering of the fines using membrane-type filter presses. The initial stages of dewatering will include coarse debris separation, coarse and fine sand separation, and pre-thickening. Dewatered sediment that is not subject to disposal requirements under TSCA ("non-TSCA sediment") will be transported by truck to the Veolia Hickory Meadows landfill, consistent with applicable federal and state requirements. Dewatered sediments subject to TSCA disposal requirements ("TSCA sediment") will be transported by truck to a landfill facility appropriately permitted to receive TSCA or Resource Conservation and Recovery Act (RCRA) waste. There are currently no landfills in Wisconsin that are licensed to accept TSCA sediments.
- **Water Treatment**. Superfund cleanups are required to meet the substantive discharge requirements of the Clean Water Act, but National Pollutant Discharge Elimination System (NPDES) permits are not required for on-site work. Thus, water generated by dredging, desanding, and dewatering operations will be treated prior to discharge back to the river and will meet all state and federal water quality standards. The water treatment process will include sand filtration, particulate filtration (e.g., bag filters), and liquid-phase granulated activated carbon (LGAC)

treatment. Treated water will be sampled and analyzed to verify compliance with the appropriate discharge requirements consistent with the attached CQAPP (see Appendix D), and will be discharged through an outfall diffuser system to be constructed in 2008. Design requirements for the diffuser system are described in Section 5.5.

- **Post-removal Residuals Management**. The ROD Amendment used the term "generated residuals" for sediment that is disturbed by dredging activities (e.g., debris removal or dredge operation) and re-deposited on the surface of a newly-dredged area (usually within the top 6 inches of the sediment), and used the term "undisturbed residuals" for sediment unaffected by dredging operations. Although it is possible for generated residuals to have more (or less) than 6 inches of thickness, the ROD Amendment considered all residuals present in the top 6 inches of post-dredge sediment to be generated residuals and all residuals below 6 inches to be undisturbed residuals. These definitions for the terms generated and undisturbed residuals are maintained throughout this 60 Percent Design Report. If 2009 verification sampling in a sediment removal area reveals post-removal generated residuals or undisturbed residuals with PCB concentrations exceeding the 1.0 ppm PCB RAL, then the following management actions will occur:
  - For management of generated residuals during the 2009 RA:
    - Generated residuals with a PCB concentration equal to or greater than 10 ppm will be: 1) re-dredged in accordance with the sediment removal requirements specified above; or 2) identified for capping in 2010 or beyond, based on the results of post-dredge engineering evaluations, as discussed in the 60 Percent Design Report Volume 2 submittal.
    - Generated residuals with a PCB concentration between 1.0 ppm and 10 ppm will be identified for covering (in 2010 or beyond) with at least 6 inches of clean sand from an off-site source (referred to as a "residual sand cover") if placement of a residual sand cover in the area is necessary to meet the SWAC goal for the OU (i.e., a SWAC of 0.28 ppm PCBs in OU 3 and a SWAC of 0.25 ppm PCBs in OU 4). No cover placement is anticipated to be performed in 2009. Cover designs for the Site are described in the 60 Percent Design Report Volume 2 submittal.
  - For management of undisturbed residuals:

  - Undisturbed residuals with a PCB concentration exceeding the 1.0 ppm PCB RAL will be remediated, typically in accordance with the sediment removal requirements specified above. However, a different residuals management approach (such as a cap or a sand cover to be placed in 2010 or beyond) may be identified for undisturbed residuals in limited areas if the PCB levels in the undisturbed residuals are only slightly above the 1.0 ppm PCB RAL, subject to USEPA and WDNR approval, and consistent with the ROD Amendment.
  - Subject to Response Agency approval under the Order, additional infill samples will be collected in summer 2008 within specific dredging-only areas of upper OU 3 (and potentially also in other areas of the Site) to refine the neatline dredging plan. The objectives of the additional pre-dredge infill sampling plans, which were submitted for Response Agency review and approval under the Order on June 2, 2008, are to: 1) minimize remediation of non-target sediment; 2) reduce costs of post-dredge verification sampling; and 3) minimize the need for re-dredging to address undisturbed residuals.
- **Engineered Caps**. An engineered cap consisting of a sand layer and an armor stone layer or equivalent armor component will be installed in portions of the Site including OU 2 where dredging is not feasible, practicable, and/or cost effective, provided the ROD Amendment eligibility criteria are satisfied. No capping is anticipated to be performed in 2009. Capping designs for the Site are described in the 60 Percent Design Report Volume 2 submittal.
- **Sand Covers**. A cover comprised of at least 6 inches of clean sand from an off-site source will be placed over certain undredged areas that have a thin layer (6 inches or less) of PCB-contaminated sediment with concentrations less than 2.0 ppm. No cover placement is anticipated to be performed in 2009. Cover designs for the Site are described in the 60 Percent Design Report Volume 2 submittal.
- **Demobilization and Restoration**. Winterizing of equipment is required at the end of the 2009 remediation season. Details of specific winterizing and decontamination procedures will be presented in 2009 RA Work Plan to be reviewed and approved by the Response Agencies.
- **Natural Recovery and Long-term Monitoring**. Although the 1.0 ppm PCBs RAL performance standard or the SWAC goal (0.28 ppm in OU 3 and 0.25 ppm in OU 4)

will be met before construction of the RA can be deemed complete in an OU, the Response Agencies have concluded that it will take additional time for natural recovery before some of the remedial action objectives (RAOs) specified in the RODs and ROD Amendment are achieved. Long-term monitoring of surface water and biota will be performed to assess progress in achieving RAOs and to determine remedial success. Long-term monitoring will also be performed on any caps that are installed in OUs 2 to 5 to ensure their long-term integrity, protectiveness, and effectiveness in perpetuity. Drafts of the LTMP and Operations, Maintenance, and Monitoring Plan (OMMP), specifying the types and frequency of monitoring, outcomes triggering response actions, and the range of additional response actions, are provided with the accompanying 60 Percent Design Report Volume 2 submittal, and are subject to further collaborative workgroup review.

1.4 Summary of 2009 Remedial Actions

This 60 Percent Design Report Volume 1 submittal describes the RD for planned 2009 RA work. Volume 2 describes the RD for the continuation of RA in 2010 and beyond. Actions targeted for implementation in 2009 include:

- Dredging of sediments within and immediately adjacent to the former Shell property staging area and bulkhead wall
- Dredging of sediments in portions of OUs 2, 3, and 4
- Dewatering, transport, and disposal of dredged sediments
- Treatment of water removed during the dewatering process and discharge of treated water back to the river through a constructed diffuser system
- Beneficial reuse of separated sand, including partial backfilling behind the bulkhead constructed at the former Shell property staging and material processing facility
- Site preparation of the secondary staging area in OU 2 adjacent to the Little Rapids Dam to support follow-on capping operations in OUs 2 and 3

Neither capping nor cover activities are planned to be implemented in 2009. All cap and cover RD elements are included in the 60 Percent Design Report Volume 2 submittal.

Figure 1-2 depicts planned 2009 dredging areas. Dredging upstream of the De Pere Dam (i.e., in OUs 2 and 3) will be performed using two of J.F. Brennan's 8-inch dredges (the *Fox*

River and the *Palm Beach*), while production dredging will be performed downstream of De Pere Dam in upper OU 4 using J.F. Brennan's 12-inch dredge (the *Mark Anthony)*. Sequencing of 8-inch and 12-inch dredge operations will proceed in an upstream to downstream direction, unless otherwise discussed and approved in advance by the Response Agencies. The three dredges will operate simultaneously to concurrently maximize production, minimize the overall project schedule and cost, and minimize the potential for subsequent recontamination of dredged areas.

As discussed in more detail in Section 4, dredging operations in 2009 will include removal of both TSCA and non-TSCA sediments, and these materials will be appropriately segregated and handled separately from each other. Within the 12-inch production dredging areas in upper OU 4 that are targeted for dredging in 2009, some TSCA deposits are currently overlain with variable thicknesses of non-TSCA material, while others are located at the existing mudline. Production dredging operations in non-TSCA dredge-only areas in upper OU 4 in 2009 will generally extend to a target elevation set approximately 1 foot above the 1.0 ppm PCB concentration neatline, with dredging of the remaining 1 foot to be performed in subsequent years (see Volume 2 of this 60 Percent Design Report). Production dredging in upper OU 4 dredge-and-cap areas in 2009 will extend to a target elevation set at the required dredge elevation, with cap placement in subsequent years (see Volume 2). Section 4 provides additional details of the 2009 dredge plans, including planned TSCA sediment removal. In addition, Section 4 presents an evaluation of post-dredge SWACs at the completion of the 2009 construction season, which are expected to remain at or below RD baseline (pre-Phase 1) conditions in OUs 2, 3, and 4, thus minimizing short-term environmental risks associated with the RA. Follow-on dredging, capping, and cover actions in subsequent years will achieve the performance standards specified in the ROD Amendment (see 60 Percent Design Report Volume 2).

The dredged slurry will be pumped to the dewatering plant located on the former Shell property through a high-density polyethylene (HDPE) pipe. Upstream of the former Shell property, the dredge pipeline will consist of one common 8-inch-diameter line for use by the *Fox River* and the *Palm Beach*. This pipeline will initially extend the entire length from the former Shell property to OU 2. In addition, a 12-inch-diameter HDPE dredge pipeline will be installed in OU 4 for use by the *Mark Anthony*. Portions of the dredge pipelines will be submerged to limit interference with navigation and will be marked in accordance with U.S. Coast Guard (USCG) requirements.

Given the length of dredge pipelines, booster stations will be necessary to convey the dredge slurry to the dewatering plant. A series of eight booster stations are planned for the 8-inch dredge pipeline extending upstream of the former Shell property to OU 2. For the 12-inch dredge pipeline, two boosters will be installed to facilitate dredging upstream of the former Shell property to the De Pere Dam. The proposed dredging sequence allows for reducing the dredge pipeline length and the number of in-line booster pumps as the dredging operations proceed. Once removed from in-line use, the booster pumps will serve as backups for the other on-line boosters. Sections 5.1 and 5.2 provide more detailed information on dredging and pipeline operations, based on J.F. Brennan's experiences with simultaneous use of similar multiple dredge pipeline systems.

Contaminated sediment will be processed through several stages, to enable mechanical dewatering of the fines using membrane filter presses. These stages include coarse debris separation, coarse and fine sand separation, and pre-thickening. The dewatering plant will be designed to operate 24 hours per day, 5 days per week; a sixth day per week is planned for regular maintenance and repair work. Output material from the dewatering plant will be stockpiled in the staging area to await off-site disposal or beneficial reuse. Dewatered material will be loaded into lined trucks for transportation to designated off-site disposal facilities.

1.5 Summary of Remedial Actions in 2010 and Beyond

Dredging of sediments will continue in 2010 and is anticipated to be substantially complete by 2017. Engineered capping and sand covering of contaminated sediment will be conducted over eight seasons, beginning in 2010 and substantially complete by 2017. In-water construction work will typically be performed between April 15 and November 15 of each calendar year. However, this is an approximate window that is dependent on actual river conditions and weather, resulting in expanded or reduced schedules for any given year. Within these approximately 7-month construction seasons, in-water operations will generally be conducted 24 hours per day, 5 days per week; with a sixth day planned for regular equipment maintenance and repair.

The 60 Percent Design Report Volume 2 submittal describes the RD for the continuation of RA in 2010 and beyond. Dredging operations will be similar to those described in Section 1.4. A broadcast spreading method will be the primary means of placing sand covers and caps and gravel-sized armor materials. Typical mechanical placement equipment (e.g., clamshell bucket or excavator bucket) will be used to place larger armor stone such as quarry spalls that can not be placed with the broadcast spreader unit. Capping and covering operations will proceed in an upstream to downstream direction following the completion of dredging in those areas. For the majority of the capping seasons, dredging will be conducted simultaneously downstream of capping and sand covering operations.

Long-term monitoring will be initiated in 2012, approximately 5 years after the baseline monitoring. Long-term monitoring plans are presented as part of the 60 Percent Design Report Volume 2.

1.6 Report Organization

Major design elements for this RA were developed during the 30 and 60 Percent Design phases. A series of collaborative workgroup discussions and technical exchanges between the RD Team and the Response Agencies/Oversight Team (A/OT) during design activities was critical in developing and completing this 60 Percent Design. Specific collaborative work elements completed for this 60 Percent Design Report Volume 1 include:

- Refinement of dredging plans including incorporation of a neatline dredge approach for dredge-only areas
- Development of design approaches in OU 2 and upper OU 3 shoreline areas, including areas adjacent to infrastructure and utilities (i.e., setback and stable slope assumptions)

To document the design effort, this report has been organized to provide the following: 1) a brief summary of site characteristics from completed RD sampling and analysis events (a more detailed summary of site characteristics is provided as part of the 60 Percent Design Report Volume 2); 2) updated 2009 dredge plan designs; 3) beneficial reuse opportunities and landfill disposal requirements for 2009 separated sand and dewatered sediments, respectively; 4) design criteria and detailed engineering plans for the staging area, sediment dredging, material handling, and transportation and disposal of sediments; 5) 2009 scheduling; and 6) location-specific applicable or relevant and appropriate requirements (ARARs).

In addition, attached to this report are the following supporting appendices:

- Appendix A Dredging and Materials Handling Design Support Documentation
- Appendix B Engineered Plan Drawings
- Appendix C Specifications/Construction Work Plans for Key Design Elements
- Appendix D CQAPP
- Appendix E HASP
- Appendix F Community Protection Plan

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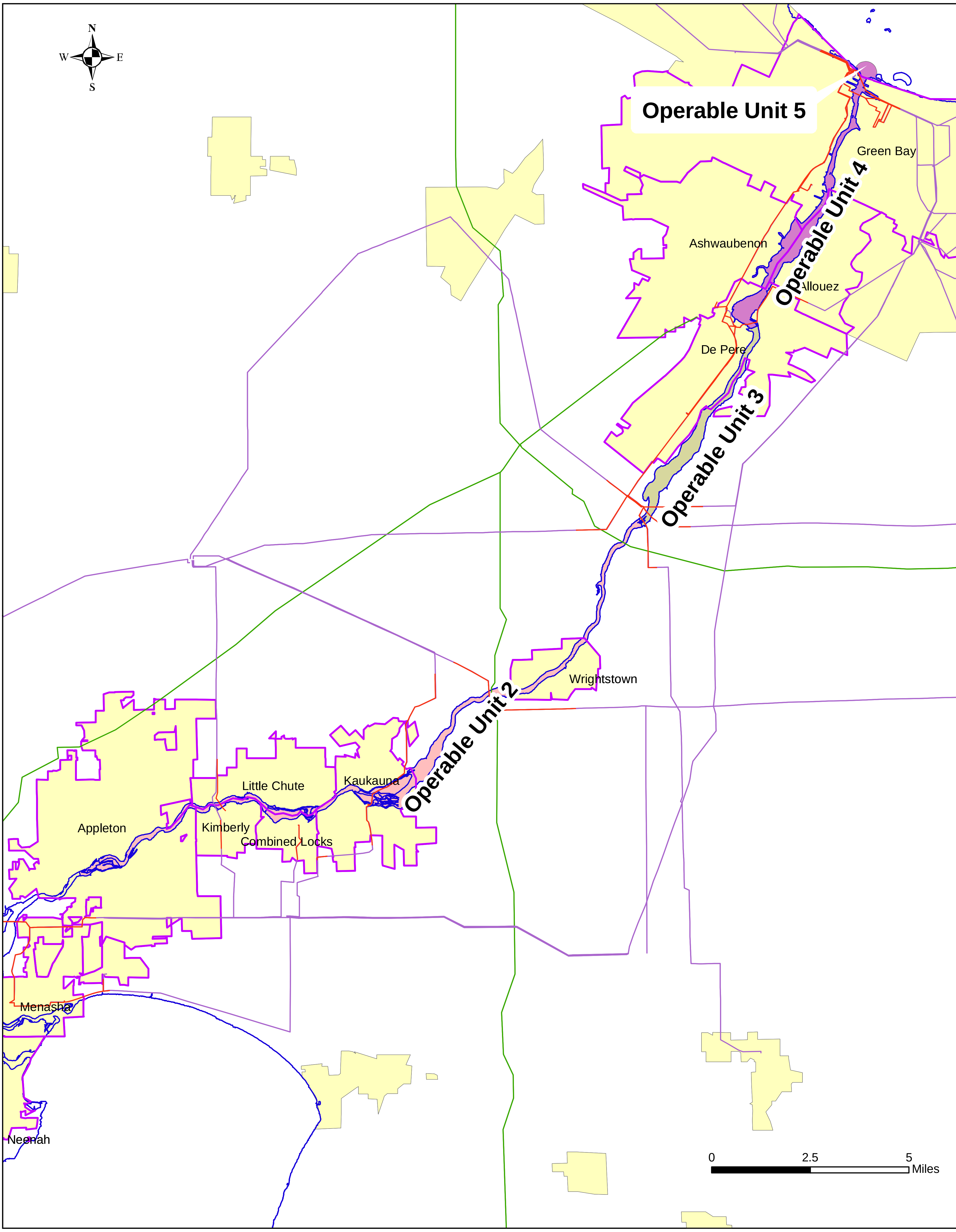

Legend

- USACE Channel Definition
- American Transmission Company Line
- Transmission System
- Natural Gas Pipeline
- Fox River Boundary
- Municipal Boundary

Operable Unit Number

- 2
- 3
- 4

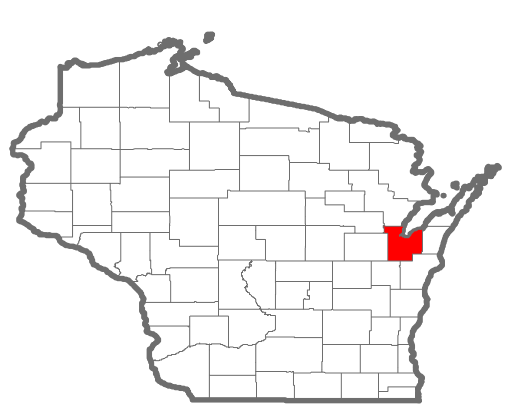

Figure 1-1
Lower Fox River
Area Location Map

Lower Fox River OU 2-OU 5

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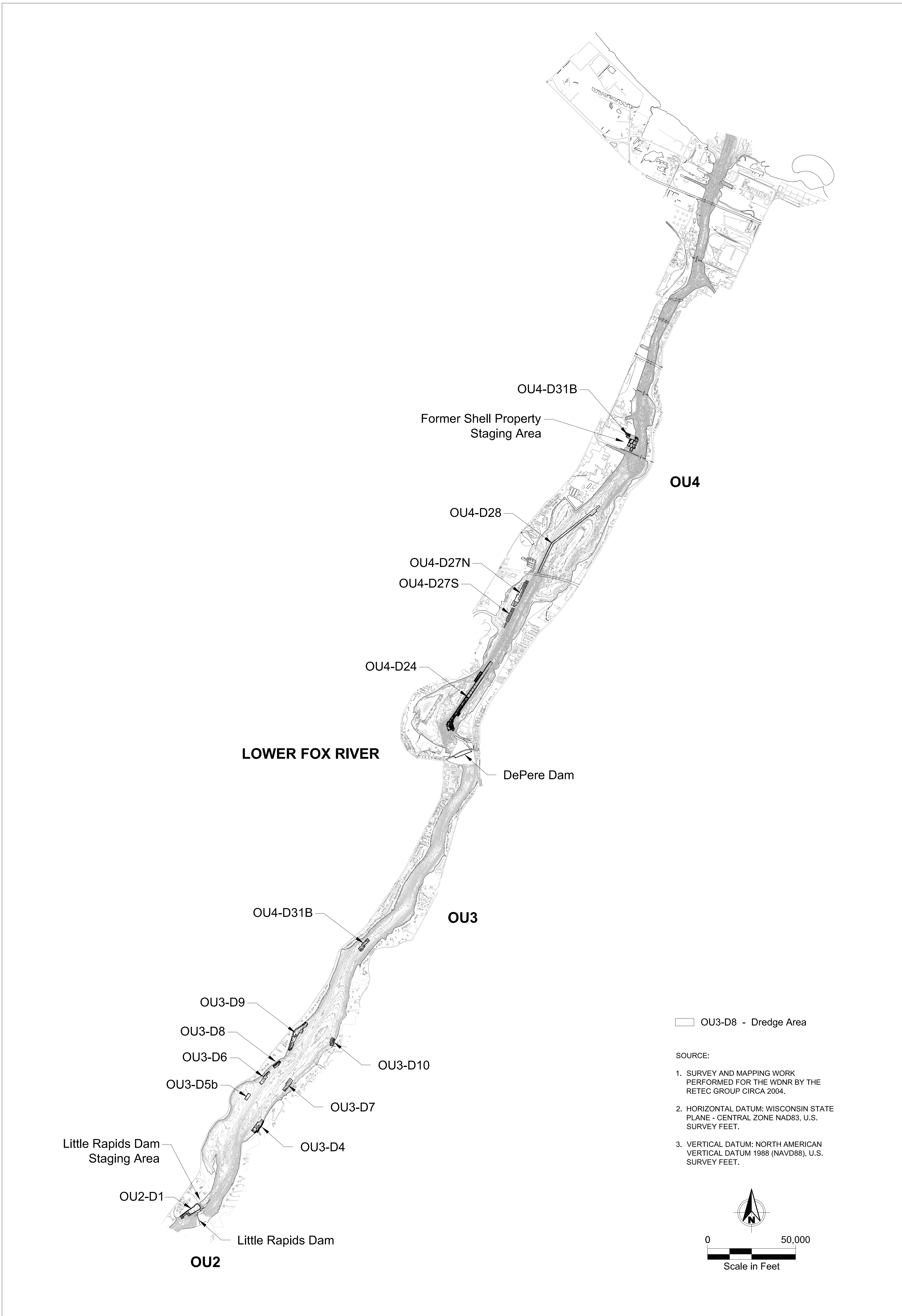

Jun 16, 2008 9:56am dbinkney C:\Documents and Settings\dbinkney\Desktop\CAD\080295-03 - 60%\WORKPLAN FIGURES\080295-03-FIG 4-3.dwg FIG 1-1

Figure 1-2
Planned 2009 Dredge Areas
Lower Fox River - OUs 2 to 5

2 SITE CHARACTERISTICS

2.1 Sampling and Analysis Data

2.1.1 Remedial Design Data

The RD sampling and analysis program conducted to date includes data collection activities from 2004 through 2007, as described below. In addition, data collected prior to 2004 have been utilized, where appropriate, to support the RD. These data were compiled and summarized to provide an assessment of current information on the nature and extent of contamination, bathymetry and sub-bottom profiles of the river channel and side-slope areas, and the location of candidate areas for active remediation, consistent with the ROD Amendment. The locations where samples were collected during the 2004 to 2007 RD field investigations are depicted in Figure 2-1. A detailed discussion of the RD data is provided in the accompanying 60 Percent Design Report Volume 2.

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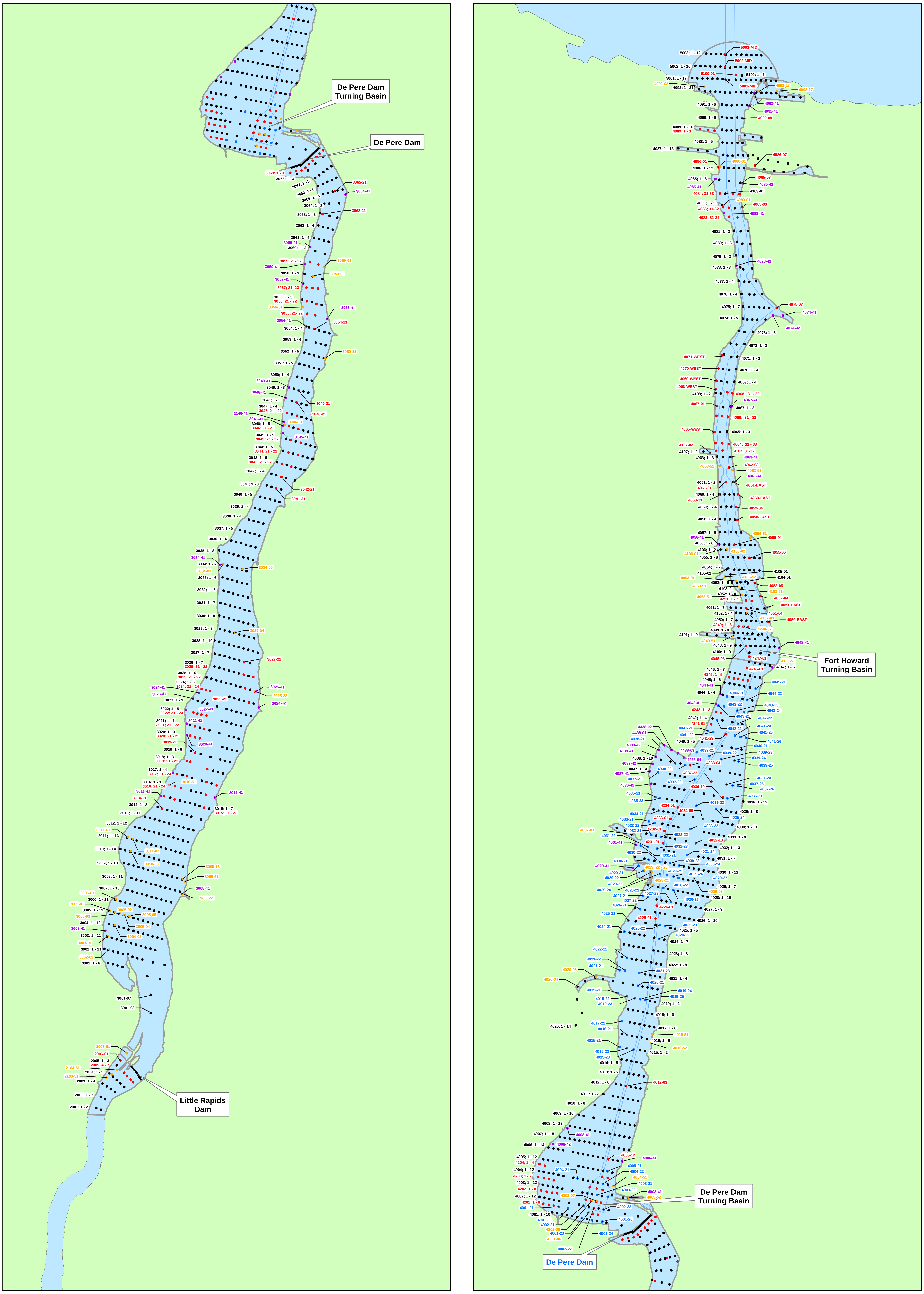

Legend

- 2007 Sample Location
- 2006 Sample Location
- 2005 Sample Location
- 2004 Sample Location
- 2004 Supplemental Sample Location
- Operable Unit Boundaries
- Dams
- Federal Navigation Channel
- 2001; 1 - 2 — Transect Number; Samples included in transect, moving from left to right.
- 2005-01 — Individual Sample Location

N

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1,500 0 1,500 Feet

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Shaw

Figure 2-1

Sample Location Map Operable Units 2 - 5

2.1.2 Ongoing 2008 Sampling and Analysis Program

A sediment sampling program will be performed in 2008 to further refine the neatline delineation of sediments containing PCB concentrations above the 1.0 ppm RAL in dredge-only areas in upper OU 3 targeted for dredging in 2009. As part of the collaborative workgroup design process, an evaluation was performed of potential further refinements to the geostatistically-based depth of contamination (DOC) model. The recent geostatistical evaluation, presented as an attachment to the accompanying CQAPP (Appendix D), indicated that doubling the current sampling density along each transect in OU 3 dredge-only areas would further optimize the dredge plans. The objectives of the additional pre-dredge infill sampling plans are to: 1) reduce remediation of non-target sediment; 2) reduce time requirements and costs of post-dredge verification sampling; and 3) reduce (and potentially eliminate) the need for re-dredging cleanup passes. Details of the geostatistical analysis are presented in the CQAPP.

A detailed work plan for 2008 sediment sampling (including a Sampling and Analysis Plan [SAP] and Quality Assurance Project Plan [QAPP] Addendum) was submitted to the Response Agencies on June 2, 2008 (Tetra Tech et al. 2008a). Subject to Response Agency approval under the Order, sediment sampling is scheduled to begin in early July 2008.

2.2 Summary of Physical Site Characteristics

The BODR provides a summary of the physical characteristics of OUs 2 to 5 including:

- OU delineation, land use (e.g., recreational, industrial, etc.) statistics, water depth and bathymetry (2003 survey), navigation channels, locks and dams, and infrastructure/utilities
- Regional geologic conditions – the Engineered Plan Drawings and other RD elements included with this 60 Percent Design are based on the data available to date, as described in the BODR; however, supplemental geophysical surveys (bathymetry, side scan sonar, upland laser scan, magnetometer, and sub-bottom profiling) are planned for summer 2008 to refine characterization of existing sediment stratigraphy and debris conditions
- Regional hydraulic conditions including Fox River flows and velocities

- Geotechnical conditions including grain size distribution and Atterberg Limits

The reader is referred to the BODR for a summary of each of these physical characteristics. In addition, the accompanying 60 Percent Design Report Volume 2 provides an updated summary of the geotechnical conditions in OUs 2 to 5, incorporating the results of sampling conducted subsequent to the BODR.

2.3 Summary of Geotechnical Conditions

Section 2.2 of the BODR provided a detailed summary of the geotechnical properties of sediments sampled during the 2004 and 2005 RD field investigations. Section 2.3 of the accompanying 60 Percent Design Report Volume 2 submittal provides a summary of the geotechnical properties for samples collected during the 2004 to 2007 RD investigations within the targeted sediment removal areas in OUs 2 to 5.

2.4 Summary of Spatial Extent of PCBs

Extensive sampling efforts were conducted in 2004 and 2005 to characterize the nature and extent of PCBs in OUs 2 to 5. Geostatistical methods were used to delineate the DOC boundary in OUs 2 to 5, defined as the boundary beyond which sediment PCB concentrations are predicted, with at least 50 percent confidence, to be at or below the RAL of 1.0 ppm as specified in the ROD Amendment. Section 2 of the accompanying 60 Percent Design Report Volume 2 summarizes additional sampling conducted in 2006 and 2007 to further delineate the spatial extent of PCBs, and also discusses refinements to the geostatistical model and the resulting updated neatline model surface.

2.4.1 Planned Refinements after 2008 Sampling

Upon completion of the 2008 infill sediment sampling and analysis program in upper OU 3 (presented in the SAP and QAPP Addendum submitted under the Order to the Response Agencies on June 2, 2008; Tetra Tech et al. 2008a), the dredging neatline elevation in dredge-only areas of upper OU 3 will be updated using ordinary kriging of all available data. The forthcoming geostatistical analyses, which will be incorporated into the first of the annual RA Work Plans (the 2009 RA Work Plan), will target a significance level of 0.5, but will also evaluate whether alternative significance levels may provide improved overall performance, with and without consideration of anticipated overdredge allowances.

As discussed in the attached CQAPP (Appendix D), the additional infill sampling is expected to substantially improve the performance of the neatline dredging plans based on ordinary kriging. The updated dredging neatline will serve as the basis for final dredge plans to be implemented in upper OU 3 dredge-only areas in 2009. Generally, the provisional infill plan includes doubling of the number of samples in each bank-to-bank transect. The density of samples along transects in the direction of flow will also be doubled. In some cases, where the standard infill spacing would have placed samples just outside the areas to be dredged, additional samples have been added with a closer spacing within the edges of the areas to be dredged, to improve spatial coverage.

The geostatistical performance metrics developed during RD to date have been calculated using simulated infill samples. As a verification step, the metrics will be recalculated for upper OU 3 using actual infill sample data. This will provide a check on the spatial variability that was assumed for the simulations, and provide a data-based update of the metrics.

This provisional plan may be modified (i.e., a different density of samples may be collected in some of the dredge areas) and will be subject to refinement as additional information is obtained that can improve geostatistical predictions, including planned sub-bottom profiling and geomorphic analysis. Additional discussion of geostatistical refinements is provided in Section 4.4.1.3.

2.5 Characterization of Material for Beneficial Use and Disposal Purposes

The BODR (Shaw and Anchor 2006) provided a comprehensive review of RD considerations relative to the characterization and quantification of dredge material for disposal including NR 500 landfills, TSCA-licensed facilities, and other facilities that provide dewatering and/or disposal. The section below describes the methodology for making characterization determinations for dredge material and debris generated from work performed in 2009, and summarizes the estimated extent and volume of sediments that may be subject to TSCA regulation when removed and disposed, consistent with Addendum No. 3 to the RD Work Plan.

Potential beneficial reuse options exist for the sand fraction of the dredge material that contains relatively low concentrations of PCBs. Significant environmental and economic benefits may be realized if the sand fraction of the dredge material can be beneficially reused rather than being disposed of at a landfill. As part of ongoing value engineering efforts, current and upcoming beneficial reuse opportunities for the sand and coarser materials contained in the dredge material are being identified and evaluated. Section 5.6.6 provides detailed information on the currently identified potential beneficial reuse alternatives.

All non-porous debris and dredge material will be characterized for disposal. The sand portion segregated from the non-TSCA dredge material as part of the mechanical dewatering operations (see Section 5.4) will be characterized for potential beneficial reuse. Flowcharts of the general process to be used for characterizing non-TSCA and TSCA material and debris dredged in 2009 for disposal and beneficial reuse purposes are presented in Figures 2-2 and 2-3, respectively.

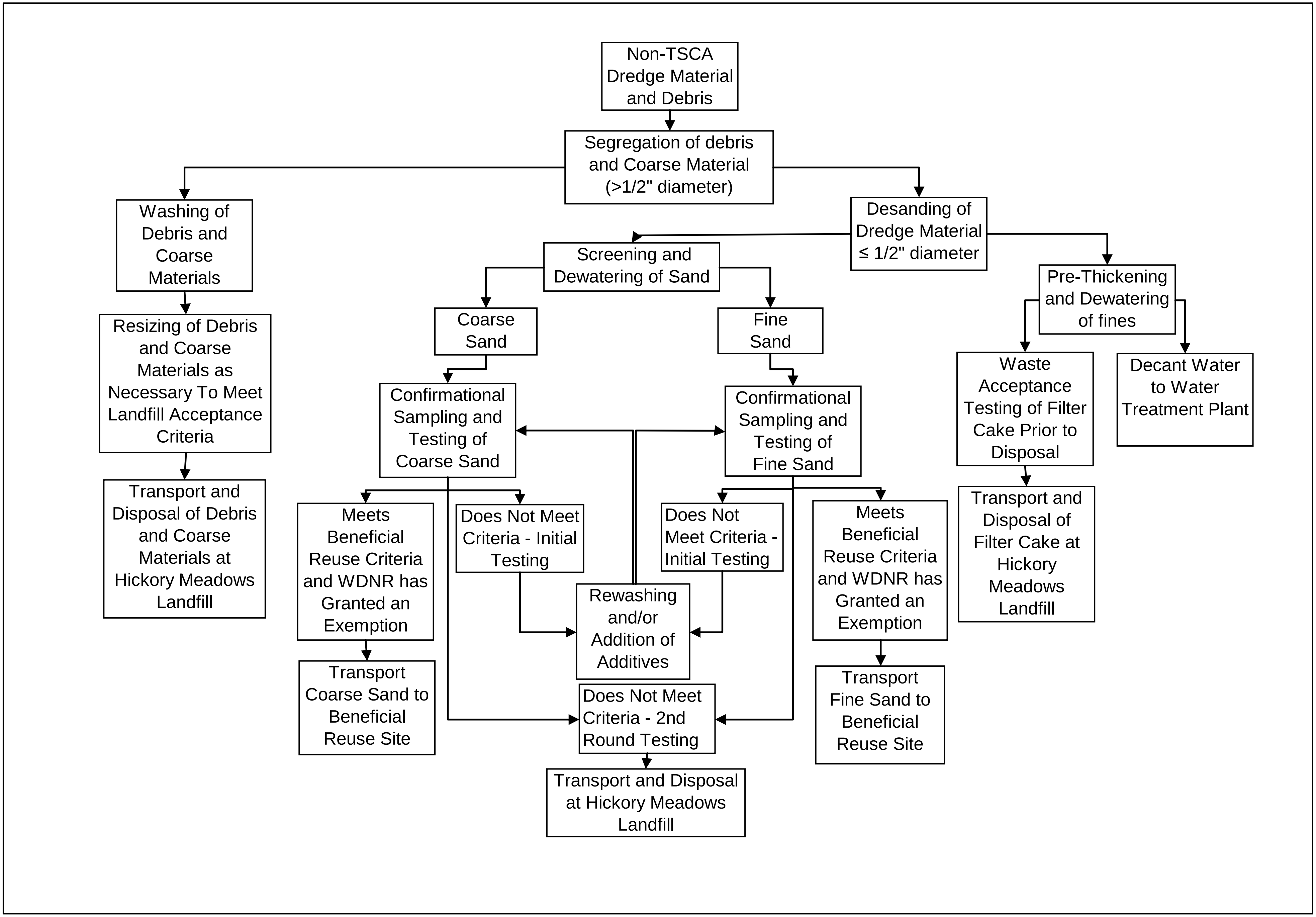

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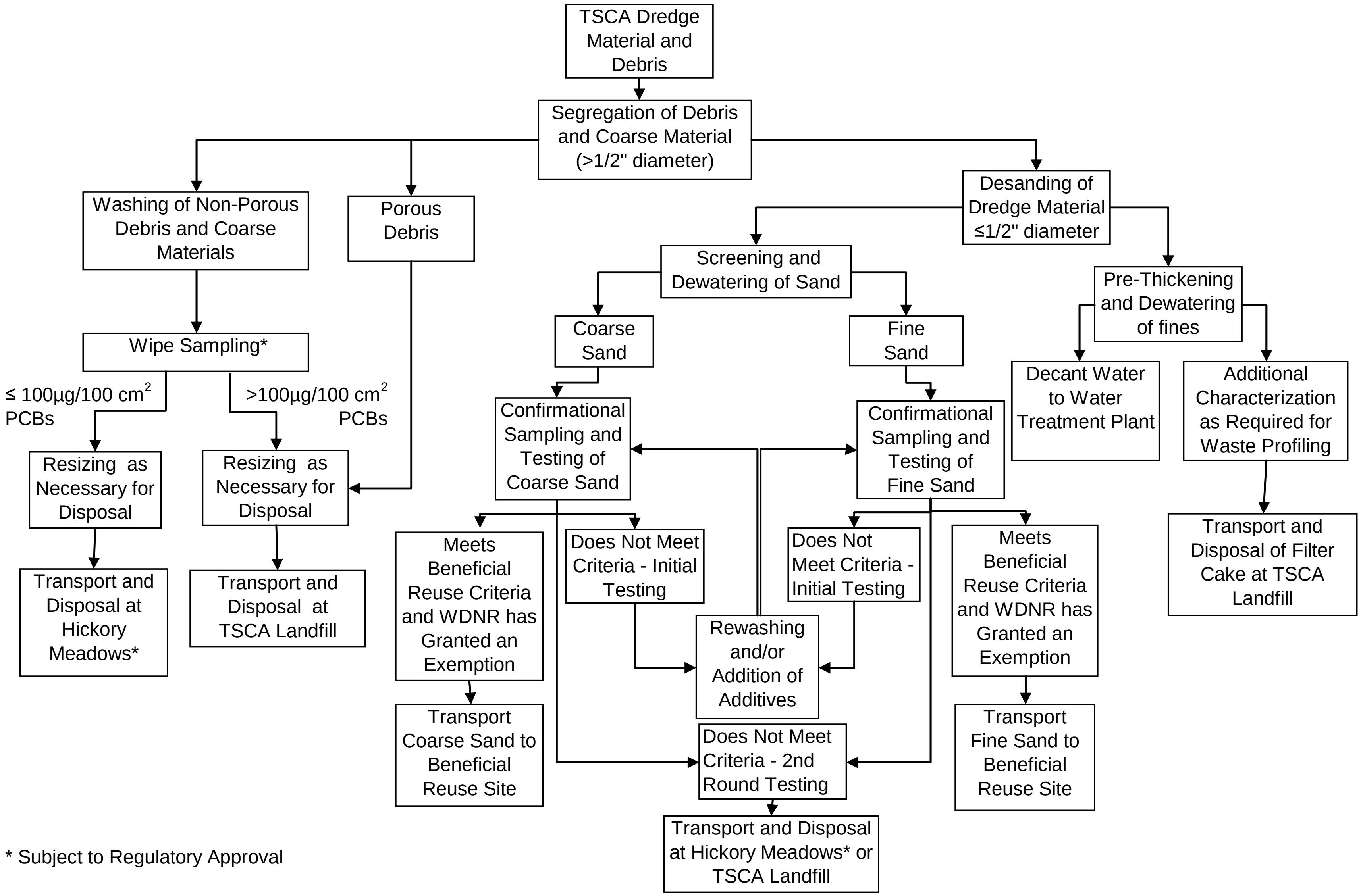
Figure 2-2
2009 Non-TSCA Dredge Material and Debris Characterization Process
Lower Fox River – OUs 2 to 5



* Subject to Regulatory Approval

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Figure 2-3
2009 TSCA Dredge Material and Debris Characterization Process
Lower Fox River – OUs 2 to 5

2.5.1 Debris Disposal Requirements

The in-water survey work being performed in 2008, as detailed in the Phase 2A Work Plan for In-Water Survey and Archeological Investigation Addendum (Tetra Tech et al. 2008b), includes collection of additional data to update the debris information collected during previous RD surveys (Retec et al. 2003). If necessary, large debris will be removed using mechanical equipment prior to dredging a specific dredge area. Such debris will be transported to the former Shell property for processing and subsequently to the appropriate off-site disposal or a recycling facility, as discussed in Section 4.1.1.1. The 2009 RA Work Plan will describe procedures for leaving relatively large debris, such as boulders, in place, should such materials be encountered.

Debris not removed in a pre-dredge mechanical removal event will be removed by the hydraulic dredge and entrained in the dredge slurry. Debris in the sediment slurry will be screened out when the sediment slurry passes through a vibrating screen (for hydraulically dredged material). Debris in mechanically dredged sediment will be removed by passing the material through a screening drum and then through a vibrating screen.

Debris will be segregated into porous and non-porous fractions. Porous debris from non-TSCA dredge areas will be disposed of as non-TSCA waste and porous debris from TSCA dredge areas will be disposed of as TSCA waste. All non-porous debris will be decontaminated in accordance with Section 02 81 00 of the Project Plan in Appendix C, Attachment C-0. Non-porous materials with surface PCB concentrations of less than 100 micrograms (μg) per 100 square centimeters based on wipe sampling of surfaces after decontamination may be disposed as non-TSCA waste, subject to Response Agency approval. Non-porous materials with surface PCB concentrations of 10 μg per 100 square centimeters or less based on wipe sampling of surfaces after decontamination may be released for unrestricted use and will be recycled, subject to Response Agency approval. The standard wipe test per 40 CFR 761.79 and 761.123 will be used. The majority of the non-porous debris is expected to be disposed as non-TSCA waste or to be recycled. Debris greater than 1 cy will be resized as required by the non-TSCA landfill disposal contracts. Debris and recyclable materials will be staged and containerized in designated areas at the former Shell property prior to shipment off-site for disposal or recycling.

2.5.2 Sand and Coarser Sediments for Potential Beneficial Reuse

Based upon the results of the 2004 and 2005 RD investigations (Shaw and Anchor 2006), sediments targeted for removal as part of the OUs 2 to 5 RA consist mainly of sand and silt-sized particles (see Table 2-1 of the 60 Percent Design Report Volume 2), with the remaining percentage consisting predominantly of clay and a trace to slight amount of gravel. The RD sampling data showed that sand and gravel comprise approximately 37 ± 24 percent by weight (± one standard deviation; 65 discrete samples) of the OUs 2 to 5 sediment samples collected within targeted removal areas. Subsequent to the RD sampling, composite samples collected in 2007 by Boskalis Dolman within the OUs 2 to 5 removal areas showed a higher overall percentage of sand and gravel at 62 ± 22 percent by weight (six composite samples; see Table 5-4). However, the analytical methods used by Boskalis Dolman were not comparable to those used during RD (e.g., organics were removed during the Boskalis Dolman sample preparation). To refine sediment characteristics, materials handling operations, and potential beneficial reuse options, additional sampling is being performed in 2008 within the targeted 2009 dredging areas under the Order as part of Phase 2A RA activities.

The PCB mass in OUs 2 to 5 sediments is largely adsorbed onto the fine-grained (less than 200 mesh) soil fractions of the sediment. Bench-scale treatability studies conducted during RD with representative composite samples collected from OUs 3 to 5 indicate that the coarse-grained fraction of the sediments (greater than 200 mesh), referred to in this document as the sand/gravel fraction, have relatively low PCB concentrations, typically less than 1.0 ppm (see RD bench-scale tests contained in Appendix C of the BODR). The separated sand/gravel fraction will be considered for potential beneficial use.

Approximately 460,000 cy (depending on actual overdepth achieved and schedule considerations, 2009 dredge volumes could potentially exceed 490,000 cy)[2] of in situ

[2] Note: All dredge volumes presented in this 60 Percent Design are based on the bathymetric survey data available at this time of preparation (2004 Retec Survey).

sediments in OU 2, upper OU 3, upper OU 4A, and within the former Shell property staging area are targeted for dredging in 2009. Preliminary mass balances summarized in Section 5.4 using the Boskalis Dolman sampling data suggest that, using planned physical separation technologies, 460,000 cy of in situ sediments will produce approximately 160,000 ± 100,000 wet tons of separated sand/gravel (± one standard deviation; based on bench-scale testing of six composite samples, assuming no sand segregation from TSCA sediments and a final water content of the sand of approximately 15 percent). Further field sampling, bench-scale testing, and pilot testing is being performed in 2008 as part of Phase 2A RA activities to refine estimated production quantities and PCB concentrations in the separated sand fractions of the dredged material.

Under Wisconsin Statute 289.43, WDNR can be petitioned for an exemption for the management of low-hazard waste, covering segregated sand from non-TSCA dredged material for beneficial reuse. Typically, WDNR evaluates the beneficial reuse of dredge sediments using its NR 538 regulations. The ROD Amendment also identifies provisions for allowable PCB concentrations in sand for beneficial reuse.

Consistent with WDNR's April 18, 2008 *Guidance for the Reuse of Sand Separated from Fox River PCB Sediment*, approval of beneficial use of separated sand will be performed by WDNR under a low hazard exemption, and evaluated on a case-by-case basis to ensure that the beneficial reuse will meet NR 500 performance standards. Pilot testing of the separated sand will be performed in 2008 as part of Phase 2A RA tasks to characterize expected chemical characteristics and to support evaluation of appropriate beneficial reuse alternatives. Full-scale production analysis of separated sand will also be required for the final suitability determination. Based on preliminary RD evaluations and as described in WDNR's April 18, 2008 guidance, potential uses for the separated sand that are currently being evaluated include:

- Fill behind the bulkhead wall at the former Shell property staging area
- Road bed fill (e.g., Highway 41 expansion)
- Mine reclamation fill
- Landfill beneficial use (e.g., capping or drainage material at the Renard or Bayport CDFs)

- Concrete or asphalt raw material
- Regional restoration projects

Section 5.6.6 provides further detailed information on the currently identified potential beneficial reuse alternatives. Ongoing value engineering evaluations through the technical workgroups are also exploring possible amendments and other design options for the separated sand to ensure that NR 500 performance standards are achieved. WDNR approval of specific beneficial uses of separated sand will be performed on a case-by-case basis during RA implementation.

2.5.3 Sediments Subject to Non-TSCA Disposal Requirements

As discussed in Section 2.5.4, designation of dredged material that is suitable for non-TSCA disposal was based on sampling data from RD sediment cores vertically composited across non-overlapping 2.5-foot (30-inch) sediment intervals beginning at the mudline. Once all cores were analyzed using this approved in situ designation methodology, the vertical and horizontal extent of sediments requiring disposal in a TSCA-licensed landfill was delineated. As discussed in Section 2.5.4, approximately 33,000 cy of the 460,000 cy of in situ sediment targeted to be dredged in 2009 will require separate handling and disposal in a TSCA-licensed landfill following desanding and dewatering.

Based on Boskalis Dolman sampling data and mass balances summarized in Table 5-4, dredging and processing roughly 427,000 cy of non-TSCA sediments will produce approximately 220,000 ± 40,000 tons of filter cake (± one standard deviation; based on bench-scale testing of six composite samples, and assuming a final solids content of the filter cake of approximately 50 percent). As discussed above, further field sampling, bench-scale testing, and pilot testing is being performed in 2008 as part of Phase 2A RA activities to refine estimated production quantities and optimal operating parameters.

USEPA and WDNR have determined that sediments designated for non-TSCA disposal using the in situ methodology (i.e., interval average PCB concentrations less than 50 ppm, see Section 2.5.4) meet the substantive requirements for PCB testing for receiving landfill facilities, obviating the need for further PCB verification testing. However, the

Plan of Operation for the Veolia Hickory Meadows landfill facility, which has been selected as the non-TSCA disposal facility, requires testing for PCBs and strength properties as part of the waste acceptance criteria.

Non-TSCA material will be tested per the waste acceptance criteria in Hickory Meadows' approved Plan of Operation. Additional testing of the filter cake, such as grain size, consolidation, Atterberg limits, etc. will be performed if required by the Plan of Operation but is not part of the waste acceptance criteria. The Plan of Operation is subject to WDNR approval and approval is currently pending. The potential requirements are listed in Table 2-1.

Table 2-1
Hickory Meadows (non-TSCA) Landfill Acceptance Criteria

Non-TSCA Landfill Criteria	Test Method	Test Frequency
PCB concentration < 50 ppm PCBs	SW-846 Method 8080	One sample per week unless otherwise approved by WDNR
Ability to support its own weight	Field observation by the low ground pressure dozer operator	For each load delivered to the disposal facility
Ability to support the over burden weight of material placed over it	Field observation by the low ground pressure dozer operator	For each load delivered to the disposal facility
Passes paint filter test	SW846 Method 9095A	As required
Minimum cohesive strength of 800 psf, or minimum frictional strength of 25 degrees, or a combined cohesive and frictional strength that provides an equivalent factor of safety for slope stability[1]	ASTM D 6528-07, ASTM D 4648-05, ASTM D 4767-04, or ASTM D 2166-06	One sample every 10,000 cy for first 30,000 cy and one sample every 30,000 cy thereafter to represent each of the areas dredged

Notes:

1 The equivalent factor of safety for slope stability is as described in the Plan of Operation for the Hickory Meadows landfill.

ASTM American Society for Testing and Materials

cy cubic yard

ppm part per million

psf pound per square foot

2.5.4 Sediments Potentially Subject to TSCA Disposal Requirements

This section summarizes the estimated extent and volume of sediments that would be subject to TSCA regulation when removed and disposed. As discussed in the Agency-approved Addendum No. 3 to the RD Work Plan (Shaw and Anchor 2005), when targeting the removal of a 0.5-foot (6-inch) layer of subsurface (buried) sediments with greater than 50 ppm using typical large-scale hydraulic cutterhead dredge equipment anticipated for the project (e.g., approximately 24- to 36-inch-diameter cutterhead), on average an additional 1 foot of sediment above and below the neatline (i.e., 2.5 feet total thickness) is the smallest practicable amount of sediment that can be removed efficiently. The type of dredge equipment anticipated at the time of the RD Work Plan Addendum was subsequently validated during the 60 Percent Design phase based on J.F. Brennan's planned dredge equipment, which will include two sizes of hydraulic dredges with cutterheads ranging in diameter from approximately 24 to 48 inches (see Section 4.2 for additional details of planned dredge equipment). Thus, for the purpose of characterizing dredged material for beneficial use or disposal purposes based on in situ sediment PCB concentrations in this 60 Percent Design, 6-inch sample depth data were averaged across non-overlapping 2.5-foot (30-inch) sediment intervals beginning at the mudline. For example, if the 2.5-foot vertically averaged sediment concentration exceeds 50 ppm, neatline and associated sediments (including overdredge allowances) dredged from this depth would be subject to TSCA disposal requirements. This relatively straightforward designation procedure uses detailed sediment sampling data to consistently designate sediments potentially subject to TSCA disposal requirements that result from successive cuts using the equipment planned for use in OU 4 (12-inch hydraulic dredges).

Using this designation procedure, approximately 33,000 cy of the 460,000 cy of in situ sediment targeted to be dredged in 2009 will require disposal in a TSCA-licensed landfill following desanding and dewatering. All OUs 2 to 5 sediments potentially subject to TSCA disposal requirements are in OU 4. No sediments requiring disposal in a TSCA-licensed landfill have been identified in OUs 2 or 3 based on the delineation method described in the Agency-approved Addendum No. 3 to the RD Work Plan and summarized herein.

Disposal sites for PCB impacted sediments classified as TSCA material were inventoried as part of the BODR. The two existing sites closest to OUs 2 to 5 are EQ Wayne Disposal in Belleville, Michigan, and Peoria Disposal Company in Peoria, Illinois. No additional sites have been identified, and there are currently no disposal sites in Wisconsin licensed to receive sediments with PCB concentrations greater than or equal to 50 ppm. Specific transportation and disposal requirements are included in Section 5.6.

The characterization of TSCA material dredged in 2009 for landfill disposal will be based on existing RD sampling data. Additional PCB analysis will not be required prior to disposal of 2009 dredge material. The data from the in situ RD sampling (detailed in the forthcoming "RD Design Anthology") will be used to determine the sediments that are targeted for shipment to the selected TSCA-licensed landfill. However, additional waste characterization will be performed in accordance with the TSCA landfill's waste profiling requirements. Waste profiling and manifest requirements are detailed in Section 5.6.

2.6 Project Datum

Consistent with the initial RD planning and the RD SAP/QAPP (Shaw and Anchor 2004), the BODR and 30 Percent Design utilized the following project datums:

- Horizontal: Wisconsin Traverse Mercator (WTM), U.S. survey feet
- Vertical: International Great Lakes Datum, 1985 (IGLD85), U.S. survey feet

During recent RD workgroup meetings, it was determined that these datums would present significant logistical concerns and inefficiencies during RA based on the current state of survey equipment planned for use on the project. Survey monuments in the Lower Fox River were installed in the Wisconsin State Plane Central (North American Datum [NAD] of 1983) horizontal datum and the North American Vertical Datum of 1988 (NAVD88). During the implementation of the remedy in OUs 2 and 5, it would be inefficient to constantly convert to the WTM and IGLD85 datum. Therefore, the revised RD/RA project datum to be used in 2009 will be as follows:

- Horizontal: Wisconsin State Plane Central (NAD83, 1997 Adjustment), U.S. survey feet
- Vertical: NAVD88, U.S. survey feet

The engineering plans presented in this 60 Percent Design Report are presented in these datums. Table 2-2 presents the National Oceanic and Atmospheric Administration (NOAA) Low Water Pool Elevations in both IGLD85 and NAVD88 vertical datums. Certain design analyses utilized alternate baseline water elevations, as described in the BODR and the 30 Percent Design.

Table 2-2
Low Water Pool Elevations in OUs 2 to 5

Pool	Operable Unit	River Mile	Low Water Pool Elevation (feet IGLD85)	Low Water Pool Elevation (feet NAVD88)	Lift (feet)
Green Bay	OU 4/5	0.0	577.5	577.6	--
De Pere Dam	OU 3	7.1	587.4	587.5	9.9
Little Rapids Dam	OU 2	13.1	593.5	593.6	6.1

Note: Low Water Pool Elevations from NOAA Chart 14918 (2004)

3 SITE PREPARATION AND STAGING AREA DEVELOPMENT

3.1 Staging Area Requirements

The OUs 2 to 5 BODR (Shaw and Anchor 2006) and 30 Percent Design Report (Shaw and Anchor 2007) identified the former Shell property adjacent to the Georgia-Pacific West Mill in OU 4 as the most promising material processing facility for the OUs 2 to 5 work. The former Shell property, which is located adjacent to OU 4, will be the location for the primary material processing plant and staging facility that is necessary for implementation of the RA in OUs 2 to 5 of the Lower Fox River.

Consistent with the findings of the BODR and 30 Percent Design Report, and as detailed in the May 30, 2008 memorandum titled *Draft Final Site Development Plan – Former Shell Property Material Processing Facility Buildout* (Anchor et al. 2008), the former Shell property is the only practicable location to process sediment dredged from the Lower Fox River. The design and construction of the bulkhead, staging area, and material processing plant are being performed in 2008, under the Phase 2A requirements of the Order, on the property located at 1505 State Street in Green Bay. Follow-on buildout of the facility will also occur in 2009 as described in this section. Figure 3-1 presents an aerial view of the former Shell property, along with the proposed staging area and bulkhead buildout area. The facility is bordered on the west by State Street, on the east by the Fox River, on the north by Leicht Transfer Facility and its associated slip, and on the south by the Canadian National Railway Company property. This property was previously used as a staging area and sediment processing facility for the Sediment Management Unit (SMU) 56/57 demonstration project.

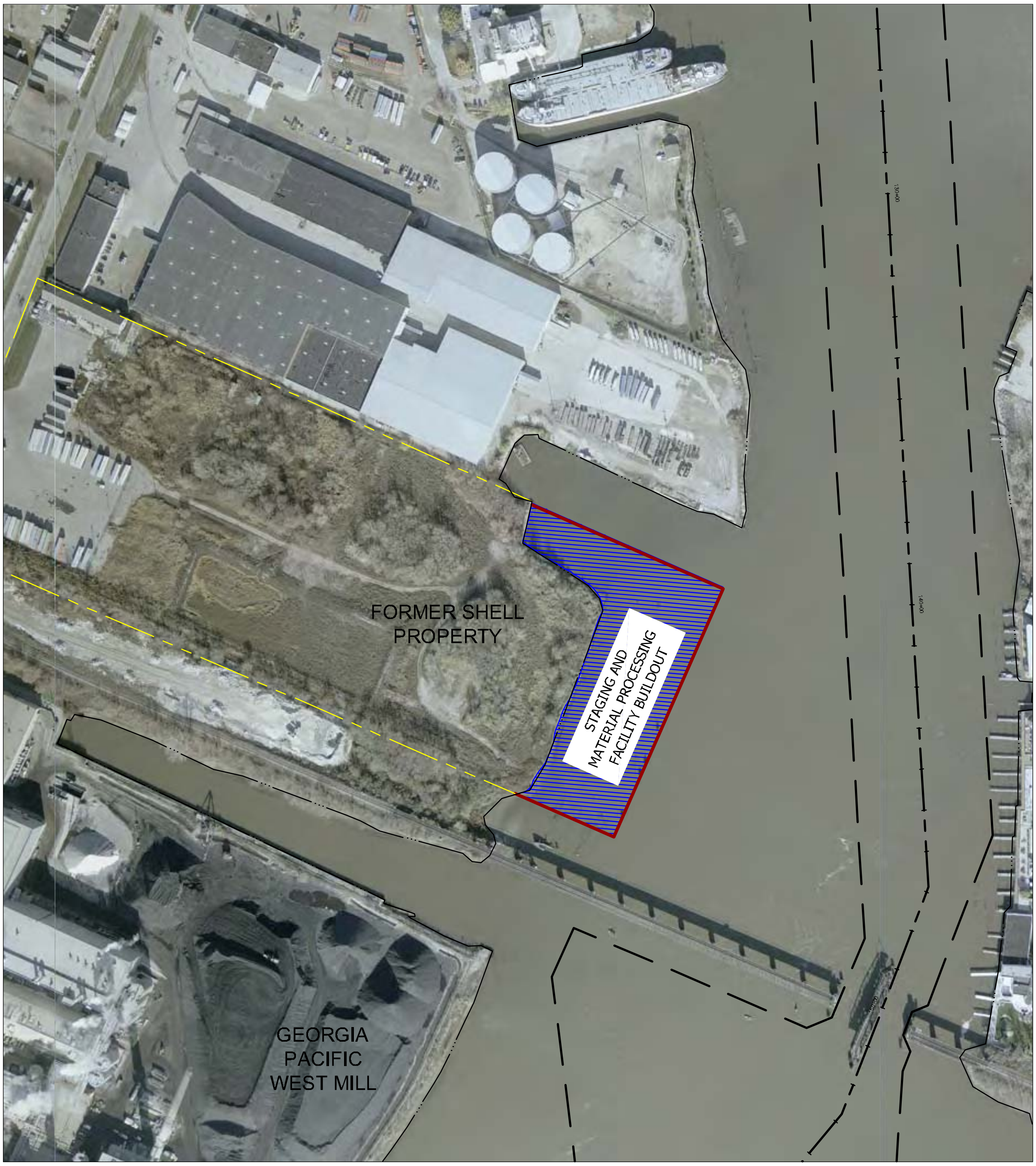
The property was formerly owned by Shell and is currently owned by Georgia-Pacific Consumer Products LP (formerly known as Fort James Operating Company, Inc.). The property will be leased from Georgia-Pacific Consumer Products LP by the Respondents to the Order and managed by Tetra Tech.

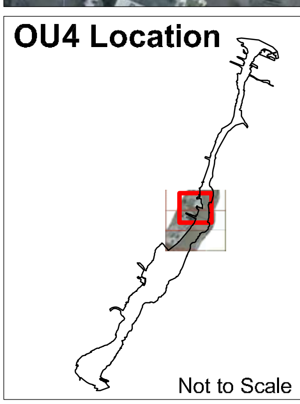
As described in more detail in the May 30, 2008, Site Development Plan, the former Shell property facility requires expansion by way of filling to the existing bulkhead line to accommodate required staging and material handling operations and accomplish onshore remedial activities pursuant to the Order. Initial construction of the bulkhead wall is occurring in 2008 under the Order and the wall will be completed in 2009 as described herein.

The property is located in an industrial portion of Green Bay with established truck traffic routes and nearby rail access. A portion of the property will require footings, piling, or foundations to support heavy processing equipment, filter presses, clarifiers, sand, and carbon media vessels to be installed in the material processing facility. Design details of the former Shell property staging and material processing facility are provided later in this section and shown on Figure 3-3.

As part of the RD, the Tetra Tech Team also reviewed available sites in OU 2 and upper OU 3 to serve as a secondary staging area to support operations upstream of the De Pere Dam. The selection of a secondary staging area in OU 2 or upper OU 3 is also time-critical because the site needs to be prepared before the start of in-water RA in 2009. Based on a consideration of availability, size, timing, and cost, the property located just off Lost Dauphin Road on Ravine Road in Brown County, on the north side of the Little Rapids Dam and Lock area, was selected by the Tetra Tech Team as the secondary staging area. This property is privately owned and includes a causeway across a dam, an abandoned mill building below the dam, and a residence in the northeast portion. Figure 3-2 presents a current aerial view of the Little Rapids Dam staging facility area. Figure 3-5 illustrates the planned Little Rapids site layout.

Jun 10, 2008 5:28pm dholmer K:\Jobs\040179-FOX_RIVER\04017901\PROJECTS\WORKING - SHELL STAGING ANALYSIS\Shell staging analysis v8.dwg Fig 3-1 plan





Staging and Material Processing Facility Buildout

0 400
Scale in Feet

ANCHOR ENVIRONMENTAL, L.L.C. TETRA TECH

Figure 3-1
Former Shell Property Staging and Material Processing Facility
Lower Fox River - OUs 2 to 5

Jun 13, 2008 4:20pm dholmer K:\Jobs\080295-03 FOX RIVER OU2-OU4\080295003-003 (Little Rapids Staging Area).dwg FIG 3-2

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Figure 3-2
Little Rapids Staging Area
Lower Fox River - OUs 2 to 5

3.2 Staging Area Layouts and Site Development Plans

3.2.1 OU 4 – Former Shell Property Staging and Material Processing Facility

The development of the former Shell property staging and material processing facility is critical to the completion of all later phases of work for the project. The project management offices, site lab, and material processing plant will be housed at the facility. This location will be the process center for management of all dredged material, which will include desanding, dewatering, debris management, wastewater treatment, and loading out of waste for transport to the landfills.

Site development at the former Shell property will commence in 2008 with surveying, clearing and grubbing, and site grading activities. Additional site preparation activities, such as removal of structurally unsuitable fill and replacement with structural or general fill, construction of site drainage features and access roads, and installation of the foundation for the material processing facility will also be completed in 2008. This work will be performed in accordance with the following detailed work plans for these activities:

- Project Plan (Appendix C, Attachment C-0)
- Statement of Work for Construction of Staging Area and Access Roads (Appendix C, Attachment C-1)
- Site Preparation Work Plan, Former Shell Site (Appendix C, Attachment C-2)
- Concrete Foundation Work Plan (Appendix C, Attachment C-4)

Installation of the sheetpile bulkhead and staging area along the Fox River will begin in 2008 and continue into 2009. Some additional filling of the bulkhead area may extend into 2010. Section 5.2 details the planned routing of the dredge slurry pipeline at the former Shell property in order to allow dredging and sediment processing operations to occur concurrently with filling of the bulkhead area. Details of these construction activities are provided in the following subsections.

The existing shoreline along the eastern boundary of the former Shell property will be expanded along the existing approved bulkhead line to generally match the shoreline of the adjacent northern property (see Figure 3-1). This involves installing an Open Cell Bulkhead® using steel sheetpile beginning in 2008 along the bulkhead line, creating a dock and platform area with 660 feet accessible for berthing along the face. Subsequent development of this area will involve filling and conversion to uplands of approximately 4.7 acres of OU 4 to meet the staging and material transfer and storage area criteria. Building out to the bulkhead line will increase the upland acreage to approximately 27.3 acres, which is necessary to support remedial operations, as more fully described in Anchor et al. (2008). The sheetpile wall installation plan is discussed in more detail in Section 3.2.1.2.

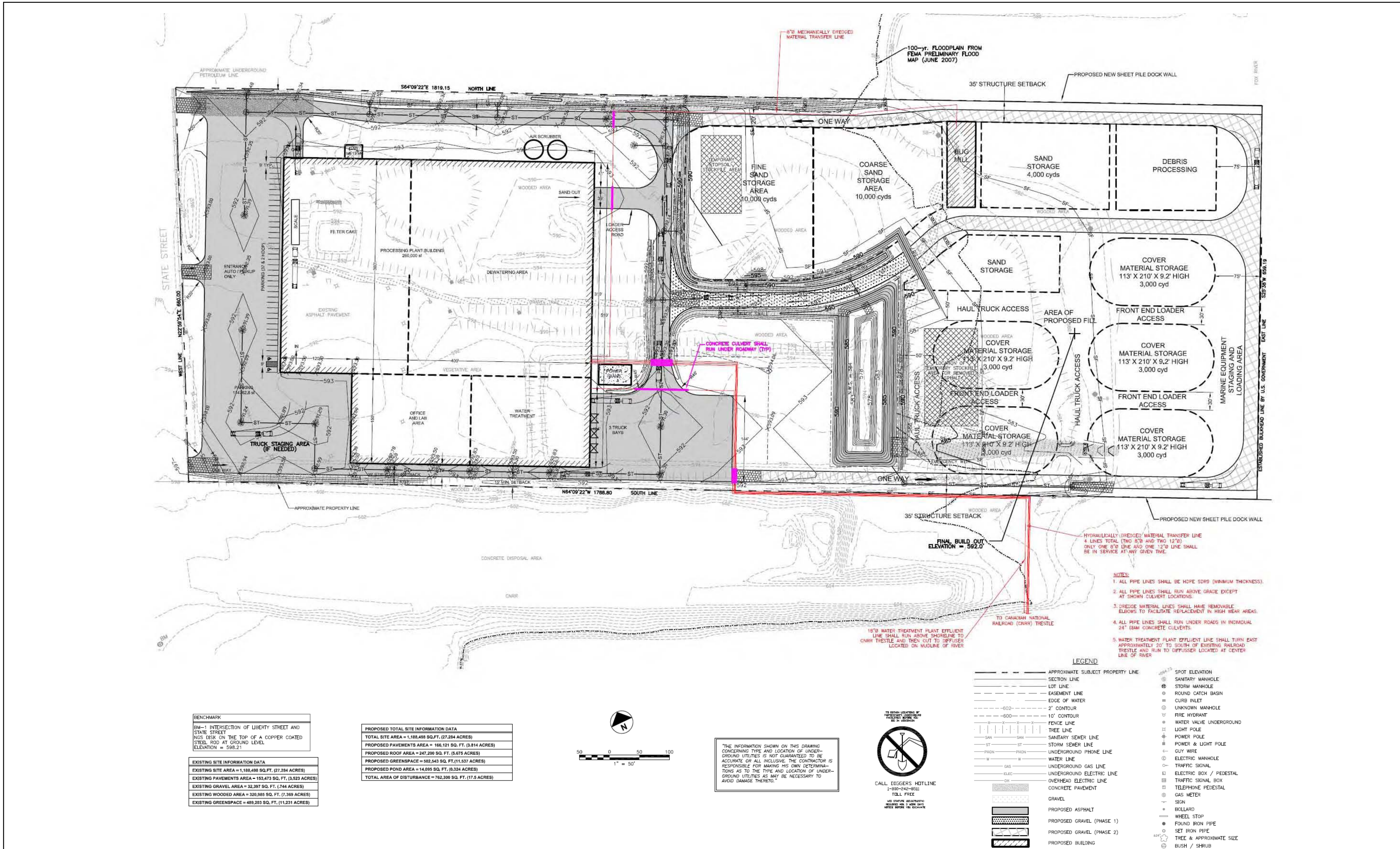

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Figure 3-3
Former Shell Property Site Development Plan
Lower Fox River – OUs 2 to 5

The former Shell property staging and material processing facility construction activities are a multifaceted operation involving the following breakdown of site construction activities, currently being performed as part of the Phase 2A RA activities pursuant to the Order:

- Site surveying
- Geotechnical investigations
- Installation of temporary support facilities
- Implementation of the approved Stormwater Pollution Prevention Plan (SWPPP)
- Installation of erosion and sediment control systems
- Site demolition
- Utility service installation
- Clearing and grubbing
- Site grading and laydown area preparation
- Onsite construction of roads
- Site security
- Sheetpile wall installation
- Concrete foundation and slab construction
- Sediment processing building erection
- Installation of process equipment and accessories (e.g., monitoring equipment, on-site laboratory, etc.)
- Testing of process equipment
- Installation of wastewater treatment system outfall
- Installation of site signs

The sections below summarize key aspects of the site development design and construction activities, with additional details provided in Appendix C.

3.2.1.1 Geotechnical Investigation

As part of Phase 2A RA activities under the Order, geotechnical investigations have been performed for the former Shell property in the planned location of the material processing building. Borings were installed to investigate the soil conditions underlying the material processing building and were advanced to a depth of approximately 50 feet below grade. Soil samples collected from the borings were analyzed for the following parameters:

- Sieve analyses
- Atterberg limits
- Moisture content
- Unconfined compression
- Tri-axial compression
- California bearing ratio (CBR)
- Corrosivity
- Organic content

From this investigation and sample analysis, final design of the building foundation and footings will be completed. The information will also indicate if there is a need for any subgrade improvements to allow construction of the various site features such as construction roads, process areas, and equipment installation.

3.2.1.2 Sheetpile Wall Installation Plan

An Open Cell Bulkhead® design is in the final stages of development by Peratrovich, Nottingham & Drage Engineers Inc. (PND Engineers) and is anticipated to be constructed at the former Shell property as part of Phase 2A RA activities under the Order. The design reflects a construction sequence in which geotechnically unsuitable materials and debris will initially be removed from the footprint of the sheetpile wall, followed by the sheetpile wall installation forming the cells. Following initial stages of sheetpile wall installation, dredging will be performed to remove sediment delineated as requiring TSCA disposal, along with overlying non-TSCA sediments. This dredging will be followed by placement of sand backfill in the cells, beginning in 2009, ultimately to elevation 592.5 feet NAVD88. Section 5.2 discusses the routing of the dredge pipeline at the former Shell property so as to not interfere with sheetpile wall installation in 2009. Based on preliminary design performed by PND Engineers, all sheetpiles are assumed to be a minimum of 50 feet long, as depicted on Figure 3-4. The preliminary design was based on the boring logs advanced along the alignment of the sheetpile wall in December 2007 (STS 2008). The final design and Site Development Plan will be developed under the Order.

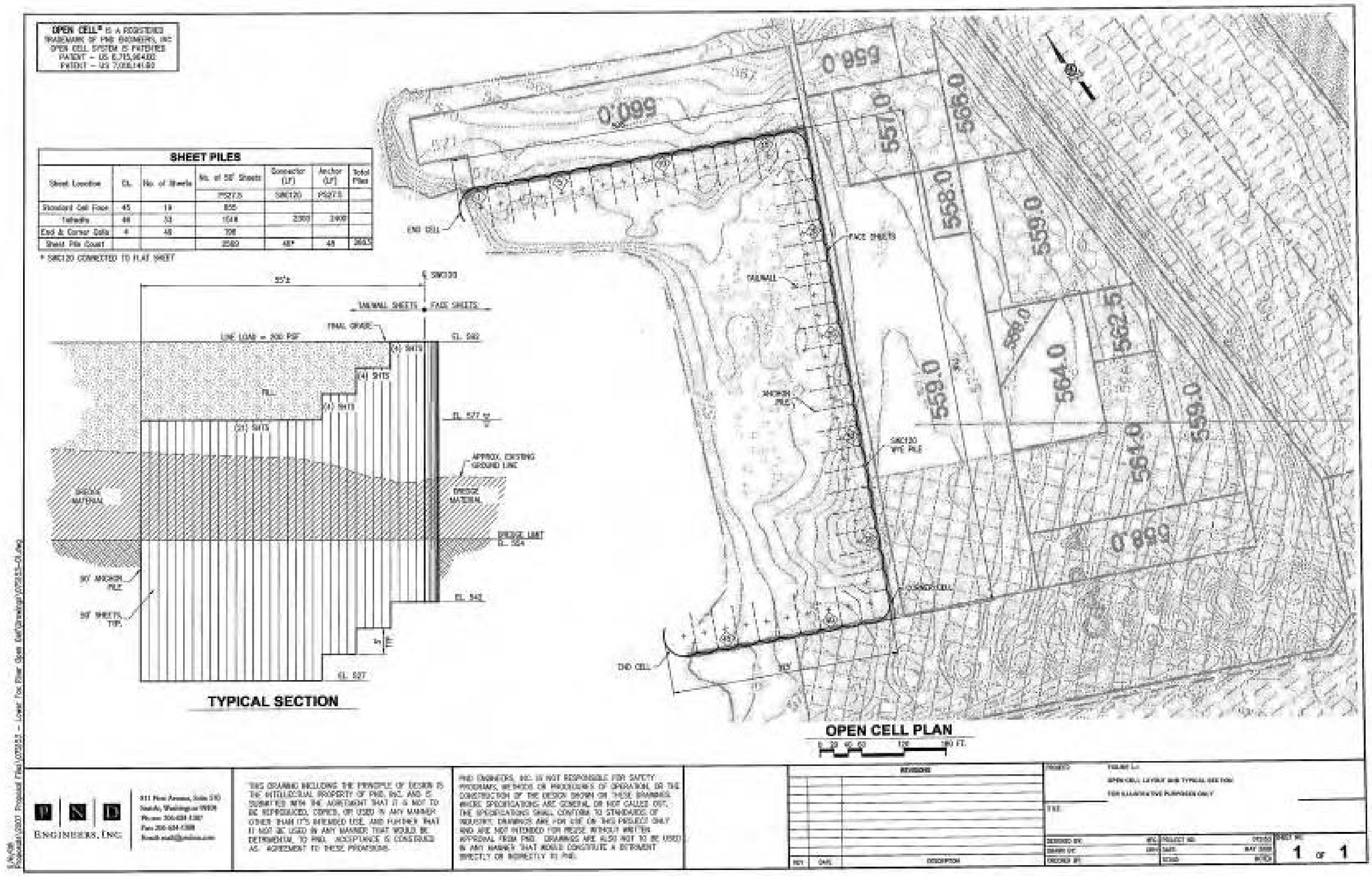


Figure 3-4

Preliminary Open Cell Bulkhead Sheet Pile Plan

Lower Fox River – OUs 2 to 5

The following presents the anticipated sequence of pile installation activities (see Section 6 for additional schedule details):

- Mobilization of two marine plants (barge with crane) for installation to the site 2 months prior to sheetpile delivery (beginning June 2008)
- Survey and mark sheetpile structure alignment for debris removal
- Removal of debris (from land and/or marine plants) that might interfere with sheetpile wall installation and site access 1 month prior to sheetpile delivery (beginning late August 2008)
- Begin installation of sheetpile wall (September 2008)
- Perform hydraulic dredging of TSCA (and overlying non-TSCA) sediments within and adjacent to sheetpile enclosure (September to November 2009)
- Complete installation of sheetpile wall (September 2009)
- Backfill of sheetpile wall (2009 to 2011)

Additional construction details are provided in Appendix C, Attachment C-0.

3.2.1.3 Concrete Foundation and Slabs

Based on the preliminary geotechnical data, the design of the sediment processing building foundation will be finalized as part of Phase 2A RA activities under the Order. This design will detail subgrade requirements for the construction of the concrete building slab including equipment pedestals and water collection features. Cut and fill operations will be performed to meet subgrade lines and grades needed for foundation footings, slab thickness, and elevation requirements as part of facility preparation. The plan will further detail all slab features, which include footing design, pedestal design, concrete strength, and coatings if required. Concrete specifications, as well as other construction details, are included in Appendix C, Attachment C-4.

3.2.1.4 Sediment Processing Building Erection

As discussed in Section 3.2.1, a building will be erected at the former Shell property to house all of the sediment processing operations. Once the design drawings for the sediment processing building, as presented in the Metal Building Erection Work Plan in Appendix C, Attachment C-5, have been finalized and agreed upon, the erection of the building will be performed in accordance with 29 CFR 1926.750 – 761.

The building erection sequence and additional construction details are also provided in Appendix C, Attachment C-5.

3.2.1.5 Installation of Process Equipment and Accessories

The construction of the sediment processing building will start in summer 2008, with the objective of having the building enclosed before winter weather sets in. The building will include two 20-metric-ton overhead cranes that will be used for initial installation of the equipment, such as the filter presses, and later for maintenance. An additional 10-metric-ton crane will be used to handle small items such as polymer bags or small equipment.

The process equipment will be installed in the building shell using standard construction practices. Installation of equipment will be in accordance with the facility drawings (see Appendix C, Attachment C-0) and will be verified by the Tetra Tech Team quality control (QC) personnel in accordance with the Construction QC Plan developed and approved by the Response Agencies under the Order. Components and materials will be receipt inspected to verify compliance with specifications and procurement documents.

Piping, electrical, and instruments systems will be installed in accordance with the construction-level drawings and specifications (see Appendix C) and inspected by the Tetra Tech Team QC representative.

In spring 2009, exterior or support facility punch list items will be completed prior to startup testing and the planned April 15, 2009 start of dredging.

3.2.1.6 Testing Process Equipment

During 2008 Phase 2A activities performed pursuant to the Order, the Tetra Tech Team will develop Startup and Testing Plans for the individual systems and plant as a whole, along with operations and maintenance procedures for the facility. The Operations and Maintenance Plans developed for the material processing facility and for the wastewater treatment plant (WTP) will include the winter shutdown, drain-down, and lay-up process to protect the process equipment during the winter months from damage or deterioration and to allow a spring start with a minimum of difficulty.

Individual system segments will be installed per manufacturer's information and standard practices. These individual system segments include the following major equipment items:

- Tanks
- Pumps
- Membrane filter presses
- Conveyers
- Clarifiers
- Hydrocyclones
- Tremmel
- Granular activated carbon (GAC) units
- Sand filters
- Cartridge filters

The installed components will be fully inspected and tested (e.g., system flushing, leak, hydrostatic) in preparation for turnover and startup testing. Equipment such as pumps and similar items will be run-in, electrical systems checked, and instrument systems verified.

Prior to the operation of the facility, a Facility Readiness Review will be completed to verify that all process equipment and support equipment is in place and ready to operate. The review will include readiness of the support facilities and personnel, including the laboratory, operations personnel, spare parts, decontamination, and administrative support, as examples. When the Tetra Tech Team management has determined that there are no significant holds to operation, the facility will be turned over to the Operations group for cold and hot testing and long-term operations.

"Cold testing" of the treatment facility will be conducted using navigational dredge sediments, removed from the north bay at the Little Rapids Dam area to create a barge access channel (see Section 3.2.2), to demonstrate the plant operation and fine tune the equipment and process monitoring. It is anticipated that the cold test will be part of the first dredging performed. This will also support the dredging startup process. Once the facility has demonstrated the ability to operate consistently with the navigational dredge materials, the plant will be cleared for "hot testing" (i.e., processing of the first known contaminated materials).

Hot testing will be performed in a controlled manner to allow verification that the processes are working and the resultant sand, filter cake, and effluents are within the expected ranges and within the permitted limits.

3.2.1.7 Installation of Wastewater Treatment Plant Outfall

A wastewater treatment system HDPE outfall has been designed as described below, and will be constructed in 2008 to discharge treated wastewater generated from sediment dewatering and water treatment operations in OUs 2 to 5. The outfall includes discharge piping with a diffuser assembly designed to achieve the necessary initial dilution to comply with water quality performance standards using a zone of initial dilution (ZID) as defined by the State regulations, which allows the use of Best Demonstrated Treatment Technology Reasonable Achievable (BDTTRA). The projected performance of the diffuser was modeled using EPA UDKHDEN software. The WTP outfall will be operated under the substantive requirements of a Wisconsin Pollutant Discharge Elimination System (WPDES) permit that would typically be issued by WDNR. The operating objective of the plant will be to comply with the WPDES requirements at all times.

Physical Location

The treated effluent outfall HDPE pipeline will run at grade from the WTP at the former Shell property staging and material processing facility eastward generally along the south side of the property to near the shoreline and then run south to a point south of the railroad trestle before turning east and entering the Fox River. Where the pipeline crosses the shoreline into the Fox River, a trench may be dredged beneath the waterway slip that extends to the navigation channel. The river portion of the effluent piping will be pre-fabricated on-site, including the multiport diffuser at the end of the pipe for installation. The temporary diffuser will be placed above the river bottom and below the authorized channel depth. The pipe and diffuser will be weighted with concrete collars to overcome buoyancy and maintain alignment. The pipe and the diffuser will be covered to protect the pipe. At the location where the outfall pipe enters the river, a ground cover thicker than the freeze level will be maintained to protect the pipe. Figure 3-3 shows the approximate location of the outfall line from the former Shell property and where it enters OU 4. The pipeline route in the river and the diffuser design will be finalized in the 100 Percent Volume 1 submittal when the EPA UDKHDEN modeling has been completed.

Effluent Process Monitoring

Effluent monitoring will be ongoing within the WTP to allow the operators to verify, on an ongoing basis, that process parameters are within operating tolerances of the substantive requirements of applicable regulations. The process monitoring will include the discharge parameters required for efficient operation. Construction monitoring is described below and in the CQAPP (Appendix D).

Monitoring of Compliance with Substantive Requirements of WPDES Permit

A discharge monitoring location will be established below the last inflow connection to facilitate sampling to demonstrate compliance with the substantive requirements of a WPDES permit. These data will be reported to the Response Agencies as described in the CQAPP. The anticipated monitoring and discharge parameters for the WTP are shown in Table 3-1.

Table 3-1
WTP Monitoring and Discharge Parameters

Effluent Properties	Frequency	Anticipated Limits
Total Suspended Solids	Daily via Auto-sampler	10 mg/L daily maximum <5 mg/L monthly average
Biological Oxygen Demand	Daily via Auto-sampler	To be addressed through waste load allocation credits (see Section 5.5.5)
Ammonia	Daily via Auto-sampler	Acute toxicity (dependent on pH and discharge rate)
PCBs	Daily via Auto-sampler	<0.5 µg/L
pH	Daily via Auto-sampler	6 to 9
Low-Level Mercury	Weekly	<0.5 ng/L *

* Or as otherwise established by WDNR in consideration of BDTTRA and performance of other cleanup operations on the Fox River

The monitoring station will be located near or inside the WTP to allow ease of reading and to protect the equipment.

3.2.2 OU 2/3 – Little Rapids Staging Facility

The Little Rapids staging facility is currently vegetated and will require minor upgrades to support the project primarily as a staging area for clean import materials and a project office. No contaminated sediment or debris (having a PCB concentration ≥ 1.0 ppm) will be permitted at this site. To facilitate project use, a new access road into the site entrance from Lost Dauphin Road will be constructed in 2008 consistent with the township of Wrightstown Building Codes, and a grading plan will be implemented to facilitate site drainage consistent with WDNR approval. The laydown area will be cleared, leveled, and constructed. A general site plan showing the planned improvements and traffic safety are shown on Figure 3-5 with additional detail provided in the Traffic Control Plan and in the Site Preparation Work Plan in Appendix C, Attachment C-3. The Little Rapids area has an inlet that can be accessed from the river channel to facilitate barge loading operations. Initial bathymetric surveys performed in this area indicate that dredging will be required in the area depicted in Figure 3-5 to support facility operations. Along the river frontage of the property there are old concrete foundations that, subject to Agency approval, will be demolished to facilitate site grading activities and use of the property as a staging facility. These foundations will be removed, resized for disposal, and properly disposed of off-site. In addition, all the above-grade portions of the existing abandoned building located on the dike area will be demolished, subject to Agency approval and concurrence by the State Historic Preservation Officer (SHPO). The resultant demolition debris will be resized as necessary for disposal and used as fill on-site or disposed of properly off-site.

Operations to complete the staging area at the Little Rapids site will start in 2008 and continue through June 2009 (see Section 6 for additional details of the project schedule). The Tetra Tech Team will follow several tracks of progress to complete upland and aquatic-based work at the Little Rapids facility including the following:

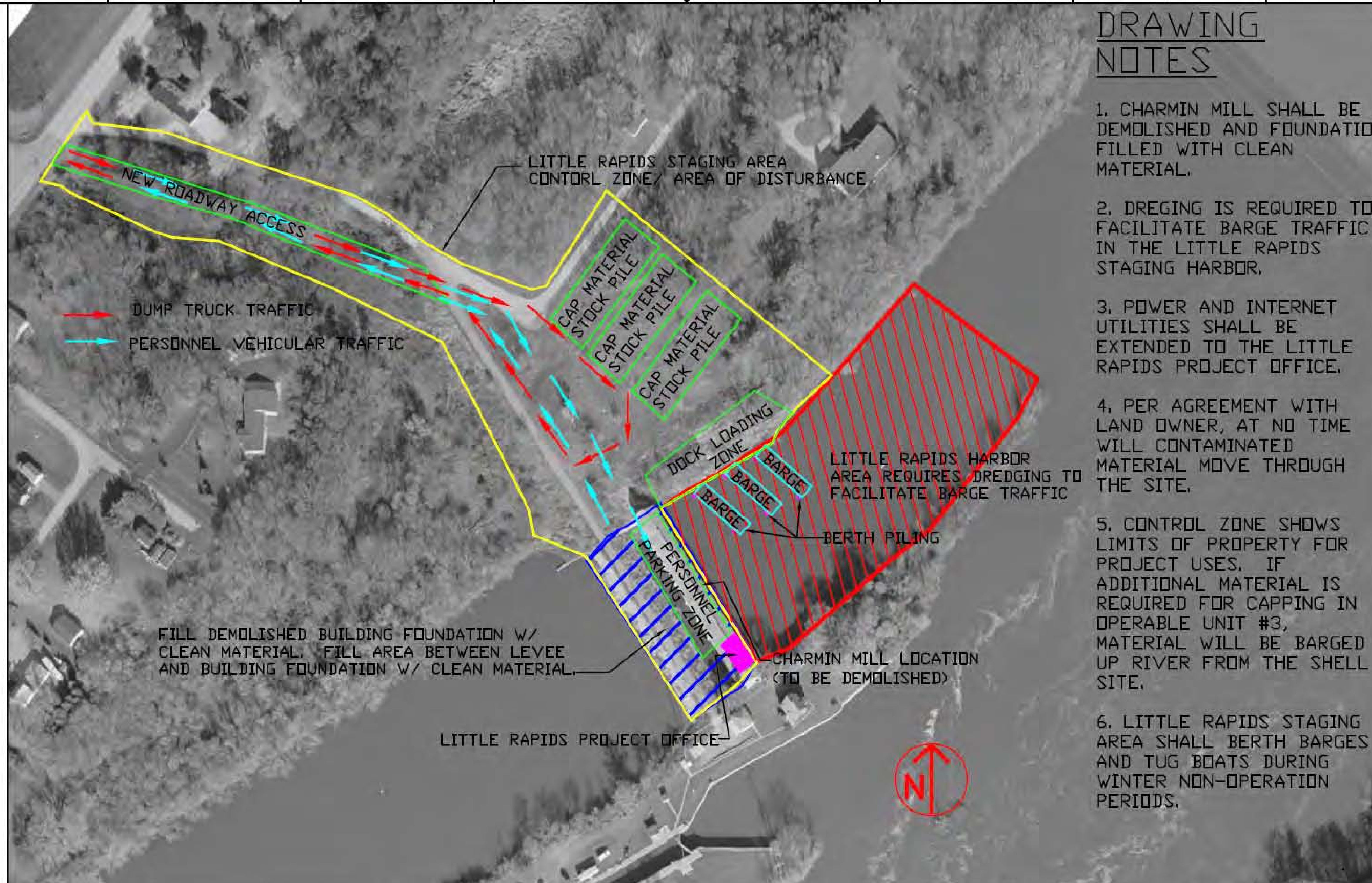
- Clearing and grubbing will commence in 2008, following Agency approval including addressing the substantive regulatory requirements, including archaeological review (see Section 7). Most of the clearing work will be completed in 2008; however, areas along the north edge of the property and loading dock will require further grading in 2009.

- In 2008, a gravel pad will be installed at the planned dock location after all clearing and grubbing work has been finalized. The gravel placement at the dock location is necessary to facilitate pipe fusing operations and future loading of capping material onto marine (barge-based) plants for capping work described in Volume 2. Additionally, as part of the gravel placement at the dock location and to stabilize the area, gravel will also be placed along the northern edge of the property and in areas where previous subsidence has been observed.
- After the gravel pad is installed, three sets of temporary timber piling will be installed for use as barge mooring structures. The timber mooring structures will allow for the simultaneous staging of three 120-foot by 30-foot material barges for the loading of capping material. Once the temporary timber piling structures are located and placed, the project crew will be dedicated to site maintenance and tasked with preparation of stockpile areas.
- As upland work is proceeding to finalization at the Little Rapids staging facility, a simultaneous course of work will be progressing towards the removal of soft sediments in the Little Rapids bay area immediately adjacent to the site. Prior to the commencement of contaminated sediment dredging in OU 2 at the start of the 2009 construction season, navigational dredging will be performed in the bay location immediately adjacent to the Little Rapids staging facility (north side of the causeway; the "north bay"), using the 8-inch hydraulic dredge system. The navigational dredge sediment removed from the north bay will be transported via pipeline for dewatering at the former Shell property facility as part of the "cold test" of the sediment processing equipment (see Section 3.2.1.6). Removal of the material in the north bay is necessary to allow access for floating barges containing capping material for work in OUs 2 and 3. In addition, material that cannot be removed with the hydraulic dredges may have to be removed along the shoreline through mechanical methods. The final piece of work in the north bay adjacent to the loading dock will be the installation of shoreline riprap protection, which will protect the bank from erosion during loading and docking activities.

Additional details of the site preparation work at the Little Rapids staging facility are presented in the following sections.

3.2.2.1 Site Survey

Upon completion of upland work at the Little Rapids staging facility, a complete land survey will be performed over the completed site. Furthermore, after dredging for navigational purposes is complete in the north bay adjacent to the staging site, an as-built survey will be performed. Figure 3-5 shows the site with an overlay of the completed facilities.



BRENNAN "Marine Professionals"	J.F. BRENNAN CO. 820 BAINBRIDGE ST. LA CROSSE, WI 54602 PHONE 608) 784-7173 FAX (608) 785-2090	FOX RIVER	TITLE: MARINE ACCESS AREA LAYOUT	
		LITTLE RAPIDS STAGING AREA	DRAWN BY: MRB	DATE: 5/8/08
			CHECKED BY:	DWG #: REV:

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Figure 3-5
Little Rapids Dam Staging Area – Site Development Plan
Lower Fox River – OUs 2 to 5

3.2.2.2 Stormwater Pollution Prevention Plan

Prior to construction in 2008, areas surrounding the Little Rapids staging facility will be delineated with silt fencing to prevent non-point source stormwater runoff of fine materials to OUs 2 or 3. Throughout the year, checks of the silt fencing will also be performed weekly or after a significant rainfall event, and fencing will be maintained until substantial vegetative growth allows for natural conditions to mitigate stormwater runoff.

As construction progresses in 2009, any areas cleared and not covered with gravel will be seeded with natural grasses so that vegetative growth can be promoted through the remainder of the year.

3.2.2.3 Installation of Erosion and Sediment Controls

All areas of the Little Rapids staging facility that border a wetland area will be delineated with silt fencing. Soil and erosion control measures will be implemented for all disturbed areas greater than 1 acre in size. Furthermore, in areas found to have substantial runoff due to site characteristics, silt fencing will further be reinforced by straw bales or man-made materials. In the event that silt fencing and straw bales are not effective and a visible turbidity plume is observed in the Fox River, a final sediment control measure will include the installation of floating turbidity booms with curtains extending to the river bed. The floating turbidity booms will be placed in close proximity to the shoreline and act as a final barrier to the open waterway.

3.2.2.4 Clearing and Grubbing

In 2008 and 2009, clearing and grubbing operations will take place along the north edge of the property as needed and along the loading dock structure. Most clearing and grubbing will take place in 2008; however, maintenance grubbing may be required in 2009. Clearing and grubbing of wetland areas will be avoided.

Upon completion of the initial site survey at the property, a grading plan will be developed. This plan will detail all cut and fill activities including compaction and drainage specifications. Currently, no borrow material is anticipated for this activity. An existing knoll on the property will provide sufficient fill quantities to allow earthwork activities to prepare the site and maintain proper drainage. The laydown area will be constructed to maintain a 2-day minimum supply of capping material. This will allow for a 1-day usage contingency in case material cannot be delivered because of mechanical or weather delay difficulties.

3.2.2.5 Site Grading and Laydown Preparation

Grading in 2009 will be limited to the dock area and any areas along the north end of the property requiring gravel. Laydown preparation in 2009 will include maintenance of areas created during the 2008 construction season, so that the facility is prepared to receive materials in late 2009.

3.2.2.6 Sediment Removal for Barge Access

To facilitate barge loading activities at the Little Rapids staging facility in 2009, the bay area immediately adjacent to the site and downstream (north) of the lock and dam facility (the north bay) will require excavation. Material barges to be used for the capping operations in OUs 2 and 3 are planned to have a width of 30 feet, length of 120 feet, and draft 5.5 feet when loaded. To facilitate barge movement within the north bay area, approximately 7,000 cy of material will require removal.

Based upon localized site poling information, the majority of material to be removed within the north bay can be dredged using hydraulic methods. However, some rock and coarse-grained material along the banks may require removal through mechanical methods after a hydraulic dredge has removed all soft material. Hard material removed through mechanical methods will be loaded into trucks for beneficial reuse or offsite disposal, as approved by the Response Agencies.

3.2.2.7 Disposal Plan for Barge Access Navigational Dredge Material

Navigational materials removed from the north bay adjacent to the Little Rapids staging facility will be hydraulically pumped to the dewatering facility at the former Shell property. This navigational dredge material will be dewatered and disposed of or reused on site, subject to Agency approval.

4 SEDIMENT DREDGING

This section presents a summary of the 2009 dredge plans within OUs 2 to 5. Additional dredge plan design support documentation is provided in Appendix A. Dredge plan drawings are provided in Appendix B, and specifications/construction work plans are provided in Appendix C.

4.1 Summary of Sediment Physical Properties

Approximately 460,000 cy (depending on overdredge and schedule considerations, 2009 dredge volumes may be up to 490,000 cy) of sediments in OU 2, upper OU 3, upper OU 4A, and within the former Shell property staging and material processing facility are targeted for dredging in 2009. As discussed in Section 2.5.2, based on the results of the 2004 and 2005 RD investigations (Shaw and Anchor 2006), sediments targeted for removal as part of the OUs 2 to 5 RA consist mainly of sand and silt-sized particles (see Table 2-1 of the 60 Percent Design Report Volume 2); the remaining sediments targeted for removal consist predominantly of clay and a trace to slight amount of gravel. In some locations within the river, a layer of stiff native clay was identified beneath the soft sediment targeted for dredging.

RD sampling results showed sand and gravel comprising approximately 37 ± 24 percent by weight (± one standard deviation; 65 discrete samples) of the OUs 2 to 5 sediment samples collected within targeted removal areas. Composite samples collected in 2007 by Boskalis Dolman within the OUs 2 to 5 removal areas suggest a higher overall percentage of sand and gravel of 62 ± 22 percent by weight (six composite samples; see Table 5-4). However, the analytical methods used by Boskalis Dolman were not comparable to those used during RD (e.g., organics were removed during the Boskalis Dolman sample preparation). The design and sizing of the sediment processing equipment included consideration of both geotechnical datasets. However, for the purposes of this 60 Percent Design, mass balance calculations are presented for the Boskalis Dolman data (see Section 5.4.8). These data were utilized because they were derived from actual bench-scale testing of composite sediment samples and included associated performance of the desanding and dewatering system for the samples tested, which is not available for the RD data.

As part of Phase 2A RA activities performed pursuant to the Order, additional core sampling is being performed in 2008 to refine sediment characteristics, materials handling operations, and potential beneficial reuse options for materials to be dredged in 2009. Sediment in these cores is being analyzed for the following geotechnical parameters:

- Moisture content
- Grain size
- Organic content
- Specific gravity
- Dry density

The results of this sampling program will be presented in a data report to be submitted to the Response Agencies. Subject to Agency approval, updated dredge plans incorporating these data will be provided with the combined Final Design Volume 1 and 2009 RA Work Plan submittal.

4.1.1 Dredgeability

Dredgeability refers to the physical characteristics of the sediments as they relate to the ease of removal using different pieces of dredge equipment. One typical measurement of dredgeability is the relative density of the in situ sediment, which can be measured using the Standard Penetration Test (SPT) and is expressed in blow counts (N-value). In general, the higher the SPT blow count, the more difficult the material is to dredge. Based on the results of RD investigations, including soft sediment poling data, the material within the dredge prism is expected to be very loose/soft, with very low or even zero (i.e., "weight of rods") blow count readings, with buried denser deposits at the native sediment contact interface. In general, the buried native deposits have been characterized as stiff clay (additional geotechnical characterization of the encountered materials are provided in Appendix A, Attachment A-6).

Limited areas of denser/harder material (i.e., "refusal" of coring equipment) immediately underlying sediment with greater than 1.0 ppm PCBs were encountered during RD sampling activities in OUs 2 to 5, as shown on Figures 4-1 and 4-2. The vibracorer used for the sampling was a Rossfelder P-3C vibracore with 3-inch-diameter aluminum barrels. It applies 3,600 to 5,400 pounds of force on 60 Hertz frequency, and

2,450 to 3,690 pounds of force on 50 Hertz frequency. In addition, during the recent dredging event in OU 1 and OU 4A (as part of the Phase 1 project) areas of native soft to stiff to hard clay were encountered within the target dredge prisms above the target dredge elevation (referred to as "high subgrade") that, in addition to being characterized with PCB concentrations below the RAL, presented difficulties to the dredging equipment as well as the sediment processing equipment (Shaw et al. 2008). Appendix C provides a procedure for identifying and delineating areas of high subgrade during dredging.

Dredgeability of the material affects the type and size/power of equipment that J.F. Brennan will use for dredging. The material to be removed during 2009 from OUs 2 to 5 consists primarily of sands and silts, with few clay-sized and trace gravel components (see Appendix A, Attachment A-7). Using the available grain size data from RD sampling, a preliminary evaluation was performed and presented in Section 3.2 of the BODR to identify the general size and power range of equipment that will be used to hydraulically transport the material (e.g., horsepower [hp] required for booster pumps), the ability to cut and remove the sediments, and the potential for coarser-grained sediment to inhibit production. In addition, Boskalis Dolman collected sediment cores for physical characterization in 2007, separate from the RD, to support the design of the dredge equipment and dewatering system. These data were provided to the Response Agencies and discussed within the technical workgroup. As noted above, the Tetra Tech Team plans to collect additional sediment data in 2008 to further refine the design and will use physical testing methods that are consistent with the previously collected RD data.

W:\3667-Fox_River\Fox_River_Remediation_GIS\maps\60Perc_Design_Vol1_Vol2_Figures\Volume1\fig4_1_ou2_3_core_refusal_locations.mxd Date: 06/10/2008

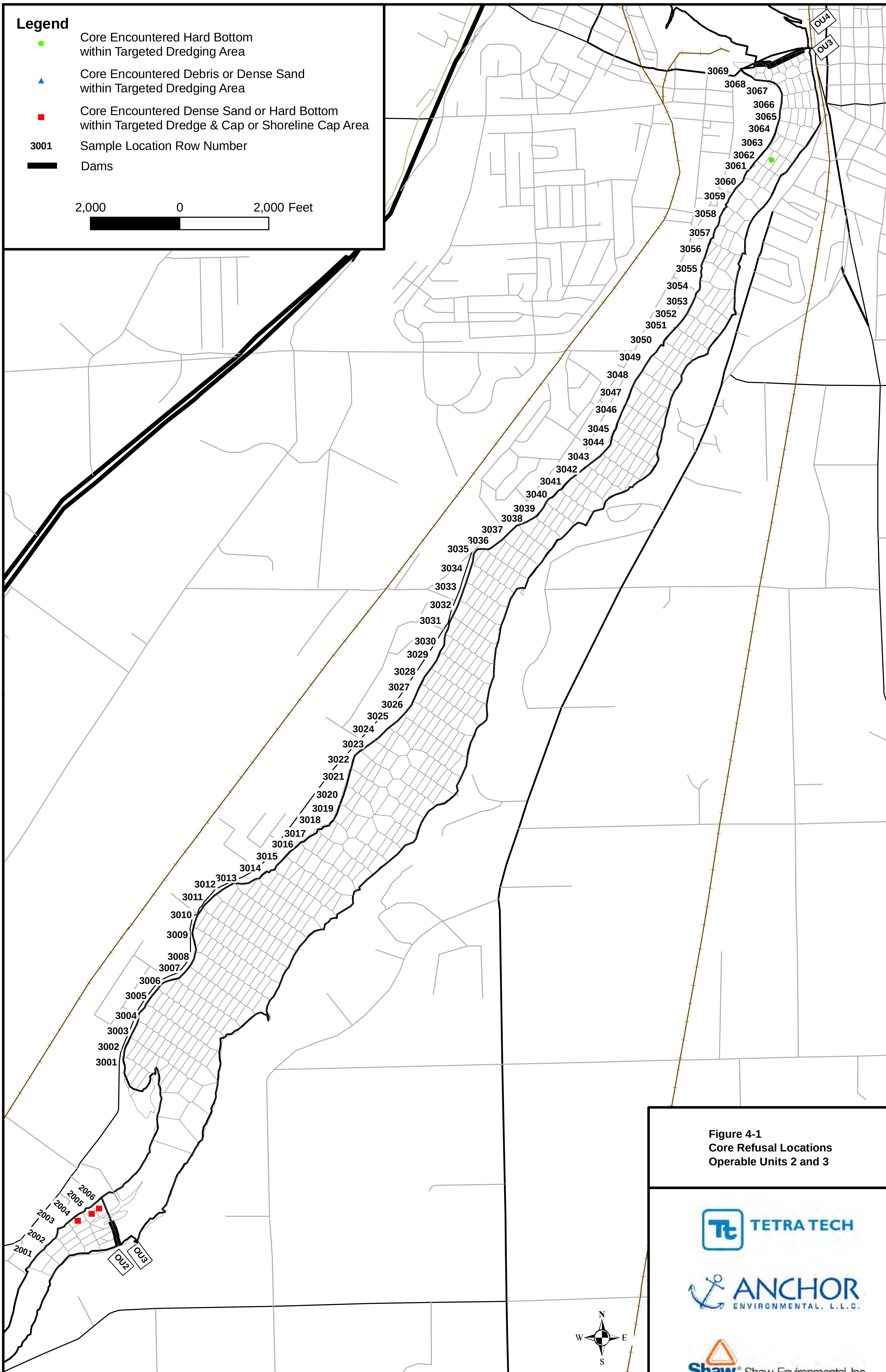


Figure 4-1
Core Refusal Locations
Operable Units 2 and 3

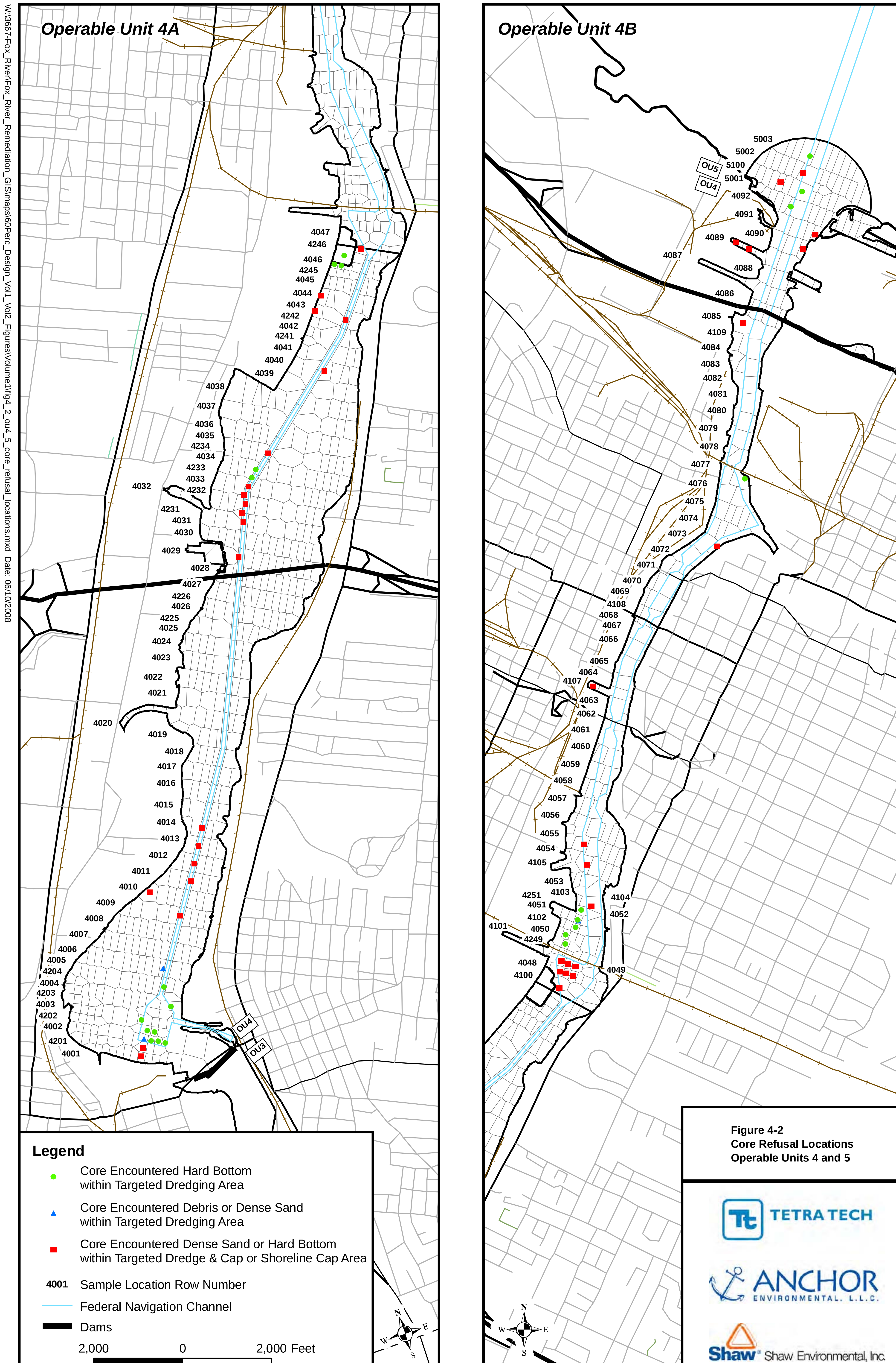


Figure 4-2
Core Refusal Locations
Operable Units 4 and 5

4.1.1.1 Debris

During the course of dredge operations, it is likely that the dredges will encounter debris, which will have to be removed through mechanical methods. Mechanical excavators on a floating marine plant will be used to remove debris from OUs 2 to 5, and the material will be placed in confined open-top containers. Water will be removed from the debris, as practicable, prior to placement in an open-top container. Upon delivery of the container at the former Shell property staging and material processing facility, a lift crane will remove the container from the marine plant. The container will be moved via truck to the area designated for debris processing. Open-top containers will be covered and removed from the facility consistent with bulk cargo operations after debris has been unloaded. Some smaller debris may be removed in conjunction with hydraulic dredging operations and will be delivered via pipeline along with the dredge material to the former Shell property staging and material processing facility. Debris in the hydraulically dredged sediment will be segregated from the dredge material, as described in Section 2.5.1.

All debris removed from OUs 2, 3, and 4 will be moved to and processed at the former Shell property staging facility for off-site disposal or recycling after characterization, in accordance with Figures 2-2 and 2-3 and Section 2.5.1. Debris removed from within dredge areas designated as non-TSCA will be disposed of at the non-TSCA landfill, unless the debris is non-porous and decontaminated in accordance with Section 02 81 00 of the Project Plan (Appendix C, Attachment C-0), in which case it may be recycled; debris removed from within dredge areas designated as TSCA will be disposed of at the TSCA landfill, unless the debris is non-porous and decontaminated in accordance with Section 02 81 00 of the Project Plan (Appendix C, AttachmentC-0), in which case it may be disposed of as non-TSCA debris or recycled, if approved by the Response Agencies.

The presence of debris will be initially identified through side-scan sonar, sub-bottom profiling, and marine magnetometer surveys scheduled to be performed in the summer of 2008, in accordance with the Agency-approved Phase 2A Work Plan Addendum (Tetra Tech and Dolman 2008). However, it is likely that not all debris will be identified during these pre-construction investigations. Therefore, debris removal equipment will be available throughout construction to remove any debris encountered during the dredging operations. Anticipated debris includes dead trees, tires, timbers, concrete, anchors, chains, cables, drums, rocks, abandoned appliances or mechanical equipment, etc.

Debris removal plants will each consist of a 40-foot by 80-foot barge supporting a crane and/or backhoe equipped with a rake, "orange-peel" grapple, or perforated bucket attachment to perform debris removal operations. The rake, orange-peel grapple, or perforated bucket will allow sediments to pass through for subsequent hydraulic dredging, while the debris and oversized materials remain in the rake or bucket for placement in confined open-top containers.

As the design progresses through the more detailed final iteration, the infrastructure and obstructions identified in the project area from bathymetric surveys, side-scan sonar surveys, sub-bottom profiling, and site surveys will be superimposed onto the dredge plans. In addition, rock and debris may inhibit dredging and may require removal prior to dredging when feasible. In areas of excessive debris and obstructions, dredging may not be possible and capping may be required, subject to engineering evaluations to be approved by the Response Agencies. Any such areas identified during the pre-construction investigations will be discussed in the 2009 RA Work Plan. Areas of excessive debris not identified during the pre-construction investigations, but encountered during dredging, will be addressed with the Response Agencies, consistent with the CQAPP (Appendix D) and Adaptive Management Plan (Appendix E of Volume 2).

4.1.1.2 Other Considerations

Shoreline structures and areas containing submerged features such as pipelines, cables, or ruins may limit the use of a dredge in that area. Desktop studies and field surveys have been undertaken and continue to be performed to locate and obtain structural surveys and as-built record drawings for the numerous shoreline and in-river structural features, utility crossings, and overhead obstructions. These features are identified on the Engineered Plan Drawings that accompany this 60 Percent Design (see Appendix B). These data were necessary to develop required setbacks protective of the structures during construction and over the long term. Section 4.4.4 describes the dredge plan design around these areas.

4.1.2 Seasonal Construction Windows and Weather-Related Work Impacts

The BODR discussed the constraints of performing in-water construction activities during the cold-weather months. To alleviate winter construction impacts, a work window is established during which all in-water work will occur. Outside of this window, major dredging operations will not take place; however, maintenance and more routine, non-weather-dependent activities may occur. The 2009 dredging season is currently anticipated to run from approximately April 15 to November 15 to avoid seasonal and weather-related impacts. However, this is an approximate window that is dependant on actual river conditions and may vary at the time of construction. Within this anticipated 7-month construction season, in-water operations will generally be conducted 24 hours per day and 5 days per week; with a sixth day planned for regular equipment maintenance and repair. Non-weather-dependent activities (mobilization, winterization, site preparation, etc.) may be completed during the several weeks immediately preceding or following this in-water work window. Operational procedures for winter shut-down and spring start-up of equipment will be provided in Operation and Maintenance Plans prepared for dredging, sediment processing, the WTP, and site maintenance. Scheduling and sequencing of RA for 2009 is discussed further in Section 6 of this report.

In addition to the planned seasonal shut down of major operations during the winter, other seasonal weather patterns could also affect the efficiency with which work is completed. Low water levels in the summer or storm events resulting in lightning, high wind, and/or current velocities can disrupt dredging production. Operational procedures will be adjusted in real-time to the extent practical (e.g., so that it does not compromise safety or a design element) to accommodate current weather conditions and any large river flow fluctuations. This way, partially completed activities can be minimized and secured from damage or erosion of exposed contaminants during high flow events. Therefore, the number of active, uncompleted dredging reaches will be limited to the extent possible to reduce the risk during these transient events.

4.1.3 Federal Navigation Channel Considerations

The federal navigation channel in OUs 2 to 5 extends 7.1 miles from the mouth of the river at Green Bay to the De Pere Dam. Upstream of the turning basin, in OU 4A (extending from the southern extent of the Fort Howard turning basin to the De Pere Dam), the federally authorized navigation channel has been in "caretaker" status and has not been actively maintained for decades. As part of the Water Resources Development Act (WRDA) of 2007 (Public Law 110-114), the width and depth of the federal navigation channel in OU 4A were re-authorized to 75 feet and 6 feet, respectively. For the purposes of preparing the Engineered Plan Drawings for this 60 Percent Design (see Appendix B), the centerline of the federal navigation channel was used as a baseline for referencing position within the river.

4.2 Equipment Selection and Production Rates

4.2.1 Equipment Selection Process

The removal of sediments in recreational and commercial environments along OUs 2 to 5 is a complex operation, which must take into account many factors. Failure to select appropriate equipment can lead to safety, productivity, and quality problems, which may have impacts on the surrounding environment. Given the large scope of the OUs 2 to 5 RA, many aspects were considered in dredge method selection, as generally described in the BODR and 30 Percent Design Report.

Due to the primary benefits of the hydraulic removal method, the Tetra Tech Team has elected to use that method to remove both TSCA and non-TSCA sediment material in OUs 2 to 5, supplemented by a mechanical method where required. A mechanical method can be utilized in areas where hydraulic dredging is not feasible (e.g., for heavy material or for material within a debris-laden area), although these areas are expected to be limited with respect to the overall project scale. A mechanical dredge plant will be maintained on-site in preparation for conditions that mandate mechanical removal. The sections below describe in greater detail the dredging equipment prescribed for operations at the Site.

4.2.1.1 Hydraulic Dredges

For the execution of sediment removal from OUs 2 to 5, the Tetra Tech Team has elected to employ three hydraulic dredges with pipeline transfer of sediment to the dewatering facility. In 2009, sediment removal will be conducted in OU 2, upper OU 3, upper OU 4A, and within the former Shell property. The following describes the need for maximum efficiency of the hydraulic dredges and how dewatering operations are related:

- Optimum production is realized when dredging operations achieve maximum percent solids in the dredge slurry delivered to the dewatering equipment.
- Maximum percent solids in dredge slurries correspond to the minimum amount of transport water that would subsequently require treatment at the WTP.
- The design of the dredging operations is closely related to the design of the dewatering plant and WTP.
- The use of three dredges gives the Tetra Tech Team the flexibility to adaptively balance production. During times when one dredge is engaged in removal of soft, fine-grained sediment, other dredges can be positioned to remove heavier materials to benefit production. Furthermore, the Tetra Tech Team will have the ability to balance flow rates to the dewatering plant through the use of three dredges. When one dredge is in softer deposits, lower flow rates are typically required to transport sediment to the dewatering facility. The lower flow rates can be used to balance flow rates from the other dredges, which may be in deposits requiring greater flow to transport material to the dewatering pad. Additionally, the Tetra Tech Team will have the ability to temporarily modify dredge production rates based on available dewatering plant capacity.

Two 8-inch-diameter hydraulic swinging ladder dredges were selected to perform removal work in areas of thinner dredge cuts in OUs 2 to 5, due to the many areas with limited sediment depths, and for cleanup pass work. Dredging productivity is directly related to the amount of material available to the dredge. Limited depths of sediment correspond to less available material for the dredge, which in turn requires a dredge to move more water as a fraction of the slurry. An 8-inch pump is advantageous for initial and final (cleanup) dredge passes in OUs 2 and 3 planned for 2009 because sediment depths match well with the dredge discharge capabilities. An 8-inch dredge will minimize the amount of water delivered to the dewatering facility while maintaining the same solids level as larger dredges.

In addition to the two 8-inch dredges, a 12-inch-diameter hydraulic swinging ladder dredge was selected to perform 2009 mass removal/production dredging work in OU 4. Sediments in OUs 4 and 5 are much thicker compared to sediments in OUs 2 and 3; therefore, it is advantageous to employ larger pump equipment in OUs 4 and 5. The 12-inch discharge pump has been optimized for the expected material depths and it will limit the amount of transport water moving to the dewatering facility.

Sections 4.2.1.1.1 and 4.2.1.1.2 describe the 8- and 12-inch hydraulic dredging equipment and the sequence of operation onsite in 2009. Details regarding the configuration of the pipelines and their interfaces are discussed in Section 5.2.

4.2.1.1.1 8-inch Hydraulic Dredges

In 2009, two 8-inch swinging ladder dredges manufactured by Dredge Supply Company, named *Fox River* and *Palm Beach*, will perform work from OU 2 south of the Little Rapids Dam moving north. The following are the characteristics of the two 8-inch dredges:

- Each 8-inch dredge is 20 feet wide by 45 feet long, drafts 20 inches, with 275 hp.
- Both dredges have a modified hull configuration that allows operation in waters as shallow as 2 feet.
- The modified hull allows for the use of hydraulic dredging in areas traditionally requiring dredging by mechanical means. The use of these modified dredges will increase production while minimizing dredge overcuts.
- Each of these 8-inch dredges can be equipped with a swinging ladder cutterhead.

- Each of these 8-inch dredges has an extended ladder, which will allow for removal operations in the deepest parts of OU 4 (up to 28-foot digging depth).

Specifications, pump curves, and cut-sheets for the 8-inch dredges are in Appendix C, Attachment C-6.

In addition to the 8-inch dredges, booster pumps (a critical component of the conveyance system) will be required. Booster pumps will be maintained at specific locations in OUs 2, 3, and 4 and provide energy to the transport slurry. The additional energy infused to the dredge slurry is critical to enable the process to maintain velocities that allow for sediment transport. To ensure maximum booster pump efficiency, the overall booster pump system is as follows:

- To ensure productivity is maintained, each booster will have automated controls that will match booster engine output with line pressures. However, boosters will also be staffed with workers to monitor each booster location.
- Initially, the 8-inch conveyance system will contain two 8-inch dredges and eight booster pumps.
- As the dredges move north toward the De Pere Dam, booster pumps will be eliminated from the system as hydraulics allow.
- It is the intent of the Tetra Tech Team to continually evaluate the head loss of the system, so the number of boosters may be reduced without compromising line velocity.
- The production rates, dredge pipelines, and booster pumps have all been sized appropriately such that one 8-inch dredge at a higher production rate could maintain operations during maintenance or repairs of the other 8-inch dredge.

Design analysis of the 8-inch system, considering hydraulic head loss and production, is provided in Appendix C, Attachment C-6. Specifications and cut-sheets for the 8-inch boosters are also provided in Appendix C, Attachment C-6.

During the 2009 season, 8-inch hydraulic dredge and booster pump operations will be conducted as follows:

- Two 8-inch hydraulic dredges will begin work immediately south of the Little Rapids Dam and continue north, performing mass removal and final pass work.
- The two 8-inch hydraulic dredges will be relocated from OU 4A to the former Shell property towards the end of the 2009 dredge season to facilitate sediment removal (in conjunction with the 12-inch dredge) adjacent to the sheetpile wall.
- Throughout operations in OUs 2 and 3, the 8-inch dredges will perform initial and final cleanup pass work.
- Both 8-inch dredges will convey material through 8-inch internal diameter HDPE Standard Dimension Ratio (SDR) 17 orange-colored safety pipelines (see Section 5.2 for details of the dredge material pipeline system).
- Prior to reaching the first booster, the 8-inch dredge lines will combine to a single 8-inch pipeline. The single 8-inch pipeline will then extend from the first booster operating location to the sediment processing facility, passing through the required set of boosters. Employing a single 8-inch line to convey material to the dewatering facility is advantageous to the project because it allows a single dredge to perform work if only one dredge can operate. Furthermore, a single pipeline through OUs 3 and 4 limits exposure to boaters and improves safety. If a larger pipeline were implemented for the combined line, operations would have to stop when one dredge discontinued production, because a single 8-inch dredge would be unable to maintain adequate line velocities. In combination, the flow from the 8-inch dredges will not exceed 2,000 gallons per minute (gpm).
- Each 8-inch dredge will be positioned through the use of Real Time Kinematic (RTK) global positioning system (GPS) and a series of inclinometers and swing sensors. In a real-time environment, the position of the cutterhead will be tracked and recorded in relation to the dredge.
- DREDGEPACK® software employed on the dredge computer will use the input from the GPS and sensors to show the dredge operator the position of

the cutterhead relative to the design removal line. Appendix C provides further system details on positioning controls and software.

4.2.1.1.2 12-inch Hydraulic Dredge

In 2009, one 12-inch hydraulic swinging ladder dredge manufactured by Dredge Supply Company, named *Mark Anthony*, will perform mass removal work (i.e., initial production passes) north of the De Pere Dam. Due to its physical size, the dredge *Mark Anthony* is suited for working in navigation channel areas of OUs 4 and 5 requiring mass removal of sediment. The following are characteristics of the 12-inch dredge:

- The dredge is 39 feet wide by 112 feet long and drafts 4 feet of water, powered by an 850 hp CAT 3412E engine.
- The lack of dredge swing wires eliminates a potential entanglement hazard within the navigation channel of OUs 4 and 5, as deep draft boats navigating a narrow channel leave little clearance for swing wires.
- The dredge uses a traveling spud method to propel it through the sediment cut. A traveling spud, in combination with the swinging ladder and bow spuds, negates the need for swing wires commonly used on larger dredges.
- The large spuds enable the dredge to maintain position on the river bottom and minimize safety impacts to the public and project personnel because underwater cables are not required to advance it, thus eliminating dangerous anchor deployment.
- Due to its massive ladder and heavy spuds, this dredge is suitable for the deep water and deeper production dredging passes anticipated north of De Pere Dam.
- This dredge can cover a 110-foot-wide sweep, allowing coverage of a 100-foot-wide area in a single pass.
- This dredge can be used in areas with water depths as shallow as 4 feet, and areas as deep as 28 feet can be dredged in a swinging ladder configuration.
- The cutterhead is outfitted with a scalping device that will minimize the size of rocks and debris from entering the pump, minimizing the potential for downtime due to obstructed pipelines.

Specifications, pump curves, and cut-sheets for the 12-inch dredge are provided in Appendix C.

In addition to the 12-inch dredge, booster pumps (a critical component of the conveyance system) will be required. Throughout operations in OU 4 (and in OU 5 in 2010 and beyond), the 12-inch dredge will work as part of the larger 12-inch conveyance system. The additional energy infused to the dredge slurry is critical to enable the process to maintain velocities that allow for sediment transport. To ensure maximum booster pump efficiency, the overall booster pump system layout is as follows:

- Depending on location, the 12-inch conveyance system will include two 12-inch boosters along with the *Mark Anthony*.
- Similar to the 8-inch boosters, the 12-inch boosters will be automated so that engine output may match conveyance system pressures. Automation of the boosters will not eliminate the need for an individual to monitor each booster location.
- As the 12-inch dredge moves to locations in close proximity to the former Shell property staging and material processing facility, boosters will be eliminated from the conveyance system as hydraulics dictate.
- It is the intent of the Tetra Tech Team to continually evaluate the head loss of the system, so the number of boosters may be reduced without compromising line velocity.

The flow rates of a 12-inch system correlate well with sediment depths north of the De Pere Dam. Design analyses of the 12-inch system, considering hydraulic head loss and production, are presented in Appendix C, Attachment C-6. Specifications and cut-sheets for the proposed 12-inch boosters are also provided in Appendix C, Attachment C-6.

During the 2009 in-water construction season, 12-inch hydraulic dredge and booster pump operations will be conducted as follows:

- The 12-inch dredge *Mark Anthony* will begin operations north of the De Pere Dam and work north toward Green Bay. Due to the depth of required dredging in portions of OU 4 targeted for dredging in 2009, the dredge will only remove a portion of the sediment column. Dredging in subsequent years will remove the sediment column to full depth, as described in the 60 Percent Design Report Volume 2.

- The 12-inch dredge will primarily work on mass removal (initial pass) of sediment in thicker material deposits, leaving final clean-up passes for the 8-inch dredges.
- Production dredging operations in upper OU 4A in 2009 will generally extend to a target elevation set approximately 1 foot above the 1.0 ppm PCB concentration neatline with dredging of the remaining 1 foot to be performed in subsequent years (see Volume 2 of this 60 Percent Design Report). As discussed in Section 4.6, post-dredge SWACs at the completion of the 2009 construction season are expected to remain at or below RD baseline (pre-Phase 1) conditions in OUs 2, 3, and 4, thus minimizing short-term environmental risks associated with the action.
- The 12-inch dredge will relocate from OU 4A to the former Shell property towards the end of the 2009 dredge season to facilitate sediment removal (in conjunction with the 8-inch dredges) adjacent to the sheetpile wall.
- The 12-inch dredge will discharge material through a 12-inch internal diameter HDPE SDR 17 orange-colored safety pipe to the dewatering facility through required boosters with hydraulic flow rates less than 4,000 gpm (see Section 5.1 for details of the dredge material transport system).
- The 12-inch dredge will be positioned through the use of RTK GPS and a series of inclinometers and swing sensors. In a real-time environment, the position of the cutterhead will be tracked and recorded in relation to the dredge. See Appendix C, Attachment C-6 for further system details on positioning controls and software.
- The 12-inch system will allow for a large amount of solids to pass through the dredge pipeline, while minimizing the amount of transport water.
- DREDGEPACK® software employed on the dredge computer within the operator cab will use the input from the GPS and sensors to show the dredge operator the position of the cutterhead relative to the design removal line.

4.2.1.2 Mechanical Dredges

The vast majority of sediment removal work on the Fox River will be performed using the hydraulic dredging methods described above. However, under certain limited circumstances, it may be necessary to utilize a mechanical dredge. During removal operations, the Tetra Tech Team will have the ability to deploy two types of mechanical removal methods. Based upon the specific task, the following two types of mechanical dredges could be used if required:

- A derrick crane with clamshell bucket mounted on a barge (marine plant)
- A hydraulic excavator with a clamshell bucket mounted on a barge (marine plant)

Use of the excavator or derrick crane will be dependent upon the activity type. Areas along the shoreline, areas requiring longer reaches, or areas requiring removal at greater depths will employ the derrick crane to facilitate removal. However, where applicable, use of the 100,000 pound excavator with clamshell bucket is preferred because this equipment allows for greater precision, quicker material barge turns, and greater overall bucket control.

Material removed by mechanical dredging methods will be loaded into material barges for transport to the former Shell property staging facility for off-loading and processing.

During the 2009 in-water construction season, mechanical dredge operations will be conducted as follows:

- Most work in OUs 2 to 5 will be performed through hydraulic removal methods, which will relegate mechanical removal equipment to long inoperable periods.
- During inoperable mechanical excavation periods, the derrick crane and excavator will be redeployed to debris removal operations.
- Each piece of equipment will be deployed on a barge with hydraulic spuds in conjunction with a material handling barge and push boat.
- Each piece of equipment (derrick crane and excavator) will employ RTK positioning equipment in conjunction with inclinometers and DREDGEPACK® software.

- Similar to the hydraulic dredge positioning system described above, the operator will have the ability in a real-time environment to move the clamshell bucket in relation to the designed removal line.
- After the bucket has been positioned and materials have been removed, sediment will be loaded into a contained barge for transport to the staging and dewatering facilities.
- Upon barge arrival at the former Shell property staging and material processing facility, sediments will be removed from the barge and processed.

4.2.2 Shallow Water and Final Clean-up Pass Dredging

Most removal of sediments in shallow water portions of OUs 2 to 5 (including all of OUs 2 and 3 planned for removal in 2009) will be performed with the 8-inch dredges. Depending on fuel load, an 8-inch dredge drafts approximately 1.7 feet of water, which is suitable for operating in most shallow water environments.

In the event that a shallow water environment does not provide depth for an 8-inch dredge, the on-site mechanical derrick or excavator will perform removal operations by loading material into a contained material barge for transport to the staging and material processing facility. A derrick or excavator has the ability to be positioned in deeper water depths and excavate material along the shoreline due to the longer reach of the equipment.

4.2.3 Production Rate Considerations

Dredge production in OUs 2 to 5 is dependent on numerous factors, which must be analyzed and correlated with project productivity. Each of these factors must be analyzed (alone and in combinations with each other) to maximize the production and efficiency of the dredging operation. The following factors were considered in this evaluation:

- **Sediment Cut Depths—**Dredge production is specifically based upon the amount of material available to the dredge as it moves through a specified dredge cut. Small cut depths relative to the size of the dredge cutterhead do not allow for high production because a dredge cannot access material quickly enough to realize pump potential. An analysis was performed of all 2009 dredge areas, applying known dredge coverage rates to sediment depths, yielding projected production.

- **Sediment Characteristics—**Each deposit of material planned for removal in 2009 may have unique physical characteristics that affect the ability of a dredge to efficiently remove the sediment. Under the optimal cut depth conditions, light organic material presents the possibility for greater production rates than denser deposits (e.g., sands and gravels).
- **Grade Requirements—**In the case of thick sediment cut depths, multiple passes may be required to achieve the design grade. Furthermore, multiple passes may be required for thicker deposits of material so that side slopes of the dredge cut are not temporarily over-steepened resulting in sloughing of dredge material into the excavated area.
- **Area Characteristics—**Each deposit was analyzed using existing RD information regarding the presence of debris, rock, or structures, which can be production-limiting. Areas observed to have large amounts of the aforementioned obstacles will have lower production rates.
- **Distance of Deposits from Sediment Processing Facility—**As the distance from the sediment processing facility increases, more booster pumps are required to transport the slurry. When more equipment is added to a sediment transport line, the risk of downtime due to equipment breakdown and maintenance is increased due to the increased machinery exposure, even with prudent planning for spare parts and equipment. It is anticipated that deposits farther from the former Shell property staging and material processing facility will incur more production-limiting downtime. The concurrent dredging operation and multiple pipeline use, and their operations and maintenance, poses another challenge when estimating production rates. J.F. Brennan experience from past sites was included when calculating downtimes associated with similar pipeline operations.
- **Navigational Traffic—**When mechanical excavation is required, dredge production can be limited due to other navigational traffic usage of the channel.

All of the above listed considerations were factored into production analyses specific to locations in OUs 2 to 5 targeted for dredging in 2009.

4.2.3.1 Production Rate

Dredging operations will typically be conducted 24 hours per day and 5 days per week, and are currently scheduled to occur over the period from April 15, 2009 to November 15, 2009 (see Section 6). This schedule will allow for dredging operations to be off the Lower Fox River during the peak times for recreational boaters (i.e., Saturdays and Sundays). However, dredging operations will have the flexibility of working 6 days per week.

Additional factors used in production rate determinations include the following:

- Based on the physical properties of the sediments observed during previous RD geotechnical studies (Shaw and Anchor 2007), the average dredge slurry concentration is expected to contain approximately 5.4 percent solids by weight based on an in situ solids concentration of 32 percent by weight for OUs 2 to 5. This solids content is expected to vary at any given time and will depend on the physical properties of the specific dredge area and other factors, including the thickness of cut.
- A typical sustained dredge efficiency (i.e., "uptime") of 65 percent (15.6 hours per 24-hour time period) has been assumed for the 8-inch dredges working in OU 2 and upper OU 3 (with eight booster pumps) and other production rate considerations outlined above. A higher uptime of up to 80 percent (19.2 hours per 24-hour period) may occur for shorter periods and during later years of RA when the 8-inch dredges will operate with a shorter pipeline and fewer booster pumps. These uptimes were used in calculating the anticipated flow rate of the dredges.

Anticipated typical production rates for the hydraulic and mechanical dredges to be used on site are shown in Table 4-1. The relationship between these typical production rates and dewatering plant capacity is provided in Section 5.4.2.

Table 4-1
Typical Dredging Equipment Production

Operating Dredge Name	Production Based on 24 Hour per Day/5 Day per Week Operation	Operating Dredge Type
Fox River [a]	15 to 40 cy/hr (960 to1,920 cy/day)	8-inch hydraulic dredge
Palm Beach [a]	15 to 40 cy/hr (960 to 1,920 cy/day)	8-inch hydraulic dredge
Mark Anthony [b]	130 to 140 cy/hr (3,120 to 3,360 cy/day)	12-inch hydraulic dredge
TBD	60 to 100 cy/hr (1,440 to 2,400 cy/day)	Mechanical dredge

Notes:
a 65 percent uptime is an assumed maximum for these 8-inch dredges operating in OUs 2 and 3
b 80 percent uptime is an assumed maximum for this 12-inch dredge

The total in situ volume targeted for dredging in 2009 is estimated to be approximately 460,000 to 490,000 cy (depending on overdredge and schedule considerations). This includes approximately 427,000 to 457,000 cy of non-TSCA sediment and approximately 33,000 cy of TSCA sediment.

Since the 8-inch hydraulic dredges have provisions for access to areas with water depths as shallow as 2 feet, mechanical dredging equipment will most likely be required in only limited areas of OUs 2 to 5, if at all.

The sequence of dredging operations will proceed in an upstream to downstream fashion unless otherwise approved by the Response Agencies. During the first year of dredging operations (2009), the three dredges will be operated in the following manner:

- The three dredges will operate simultaneously to optimize production and reduce the overall project schedule.
- The simultaneous dredging operations will include upstream to downstream use of two dredges in adjacent areas south of the De Pere Dam (OU 2 and upper OU 3) while the third dredge operates in an upstream to downstream fashion north of the dam (OU 4A).
- Towards the end of the 2009 dredging season, the two 8-inch dredges and the 12-inch dredge will move north to the former Shell property staging area and begin removing sediment from within and adjacent to the bulkhead wall.
- This configuration will increase production while minimizing the potential for recontamination of dredged areas.

- Unnecessary dredge pipeline and booster pumps will be removed as the dredging operations proceed north of each booster station.
- In dredge areas where both TSCA and non-TSCA material is present, the overlying non-TSCA material will be dredged first, leaving the underlying TSCA material to be removed at the end of the 2009 season. In the limited areas where non-TSCA material underlies TSCA material targeted for removal in 2009, the deeper non-TSCA material will be dredged in subsequent years (see Volume 2). Both of the 8-inch dredges, as well as the 12-inch dredge, will initially focus on non-TSCA material in 2009.
- TSCA dredging will generally be scheduled as close-of-season work, allowing for the proper winterization of dredges and ancillary equipment, booster stations, and other equipment not needed during TSCA dredging.
- By segregating the TSCA and non-TSCA dredging in this manner, non-TSCA sediment will not be cross-contaminated. This sequencing will also allow ample time to complete the multiple long-haul round-trips required to transfer all TSCA material to a permitted out-of-state TSCA landfill(s).

A more detailed breakout of anticipated dredging production in 2009 is shown in Table 4-2.

Table 4-2
2009 Dredge Production Estimates

Operable Unit	Booster Pump Area	Dredge Area	Operating Dredges	Estimated Non-TSCA Dredge Production (cy)		Estimated TSCA Dredge Production (cy)
				Excluding Overdredge	Including 6-inch Overdredge	
OU 2	8	D1	8" *Palm Beach and Fox River*	24,500	31,300	
OU 2 Subtotal				**24,500**	**31,300**	**0**
Little Rapids Dam – North Bay	8	N/A	8" *Fox River*	**7,000**	**7,000**	
OU 3	7	D4	8" *Palm Beach*	8,900	11,800	
OU 3	7	D5B	8" *Fox River*	1,300	2,500	
OU 3	7	D6	8" *Fox River*	3,000	5,400	
OU 3	7	D7	8" *Fox River*	3,400	6,300	
OU 3	6	D8	8" *Palm Beach*	2,100	3,700	
OU 3	5	D9	8" *Palm Beach*	19,000	27,000	
OU 3	5	D10	8" *Fox River*	1,700	3,300	
OU 3	5	D11	8" *Palm Beach*	6,600	9,400	
OU 3 Subtotal				**46,000**	**69,400**	**0**
OU 4A	3	D24	12" *Mark Anthony*	182,500	n/a	
OU 4A	3	D27-South	12" *Mark Anthony*	13,000	n/a	
OU 4A	3	D27-North	12" *Mark Anthony*	38,100	n/a	
OU 4A	3	D31a	12" *Mark Anthony*	61,700	n/a	
OU 4A Subtotal				**295,300**	**295,300**	**0**
OU 4B		Inside Sheetpile Wall	8" *Fox River and Palm Beach*	8,700	n/a	12,600
OU 4B		Outside Sheetpile Wall	12" *Mark Anthony*	44,600	n/a	20,000
OU 4B Subtotal				**53,300**	**53,300**	**32,600**
OU 4 Total				**348,600**	**348,600**	**32,600**
TOTAL 2009 DREDGE PRODUCTION				***426,100***	***457,800***	***32,600***

4.3 Survey and Position Control

Successful execution of work and survey operations in OUs 2 to 5 will rely heavily upon accurate equipment and survey vessel positioning. To complete the work with the necessary degree of accuracy, an RTK GPS network will be established along the entire length of the OUs 2 to 5 RA area and allow access to survey vessels or equipment using the correct frequency. The network will be checked on a regular basis against WDNR-established points along the river to verify continued accuracy. Additional details of the survey and position control equipment are provided in Appendix C, Attachment C-6.

4.3.1 Equipment Position Control

Geodetic control established by WDNR for the Lower Fox River will be utilized in OUs 2 to 5. The accuracy of the control network will be the backbone for reliable surveying and mapping throughout the construction of the project. Positioning of the construction equipment is described below in greater detail.

Remedial construction equipment will utilize RTK GPS for position and elevation tracking. The RTK GPS system has the following components and characteristics:

- Uses satellite links to two equipment-mounted receivers
- Uses a fixed location receiver with known coordinates
- Uses a geometric method known as trilateration to determine the real-time position and elevation of a reference point on the equipment (e.g., pivot point between an excavator body and the boom) to within 4 centimeters (cm) accuracy
- As the equipment travels, turns, rises, and falls, the system continually updates the northing and easting coordinates, heading, and elevation of the reference point on the equipment

Because the point of interest on the equipment is not always the reference point (e.g., pivot point vs. bucket on end of boom), additional instrumentation can be added to the equipment to calculate the real-time, real-world position of the point of interest. These are as follows:

- Inclinometers provide continual measurements of the boom, stick, and bucket angles.
- Two tilt sensors provide continual measurements of the pitch and roll angles of the equipment. The sensor signals are wired to a dedicated monitoring system sold by Ocala Instruments, Inc.

These angle measurements, along with basic dimensions of the equipment, are used in a group of geometric and trigonometric calculations within the Ocala Instruments device to determine the real-time position offsets of the point of interest. By continually applying these three offsets (x,y,z) to the RTK GPS reference point, the position and elevation of the point of interest is known to a high degree of accuracy at all times. The coordinates of the point of interest, as calculated using the RTK GPS system and angle sensors, are sent to a survey software system by HYPACK® known as DREDGEPACK®. DREDGEPACK® serves two purposes:

- It provides a continuous log of coordinates and elevations for the point of interest.
- It provides tools to help the operator accurately position equipment at required coordinates and elevations. The system accepts and displays existing survey information in both plan and elevation views.

The system updates the plan view with the real-time cutterhead position and uses a color gradient to easily show the operator an updated, color-coded view of the river bottom in real-time.

4.3.2 Pre-Construction and Post-Construction Surveys

To facilitate pre-construction surveys, continuous QC, and post-construction elevation verification, the Tetra Tech Team will employ two survey systems located on two to three vessels.

Prior to the 2009 dredge season, pre-dredge multi-beam surveys will be performed in areas scheduled for excavation in 2009. The pre-dredge data recorded prior to each season will be entered to the dredge computers and used as the top layer or existing layer of sediment.

After a dredge has moved through an area, single-beam survey checks will be performed to ensure the dredge is nearing grade or has achieved design elevation. When single-beam surveys preliminarily indicate that an area meets its acceptance criteria, a final post-dredge multi-beam survey will be performed to verify compliance (see the CQAPP in Appendix D for additional details of compliance criteria). The post-dredge multi-beam survey will be used as the record document, verifying completion of work in an analyzed area.

4.3.3 Survey Methods and Equipment

Survey methods for multi-beam and single-beam acoustical systems will conform to guidelines set forth by the USACE guidance (EM 1110-2-1003, Engineering and Design -

Hydrographic Surveying dated January 2002). The equipment listed below represent some of the more sophisticated hydrographic survey tools currently in use on the inland waterways and will be used to complete work in OUs 2 to 5:

- **Reson SeaBat 8124**—The Reson 8124 multi-beam will be used for pre-dredge, interim, and final post-dredge surveys. The 200 kilohertz (kHz) transducer, sending out 80 1.5° beams, will provide bottom coverage of approximately 3 times the water depth.
- **Applanix WaveMaster**—The Applanix WaveMaster is used in conjunction with the Reson 8124 multi-beam to provide heave, pitch, roll, and heading corrections to the data. This type of motion sensor will handle motion corrections that the multi-beam may encounter in OUs 2 to 5.
- **Knudsen 320B/P Echosounder**—The Knudsen 320B/P is a dual frequency echo sounder operating at 200 kHz and 20 kHz. This equipment will primarily be used to measure bulk dredging activities in very shallow areas where the multi-beam system may prove impractical or inaccurate.
- **TSS RP-25**—The TSS RP-25 motion sensor will be used alongside the Knudsen 320B/P to provide corrections for pitch and roll.
- **J.F. Brennan Single-Beam Survey Vessel**—This unique survey vessel will be the platform from which all single-beam surveys are performed. It has been designed and custom-built to provide accurate and safe hydrographic data collection.
- **J.F. Brennan Multi-Beam Survey Vessel**—This survey vessel was built for multi-beam duties on the Lower Fox River. This vessel is capable of traversing the entire project length in short periods of time, which will allow it to cover survey duties for the 8-inch and 12-inch systems.

4.3.4 Data Management

Processing of data will commence immediately after the single-beam or multi-beam survey vessel returns to its docking location. Data processing will include an analysis of all raw data and a compilation of edited recordings, which will exclude any erroneously recorded points. The edited data will be assembled so that it forms a surface that can be interpreted as a depth chart. Project engineers will then examine the processed data depth charts and calculate dredge productivity and accuracy. If project engineers find that areas remain above the dredge plan elevations, data can be inserted in the dredge computer to guide the dredge to specific locations requiring further excavation.

Each day, a second set of data will be recorded from the on-board dredge computers. The second set of data, recorded on a specified time interval, will detail the position of the dredge cutterhead. At the conclusion of a 24-hour period, dredge computer recordings will be downloaded and returned to the project office for analysis by project engineers. Furthermore, engineers will use the data as a comparison to project survey data and adjust removal strategies accordingly.

On a daily basis, depth charts and dredge square foot coverage will be available for viewing in the project-specific office or submitted with daily reports. Furthermore, after the data have been processed, all raw, edited, and x,y,z data will be cataloged by date and stored at the project site to allow any necessary future analysis.

4.3.5 Dredge and Survey Software

All equipment used for dredging, capping, and survey purposes on the Lower Fox River will employ HYPACK® software. HYPACK® is a hydrographic surveying, engineering, and equipment positioning software, which will be used in three forms in OUs 2 to 5:

- **HYPACK®**—HYPACK® is the original software form and is used to position survey vessels, record soundings, engineer dredge excavation cuts, and process single-beam survey and dredge data. HYPACK software is the primary tool used for data analysis and recording.
- **HYSWEEP®**—HYSWEEP® is HYPACK's module for the recording and processing of multi-beam survey data and will be utilized by the Tetra Tech Team throughout the OUs 2 to 5 RA.
- **DREDGEPACK®**—DREDGEPACK® is employed only on the dredge computers and is a module for dredge guidance and dredge data recording. Furthermore, DREDGEPACK® will also be utilized by mechanical dredging, mechanical capping, and hydraulic capping equipment.

In addition to the software listed above, the Tetra Tech Team will also employ Wonderware software on the dredges. Wonderware software receives signals from dredge sensor components and will supply ladder, pitch, and roll positional data to DREDGEPACK®. DREDGEPACK® will then combine Wonderware data with GPS data to present a geographically referenced position for the dredge cutterhead.

4.4 Dredge Plan Development

When preparing an engineering design to dredge and dispose of sediment, a major component of the design is to define the dredge template (horizontal and vertical extents of required dredging). The dredge plan presented in this 60 Percent Design Report for those portions of OUs 2, 3, and 4 targeted for dredging in 2009 consists of a required dredge elevation and an allowable overdepth. The required dredge template represents the elevations, grades, and horizontal extents that J.F. Brennan will remove during RA implementation. Consistent with the ROD, the dredge plan presented in this 60 Percent Design Report has been designed to remove PCB contaminated sediment with concentrations greater than the 1.0 ppm RAL. The allowable overdepth is a constant thickness of sediment below the required dredge template to account for dredging equipment accuracy and tolerances.

Appendix A, Attachment A-1 summarizes the process used to delineate the lateral extents of RA areas, including dredging areas. The RD used the following steps for this delineation:

1. RA areas were initially delineated based on a core-by-core analysis using a Thiessen polygon approach during the BODR phase. Each polygon represented a single RD sampling location and preliminary RAs were assigned to each polygon based on the PCB data from the RD sampling (see additional details in Section 4.4.1.1).
2. A geostatistical model, using full indicator kriging (FIK; see Section 2.4 of Volume 2) with RD data collected in 2004 and 2005 provided a three-dimensional surface representing the elevation of contamination above the RAL at various levels of significance (LOS). As discussed in the BODR and 30 Percent Design, the technical workgroups concluded that the LOS of 0.5 provides the optimum combination of maximum percent correct predictions and minimum overall bias and was therefore selected as the basis for delineating sediment with PCB concentrations exceeding the RAL.
3. During the 30 Percent Design phase, the delineation of RA areas were refined from the Thiessen polygons developed in the BODR using the FIK performed using the

2004 and 2005 RD sampling data. Geostatistical delineation of PCB contamination, discrete RD sampling data, and engineering judgment were used to refine the dredge prisms, as explained below:

a. Cross-sections were generated every 100 to 200 feet along the alignment of the river and at various locations where additional detail was warranted (e.g., areas where the channel alignment and shoreline are not parallel).
b. Each cross-section was analyzed individually and the lateral extents of remediation (dredging, capping, and sand cover) were delineated based on consideration of the following:
    - RA areas were delineated to address areas where the DOC was predicted be in excess of approximately 2 to 4 inches (0.2 to 0.3 feet) by the FIK geostatistical model.
    - Review of PCB data from discrete core locations within and adjacent to the area being evaluated were considered along with the FIK geostatistical model results. In some instances, the geostatistical model predicted the DOC upwards of 6 inches where the discrete core indicated all samples below the RAL. In these cases, the results of the discrete core samples were considered more accurate and RA areas were delineated accordingly.
    - Engineering judgment was used to achieve a more efficient and constructable design. This involved creating minimum width and constant width "lanes" parallel to the channel centerline, bathymetry, or shoreline.
c. Plan view maps of the RA areas were reviewed along with predicted DOC from the geostatistical model shown on a regular grid spacing (see Appendix A, Attachment A-1 for example). Additional refinements were made to the lateral extents of the RA areas based on this review to ensure that the RA boundaries appropriately addressed areas where at least 2 to 4 inches of sediment above the RAL exist.

Because the dredge plan design relies on multiple sets of data, the precision of each data set (e.g., bathymetry and the horizontal and vertical extent of contamination; i.e., the "neatline" as defined by geostatistical methods) affects the level of certainty that the dredge template encompasses all the contaminated sediments. Subject to Response Agency approval under the Order, additional infill samples will be collected in summer 2008 within specific 2009 dredge areas to refine the geostatistical modeling and subsequently the neatline dredging plan, as appropriate. The infill sampling will include additional sediment core collection along the boundaries of dredge areas with the most uncertainty, to further refine the delineation of the DOC in these areas. In addition, infill sampling may also target areas where previous RD sampling did not completely delineate the DOC above the RAL. Refinements to the lateral and vertical extents of dredging planned for 2009 will be documented in the Final Design Volume 1 and 2009 RA Work Plan.

During initial project planning leading up to the 30 Percent Design submittal and the subsequent selection of the Tetra Tech Team in February 2008, the dredge plan design was developed as a traditional set of engineered dredge prisms (or boxes), each with a constant elevation or slope. For dredge-only areas, the required elevation within these dredge prisms were designed to remove sediments exceeding the 1.0 ppm RAL for PCBs at an appropriate statistical confidence level, as delineated using geostatistical modeling of the 2004 and 2005 RD sampling data (see Section 2.4 of the 60 Percent Remedial Design Report Volume 2). However, since the vertical extent of the geostatistically model for OUs 2 to 5 is an undulating surface, the dredge prisms designed with areas of constant elevations inherently results in the planned removal of some volume of sediment with PCB concentrations below the RAL, typically resulting in higher material processing and disposal volumes and associated costs.

An alternate approach for delineating the vertical extent of required dredging, based on a dredge template or neatline (i.e., geostatistically modeled surface representing the extent of PCB-contaminated sediments exceeding the RAL at an appropriate statistical confidence level), was evaluated during the preliminary design phases, but was initially not selected because the resulting dredging surface is more complicated and requires precise removal techniques, which not all remedial dredging contractors can efficiently achieve. Instead, the engineered dredge prism approach was initially selected for the 30 Percent RD because it was anticipated to offer the most flexibility and bidder competition, and potentially the lowest overall cost, during a traditional design-bid-build project. However, the Order Respondents recently selected the Tetra Tech Team including J.F. Brennan to join the RD team and also perform the RA. J.F. Brennan is one of a few contractors that have experience with neatline-based dredge plans, as recently demonstrated through their remedial dredging work in OU 1 of the Lower Fox River. Therefore, the 60 Percent Design dredge plan is based on the neatline approach for dredging-only areas to maximize the likelihood of reducing the overall project duration (by reducing total dredge volumes), and to reduce overall project costs. Furthermore, the 60 Percent Design dredge plan was developed in consideration of J.F. Brennan's proposed equipment and production goals, as described in Section 4.2.

Development of the 2009 dredge plan design, which is presented in Appendix B, was an iterative process, combining a dredging neatline (as defined by geostatistical methods) in dredge-only areas with constant elevation dredge cuts (i.e., an engineered dredge prism) in dredge-and-cap areas to create an overall dredging template that will be used by the dredge operator to guide the work. In addition, development of the 2009 dredge plan included consideration of appropriate dredge elevations and offsets around in-river structures and utilities, as described below. As described in the 30 Percent Design report, during optimization, the final elevations of adjacent remedies (cap, cover, dredge, etc.) were assessed to ensure that implementation of the design will result in the construction of consistent channel and river bottom elevations. For example, some isolated areas, initially designated in the BODR as "cap", were converted to "dredge" areas to provide a consistent river bottom elevation (the forthcoming "RD Design Anthology" will include a summary of design adjustments since the BODR).

4.4.1 2009 Dredge Plan and Neatline Refinements

For dredging-only areas in upper OU 3 targeted for dredging in 2009, the neatline area, depth, and associated volume were based on the geostatistical delineation of the horizontal and vertical distribution of PCB concentrations exceeding the 1.0 ppm RAL (see the 60 Percent Design Report Volume 2, Section 2.4 and Figures 2-6 to 2-9; also see Appendix A, Attachment A-1 for a summary of the delineation of the horizontal extents of the required dredging). As discussed in the BODR and in the attached CQAPP (Appendix D), geostatistical analyses and cross-validation results indicate that a neatline established at a LOS of 0.5 provides an optimum combination of maximum percent correct predictions and minimum overall bias. Thus, the LOS of 0.5 was used as the primary method for defining the geostatistical neatline in upper OU 3.

Within those areas of upper OU 4A targeted for production dredging in 2009, scatter plots of predicted versus observed remediation depths for geostatistical FIK identified a few isolated outliers with unusually high negative or positive biases (refer to the 60 Percent Design Report Volume 2, Figure 2-7). Thiessen polygons were superimposed over the kriged surface at these outlier locations to adjust the DOC and improve the accuracy of the neatline surface based on observed core information. As discussed above, 2009 production dredging operations in upper OU 4A will generally extend to a target elevation set approximately 1 foot above the 1.0 ppm PCB concentration neatline with dredging of the remaining 1 foot to be performed in subsequent years (see Volume 2 of this 60 Percent Design).

4.4.1.1 Initial Remedial Design Development

The delineation of specific RD for areas targeted for dredging in 2009 was defined through a multi-step, iterative process as summarized in Section 4.4. Initially, a core-by-core evaluation was performed (as part of the BODR development) to determine preliminary dredge, cap, cover, and dredge-and-cap boundaries using Thiessen polygons based on sediment PCB concentration profiles, comparisons of mudline elevations with stability benchmarks, and other relevant design information. At many locations, removal of contaminated sediments through dredging was determined in the BODR to be the optimal RA. Once the core-by-core evaluation was completed, a "mosaic" of RAs was developed and applied in the BODR across OUs 2 to 5 to identify and group areas of common RAs (e.g., dredge-only, dredge-and-cap, cap, sand cover). In this step, RAs and groupings were applied to the entire Thiessen polygon areas associated with each core location. Then the mosaic was examined for apparently isolated RA "outliers," and actions in some Thiessen polygons were adjusted to be more compatible with RAs in neighboring areas. For example, if the preliminary RA for a particular area was to apply a cap, but several neighboring areas were preliminarily designated for dredging such that a side slope would extend into the subject area, the final RA for that area might be dredging, rather than capping, in order to achieve a more uniform and constructable dredge surface.

Following delineation of RAs on a Thiessen polygon basis, a dredge plan was then developed in which individual engineered dredge prisms (boxes) were delineated, each with a required elevation or slope that targeted complete removal of the neatline, as predicted using the geostatistical model with an LOS of 0.5 and consideration of PCB data from discrete RD core locations. This dredge plan (comprising of engineered dredge prisms) was presented in the 30 Percent Design. Appendix A, Attachment A-1 provides additional details of the process for delineating the horizontal extents of the required dredging.

4.4.1.2 60 Percent Design Neatline

As discussed above, the design of the dredge plan for dredge-only areas in upper OU 3 presented in this 60 Percent Design reflects a modification from the engineered dredge prism approach presented in the 30 Percent Design to a neatline approach capitalizing on the experience of J.F. Brennan and concurrently maximizing the likelihood of reducing the overall project duration and project costs. In general, dredging will be performed to the neatline within the horizontal extents of dredge-only areas as developed for the 30 Percent Design. As noted above, the dredge plan approach for OU 2 remains similar to that presented in the 30 Percent Design since the majority of the area is designed as a dredge-and-cap remedy (see additional discussion below).

The neatline dredge plan approach for 2009 dredge-only areas in upper OU 3 is based on the geostatistically modeled surface representing the 1.0 ppm RAL with an LOS equal to 0.5. In addition, an overdepth allowance (depth below the required dredge depth) of 6 inches has been accounted for in the dredge volumes presented herein. Experience on similar projects suggests that sediment will likely be removed to the allowed overdepth, on average, thereby achieving an overall LOS on the anticipated post-dredge surface generally ranging between 0.2 and 0.4, based on geostatistical modeling. J.F. Brennan's recent dredging experience on the OU 1 project resulted in an average overdepth of approximately 4 to 6 inches, depending on the nature and consistency of the material underlying the sediment targeted for dredging. As discussed in the collaborative workgroups, the most efficient neatline significance level for dredge-only areas is 0.5, since the additional remediation required to achieve a lower LOS would not substantially improve anticipated performance and, considering expected overdepth dredging, would significantly increase the removal volume of potentially clean sediments below the RAL.

The forthcoming RD Design Anthology will present the acreage changes and a plan view mosaic comparing the BODR and current 60 Percent Design remedy areas, including areas where the planned RA represents an exception to the ROD and/or ROD Amendment based on site-specific conditions. These exceptions were developed within the collaborative workgroup and approved by the Response Agencies.

4.4.1.3 Refinement of the 60 Percent Design Neatline

As described above and subject to Response Agency approval, additional sediment characterization data will be collected in 2008 to refine the delineation of PCB-contaminated sediment above the RAL and to further improve the overall confidence of the geostatistical model in those areas targeted for completion of dredge-only RAs in 2009. This may include collection of additional data in areas where previous RD sampling did not completely delineate the DOC above the RAL (note: these areas will continue to be discussed in the technical workgroups; see Appendix D – CQAPP for additional discussion). Refined dredge plans incorporating the new data will be included in the Final Design and 2009 RA Work Plan. Additional pre- dredge sampling will be conducted annually to refine the neatline delineation of the areas planned for dredging in the following construction season (2010 and beyond) if it would reduce the overall construction schedule or costs, as determined by adaptive management. Refinements to the dredge plan, should they be made based on annual infill sampling, will be documented in annual RA Work Plans. Collection of additional data to refine the geostatistical model is anticipated to reduce the uncertainty of the model, resulting in less vertical variation in the LOS surfaces (e.g., LOS surfaces converge with increasing sample density and decreasing uncertainty).

Provisional 2008 infill sampling to inform final dredge plans in upper OU 3 are discussed in Section 2.4.3. In a number of respects the upstream portion of OU 3 presents a good test case for verification of the expected benefits of infill sampling, as PCB concentrations, contaminated sediment thicknesses, and spatial variabilities of concentrations and thicknesses are all generally lower in upper OU 3 than in the remainder of OU 3 or in OU 4. The latter sections of river are also more sinuous than upper OU 3. These differences suggest that there may be benefit to further method development to support evaluation of infill sampling to lower OU 3 and to OU 4 to refine annual RA Work Plans as necessary.

Additional sub-bottom profiling efforts now underway may be especially useful in areas where geostatistical modeling of the DOC is uncertain. Results of sub-bottom profiling are expected to become available during summer 2008. It is expected that sub-bottom profiling may provide a surrogate for DOC in the form of the depth of an interface between softer and harder sediment. If this depth correlates well with DOC based on chemical analyses, then the sub-bottom profiling can be used to support estimation of DOC at locations intermediate to cores. Differences between DOCs from cores and from sub-bottom profiling (possibly interpolated spatially) would likely be used to adjust the sub-bottom data. Once the sub-bottom data become available, these methods can be developed and tested.

4.4.1.4 2009 Dredge Plan Development

The 2009 dredge plans were determined separately for OU 2, OU 3, and OU 4, as described below.

OU 2. Because of the relatively limited extent of sediments exceeding the RAL in OU 2, evaluation of individual sediment core data collected from 2004 to 2007 and relatively simple Thiessen polygon analysis (rather than geostatistical modeling), was used to define dredge templates in OU 2. Consistent with the 30 Percent Design, a dredge-and-cap remedy is the optimized remedial approach for OU 2. Dredging in OU 2 will be performed in 2009 in part to remove PCB mass in this area, and also to accommodate subsequent installation (in 2010) of engineered caps. The overall RD for OU 2 maintains post-remedy water depths and provides a consistent river bottom elevation. Because of the likelihood of encountering considerable amounts of submerged wood debris in this former mill area and to address anticipated dredge residuals commonly associated with debris area dredging, use of engineered caps in this application will provide more certainty that the RAOs described in the ROD Amendment will be achieved. Details of the engineered caps to be placed in OU 2 are provided in the 60 Percent Design Volume 2.

OU 3. 2009 dredging in OU 3 will target removal to the 0.5 LOS neatline in dredge-only areas and to the required dredge elevation as defined by the engineered dredge prisms in dredge-and-cap areas. As discussed above, the geostatistical model defining the neatline in upper OU 3 will be refined based on supplemental sediment characterization data and updated river bathymetry, both of which are planned to be collected in 2008. Changes to the dredge-only plan resulting from these refinements will be presented in the Final Design and 2009 RA Work Plan scheduled to be submitted to the Response Agencies on December 30, 2008. In upper OU 3 dredge-and-cap areas, the engineered dredge prisms (i.e., constant dredge elevation boxes over defined areas) developed for the 30 Percent Design will be utilized since it is more practicable to dredge to an engineered prism in areas that will be subsequently capped. Section 4.4.3 provides additional details of the dredge plan design in dredge-and-cap areas.

OU 4. 2009 dredging in OU 4 will be performed to maximize dredge production and efficiency of the sediment processing system, and to reduce the overall project schedule. Dredging in OU 4 will be performed primarily with the 12-inch dredge, focusing on bulk sediment removal in relatively thick deposits, targeting an elevation approximately 1 foot above the currently-designed required elevation (e.g., neatline in dredge-only areas or specified elevation in dredge-and-cap areas). Based on an anticipated overdredge of approximately 4 to 6 inches, approximately 6 to 8 inches of sediment will remain above the required dredge elevation following initial pass dredging with the 12-inch dredge. This 6 to 8 inch layer represents an efficient cut thickness for the 8 inch dredges, which will perform final pass-dredging of sediment in these areas in subsequent years (see Volume 2). Planned dredging in OU 4 during 2009 with the 12-inch dredge will focus on areas with typical cut depths of approximately 2 feet or more, to maximize the production efficiency of the 12-inch dredge. In addition, towards the end of the 2009 dredging season, the 12-inch dredge and both 8-inch dredges will be utilized for localized removal of sediment in OU 4 adjacent to the former Shell property to facilitate completion of the sheetpile wall installation and site build-out (see Section 3.2). The extents of dredging in OU 4 in 2009 with both the 12-inch and 8-inch dredges have been designed with consideration of the PCB concentrations of exposed sediments (i.e., leaving 6 to 12 inches of sediment above the neatline) such that the post-dredge 2009 SWAC in OU 4 will not be substantially different from pre-Phase 1 baseline conditions (see Section 4.6.3 for additional details of SWAC estimates).

4.4.2 Channel Adjustments in Dredge-Only Areas

As discussed in Section 2.4.1 of the 60 Percent Design Report Volume 2, the federal navigation channel, including the recently reauthorized portion in OU 4A, was segregated and evaluated separately in the geostatistical model. This was done because of the distinct character of the channel and its past activities, and past disturbance and sloughing of sidewalls that likely occurred during historical channel dredging. The 2009 dredge plans in upper OU 4A presented in Appendix B incorporated these channel adjustments along with the 1-foot production dredge offset described above.

4.4.3 Dredge Plan Design in Dredge-and-Cap Areas

As discussed above, the initial boundaries of RA areas (including dredge-and-cap) selected from the BODR core-by-core process were delineated using a Thiessen polygon approach. As the design progressed from the BODR conceptual level to the 60 Percent Design level, the boundaries of RA areas were refined using the preliminary dredge plan, the areal extent of the DOC at a LOS of 0.5, and PCB data from discrete RD core locations (see Appendix A, Attachment A-1 for additional details). The preliminary dredge-and-cap plan was developed by delineating a series of rectangles set at either a constant elevation or a constant slope to maximize PCB mass removal, yet containing some contaminated sediments in-place and creating consistent post-construction bed elevations. Slope-based removal approaches were developed based on nature and extent of contamination, considering post- dredge cap installation and stability. The dredge-and-cap plans presented in this 60 Percent Design are consistent with those originally developed in the 30 Percent Design report.

4.4.4 Dredge Plan Design near Utilities and Infrastructure

As noted above and shown on the engineered plans (see Appendix B), the RD identified in-water structures and utilities that need to be accommodated in the dredge design. This section presents the basis for design (or "ground rules") for accommodating various utility and infrastructure types typical of OUs 2 to 5. These ground rules will be used to develop RA plans specific to individual structures and utility crossings. Details of the 2009 designs will be presented in the Final Design Volume 1 and 2009 RA Work Plan.

4.4.4.1 In-water Structures

Residential Dock Facilities: The primary design consideration for the dredging and subsequent placement of capping materials near a floating dock with guide piles are interference with navigation (i.e., recreational vessels) and the potential to damage or compromise the integrity of a structure following dredging (due to settlement or loss of bearing support). To protect against these potential impacts, the following "ground rules" were established for proposed remedies near floating docks with guide piles:

1. Dredging and capping in 2009 have been designed to be performed no closer than about 25 feet from a pile, except as modified by site-specific conditions (i.e., a larger or smaller offset) during preparation of the 2009 RA Work Plan.
2. During development of the 2009 RA Work Plan, discussions will be held with the owners of residential docks located where RD plans (Appendix B) contemplate RA closer than 25 feet from the structure. These discussions will determine the existence of design details (to assist with revising typical offsets) and navigational depth required for vessels.

The proposed remedy will be discussed and coordinated with the owner of the floating dock during 2008, and the resulting RA will be documented in the 2009 RA Work Plan (scheduled to be submitted to the Response Agencies on December 30, 2008).

Bridge Crossings: Several logistical and safety concerns are associated with remedial construction (dredging and capping) in close proximity to in-water or nearshore structures such as a bridge piers, including the potential to damage or compromise the integrity of a structure (due to settlement or loss of bearing support) and ultimately cause damage to the bridge (in the short or longer term). Therefore, to minimize these concerns, the following ground rules were established through the collaborative workgroup process:

1. Dredging will be performed to a distance of about 25 feet from a bridge pier, dolphin, or fender, except if site-specific conditions require larger offsets.
2. The placement of a sand cover closer than 25 feet from a bridge pier may be performed if technically feasible and RD sampling results indicate significantly elevated PCB concentrations and environmental risk warranting special consideration.
3. The placement of capping materials around and under the bridge will be evaluated on a case-by-case basis depending on the vertical clearance under the bridge deck as well as horizontal distances between the piers and structures.

In addition, sand cover placement is currently being evaluated by J.F. Brennan during implementation of RA in OU 1. The results of this work will assist in the selection of the site-specific remedies for each bridge located within 25 feet of where RAs are contemplated in 2009 (Appendix B). An example bridge crossing design is included in Appendix A, Attachment A-2. The proposed remedy will be discussed and coordinated with the owner of such structures in 2008, and the agreed-upon RA will be documented in the 2009 RA Work Plan (scheduled to be submitted to the Response Agencies on December 30, 2008).

4.4.4.2 Submerged Utilities/Pipelines

The primary concern with dredging or capping near buried utilities is that the utility could be damaged during (or following) the implementation of the remedy, potentially resulting in significant worker/public safety issues, environmental damage, as well as disruption of public service. Similar to the ground rules developed for bridge crossings, an offset from the utility is planned to minimize the chance of damaging the utility during remedial construction. The width of the offset will be based on several factors, including:

- The nature of the utility (water, electric, sewer, communication, petroleum, natural gas, or other)
- The availability (and reliability) of design drawings or construction (i.e., as-built) data
- PCB concentrations in the sediment surrounding the utility

In order to minimize the potential for environmental damage or safety concerns, the following ground rules were established through the collaborative workgroup process:

- Dredging will be performed to a distance of about 50 feet from each known or reported river utility crossing
- Dredging may be conducted using a closer offset distance of 25 feet, if all of the following conditions are met:
  - If the horizontal and vertical position of the utility or utilities is known with an accuracy of ± 6 inches vertically and ± 5 feet horizontally along the entire utility length as verified by physical surveys (e.g., manual probing)
  - If RD sampling results indicate significantly elevated PCB concentrations and environmental risk warranting special consideration
  - If dredging and/or capping will not pose an adverse stability condition to the submerged utility crossing caused by undue stresses or excessive settlements

Example utility crossing designs are included in Appendix A, Attachment A-2. The proposed remedy will be discussed and coordinated in 2008 with the owner of utilities located within 50 feet of where RAs are contemplated in 2009 (Appendix B), and the agreed-upon RA will be documented in the 2009 RA Work Plan (scheduled to be submitted to the Response Agencies on December 30, 2008).

4.4.5 Dredge Plan Design in Shoreline Areas

This section establishes the basis for design (or "ground rules") for developing appropriate transitions from offshore remedies into adjacent shoreline areas. Three example cases, representing the range of shoreline conditions in OUs 2 to 5, were reviewed within the technical workgroups to develop the following ground rules.

1. For shoreline areas involving a transition from an offshore dredge area where the DOC (represented by the LOS of 0.5 surface) or site-specific shoreline samples indicate that sediments exceeding the 1.0 ppm RAL extend to a depth greater than 2 feet below the mudline and preliminary RA delineation included dredging:
   - The dredge cut will be designed to daylight at the edge of the shoreline and slope down away from shore towards deeper water to the required dredge elevation at a 5 horizontal to 1 vertical (5H:1V) slope (maximum slope based on shoreline slope stability analysis). Alternate slopes will be considered on a case-by-case basis using site-specific physical/geotechnical and chemical information. The "edge of the shoreline", as it pertains to delineating the extent of in-water RA addressed by this RD, is defined as the shoreline identified during the November 2003 photogrammetric aerial survey performed by Jenkins Survey and Design, Inc, as part of the site survey work contracted by WDNR.
   - Sediments with PCB concentrations above the 1.0 ppm RAL that are left in place immediately adjacent to the shoreline will be capped following the dredging (see Volume 2 for shoreline cap design).
2. For shoreline area involving a transition from an offshore dredge area where the DOC (represented by the LOS 0.5 surface) or site-specific shoreline samples indicate that sediments exceeding the 1.0 ppm RAL extend to a depth less than 2 feet below the mudline and preliminary RA delineation included dredging
   - The dredge cut will be designed to daylight at the edge of the shoreline and slope down towards the river to the required dredge elevation at a 5H:1V slope. Alternate slopes will be considered on a case-by-case basis using site-specific physical/geotechnical and chemical information.
   - Since essentially all of the targeted sediment will be removed, a shoreline cap will not be placed in these areas.
3. For shoreline area involving the transition from an offshore dredge-and-cap (or offshore cap) area into the shoreline where preliminary RA delineation included capping:

- The dredge cut will be designed to daylight at the edge of the shoreline and slope down towards the river to the required dredge elevation at a 5H:1V slope. Alternate slopes will be considered on a case-by-case basis using site-specific physical/geotechnical and chemical information.
- Sediments with PCB concentrations above the 1.0 ppm RAL that are left in place immediately adjacent to the shoreline will be capped following the dredging (see Volume 2 for shoreline cap design).

Application of these ground rules will be performed as RA work progresses within the river, such that site-specific remedies are designed in the year prior to construction in that area and the final remedy for each area documented in the annual RA Work Plans. Appendix A, Attachment A-3 provides detailed examples illustrating the three cases summarize above.

4.5 Sediments Potentially Subject to TSCA Disposal Requirements

As discussed in Section 2.5.4, sediment PCB concentrations in some areas of OU 4 exceed 50 ppm and may become subject to management and disposal requirements under TSCA. An initial dredge plan analysis, based on Thiessen polygons, was conducted as part of the BODR to determine the volume of sediments potentially subject to TSCA disposal requirements. For delineating sediments requiring disposal in accordance with TSCA requirements, sampling depth data from individual RD sediment cores were vertically composited across non-overlapping 2.5-foot (30-inch) sediment intervals beginning at the mudline corresponding to successive cuts using the proposed dredging equipment (a 12-inch hydraulic cutterhead dredge, as discussed in Section 4.2).

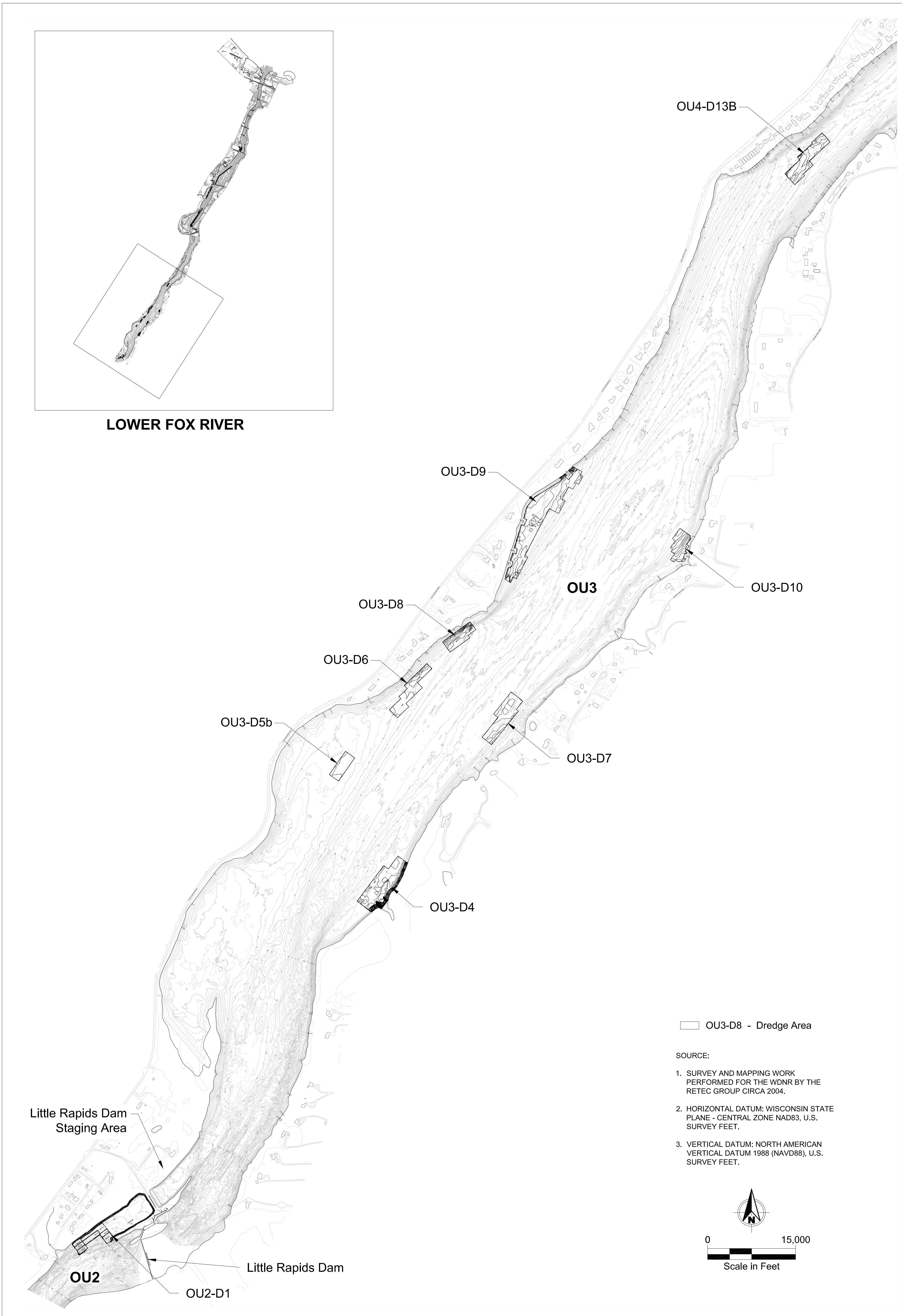
The horizontal extent of TSCA dredging to be performed in 2009 was delineated using Thiessen polygons, which were subsequently refined based on site-specific considerations including bathymetric contours and other historical features such as the previously-authorized federal navigation channel. Vertical delineation of TSCA dredging limits were identified for this 60 Percent Design based on the 2.5-foot compositing approach at specific RD sampling locations as described above and then applied as a constant thickness across the area representative of that RD sampling location. The TSCA dredge plan in OU 4 for 2009 is presented on Sheet D-13 of the engineered dredge plan (Appendix B).

4.6 2009 Dredge Plan Design Summary

4.6.1 2009 Sediment Removal Estimates

Approximately 460,000 cy (depending on overdepth and schedule considerations, 2009 dredge volumes may exceed 490,000 cy) of in situ sediments in OU 2, upper OU 3, upper OU 4A, and within the former Shell property staging area, including overdepth allowances, are targeted for dredging in 2009. Figures 4-3 and 4-4 illustrate the aerial extent of the dredge plan for OUs 2/3 and 4/5, respectively, designed as described above. Detailed design plans are provided in Appendix B of this 60 Percent Design report. Removal volumes associated with the 60 Percent Design dredge plan were calculated using AutoDesk's Land Development Desktop (LDD) software. A three-dimensional surface was created in AutoCAD Civil 3D Land Desktop Companion 2008 for both the existing (2004 Retec survey) bathymetry and the required dredge prism, accounting for design side slopes[3]. These surfaces each consisted of a set of contiguous, non-overlapping triangles known as a triangulated irregular network (TIN). Using LDD, the volume between these two TINs was calculated to represent the required dredge volume. Table 4-2 summarizes the required (e.g., neatline; without overdepth allowances) 2009 dredge volumes in each OU. The volume calculations will be updated using 2008 bathymetric survey and infill sampling data, and the revised quantities will be presented in the Final Remedial Design Volume 1 and 2009 RA Work Plan. The dredge quantities presented in this Volume 1 for OU 2, upper OU 3, and portions of OU 4 are based on the neatline dredge template; however, dredge quantities presented in Volume 2 are still based on the 30 Percent Design dredge template, but will be refined through future infill sampling and geostatistical analysis.

[3] Note: All dredge volumes presented in this 60 Percent Design are based on the bathymetric survey data available at this time of preparation (2004 Retec Survey).



Jun 16, 2008 9:51am dbinkney C:\Documents and Settings\dbinkney\Desktop\CAD\080295-03 - 60%\WORKPLAN FIGURES\080295-03-FIG 4-3.dwg FIG 4-3

ANCHOR ENVIRONMENTAL, L.L.C. TETRA TECH

Figure 4-3
2009 Dredge Plan: OUs 2 & 3

Jun 16, 2008 9:29am dbinkney C:\Documents and Settings\dbinkney\Desktop\CAD\080295-03\080295-03 - 60%\WORKPLAN FIGURES\080295-03-FIG 4-4.dwg FIG 4-4

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TETRA TECH

Figure 4-4
2009 Dredge Plan: OU4

4.6.2 2009 PCB Mass Removal Estimates

The BODR provided an estimate of the mass of PCBs within OUs 2 to 5 based on the results of the 2004 and 2005 RD sampling and analysis programs using the equations shown below for each core location delineated on a Thiessen polygon basis. For the 60 Percent Design, the approach to calculating the volume of sediment associated with each core was refined to better represent the modeled DOC using a geographic information system (GIS) based calculation. The Thiessen polygon approach simplifies the dredge prism neatline by assuming a constant bottom elevation (i.e., simplified to length times area as shown in the equation below). The GIS-based approach calculates volume (and associated PCB mass) by integrating within the required dredge plan the geostatistically modeled neatline (i.e., the LOS 0.5 surface) over a specified area of influence for each core location.

$$\text{PCB Mass per core} = PCB \cdot \rho \cdot l \cdot A$$

where:

PCB = Sample PCB concentration, mg/kg (dry weight basis)
ρ = dry density of sediment, g/cm^3
l = sample length, cm
A = Thiessen polygon area represented by core.

Additional details of the GIS-based approach to computing the PCB mass to be removed by the OUs 2 to 5 RA are presented in Appendix A of the 60 Percent Design Volume 2. Table 4-3 presents estimates of the PCB mass in OUs 2 to 4 targeted for removal in 2009.

Table 4-3
Lower Fox River 2009 PCB Mass Removal Estimates

Operable Unit	60 Percent Design Estimated PCB Mass Removed (kg)
OU 2 [(a)]	92
OU 3	45
OU 4	1,388
Site Total	1,525

(a) Deposit DD only – calculated using Thiessen polygon-based method

4.6.3 2009 Post-Dredge SWAC Estimates

The GIS-based computational system summarized in Section 4.6.2 was also used to estimate post-dredge SWAC at the completion of the 2009 dredging season, following the procedures outlined in the Boldt January 29, 2008 memorandum titled *SWAC Estimation Procedure* (Boldt 2008). Using SWAC as a measure of remedial success (including annual performance metrics) provides an estimate of the risk to resources within aquatic systems that is proportional to exposure to PCBs. Exposure in this case is proportional to the weighted average PCB concentration across a given OU within the surface biologically active layer of sediment, operationally defined as the top 6 inches of sediment.

The Phase 1 Project reduced the overall SWAC in OU 4 from approximately 3.2 ppm to 2.7 ppm (Anchor and Foth 2008). The GIS-based 2009 post-dredge SWAC predicted in OU 4 is 2.9 ppm, intermediate between these values (Table 4-4). Estimated post-dredge SWAC values in OUs 2 and 3 are also at or below RD baseline concentrations. The 2009 post-dredge SWAC estimates summarized in Table 4-4 consider undisturbed residuals only; incorporating generated residuals in the calculations will reduce the post-dredge SWAC in OU 4, since generated residuals in this situation have lower PCB concentrations than undisturbed sediments. Based on these calculations, post-dredge SWACs at the completion of the 2009 construction season are expected to remain at levels that are similar to RD baseline (pre-Phase 1) conditions in OUs 2, 3, and 4, thus minimizing short-term environmental risks associated with the RA. Follow-on dredging, capping, and cover actions in subsequent years will achieve the performance standards specified in the ROD Amendment (see 60 Percent Design Report Volume 2).

Table 4-4
Lower Fox River 2009 Post-Dredge SWAC Estimates

<table>
<tr><th>Operable Unit</th><th>2004 to 2007 Remedial Design Baseline SWAC (ppm)</th><th>2007/2008 Post-Phase 1 Project Measured SWAC (ppm)</th><th>Calculated 2009 Post-Dredge SWAC[a] (ppm)</th></tr>
<tr><td>OU 2</td><td>0.61</td><td rowspan="2">1.9 [a]</td><td rowspan="2">1.8 [b]</td></tr>
<tr><td>OU 3</td><td>2.0</td></tr>
<tr><td>OU 4</td><td>3.2</td><td>2.7</td><td>3.6</td></tr>
</table>

Notes:

a. Undisturbed residuals only; consideration of generated residuals in the calculations will reduce the post-dredge SWAC (see text)

b. SWAC estimate for Deposit DD in OU 2 included with OU 3, consistent with ROD Amendment.

4.7 Management of Potential Impacts from Dredging

4.7.1 Best Management Practices for Dredging Operations

J.F. Brennan will utilize several best management practices (BMPs) to minimize turbidity and other dredging-related impacts. It has been J.F. Brennan's experience with OU 1 of the Lower Fox River that employing BMPs has been effective in achieving turbidity control requirements without the need for engineered systems (e.g., silt curtains). Not using silt curtains during dredging operations also allows for greater use of the Lower Fox River by recreational and commercial vessels while concurrently increasing effective productivity of the dredging operations. However, silt curtains will be available as a contingency measure to control turbidity while dredging in localized areas.

The following BMPs will be utilized during dredging operations:

- Biodegradable oil will be used to operate dredge hydraulics, as opposed to hydraulic oil.
- During startup, the dredge pump will be started prior to starting the cutterhead on the dredge.
- The cutterhead will be run in reverse in known areas of clay in an effort to minimize agitation energy, thereby limiting turbidity.
- The cutterhead speed will be maintained at the minimum level necessary to agitate the material in order to minimize the resuspension of sediments in previously dredged areas.
- Dredging operations will be sequenced in an upstream to downstream fashion, with the exception of planned concurrent dredging with the 12-inch dredge to maximize efficiency and reduce overall project schedule, or as otherwise approved by the Response Agencies.
- Dredge cuts will be overlapped to avoid leaving ridges or windrows of sediment between adjacent cuts.
- During period of temporary dredge shutdown, the dredge pump will be stopped after the cutterhead is turned off.
- Dredged areas will be surveyed on a daily basis (as the dredge pipeline location permits) to determine the effectiveness and demonstrate completion of the dredging operations.
- Hospital-grade mufflers will be used to limit engine noise.

- Dredge line blow back during non-operating periods will be prevented through the installation of a pneumatically-operated knife gate valve inserted behind the dredge. Manual verification of the knife valve position (i.e., open or closed) will be performed regularly.
- The dredge pipeline will be inspected daily for leaks and other problems. Observations will be logged on daily reports.
- Clear direction regarding chain-of-command during emergencies will be provided to all employees.

4.7.2 Dredge Residual Management

The presence of residual contaminants is inevitable when dredging contaminated sediments due to the inability of any dredging equipment to completely remove all sediment within a dredge prism. A review of numerous recently completed environmental dredging projects demonstrates that post-dredge residuals can be expected in all dredging projects to differing degrees, and can result in post-remediation contaminant exposure within and immediately beyond the dredge prism if not adequately addressed (Patmont and Palermo 2007).

A workshop held at the U.S. Army Engineers Research and Development Center (ERDC) on Relating the "4 Rs" of Environmental Dredging: Resuspension, Release, Residual, and Risk (Bridges et al. 2008) focused in part on dredging residuals. Based on this work, dredging residuals can be generally defined as follows:

- Undisturbed Residuals: Contaminated sediments (at concentrations above the action level) found at the post-dredge sediment surface that have been uncovered but not fully removed as a result of the dredging operation.
- Generated Residuals: Contaminated post-dredge surface sediments (at concentrations above the action level) that are dislodged or suspended by the dredging operation and are subsequently re-deposited on the bottom either within or adjacent to the dredging footprint.

In order to accurately characterize the nature and extent of post-dredge generated and undisturbed residuals in OUs 2 and 3 in 2009, sediment samples will be collected following dredging and submitted for chemical (PCB) and physical (primarily percent solids and/or density) testing. Appendix D presents the draft CQAPP, which contains a draft sediment removal verification plan for OU 2 to 4, as briefly summarized below.

If concentrations in the post-dredging surface sediments are found to exceed the 1.0 ppm RAL, an initial screening assessing the suitability of a sand cover (to be placed in 2010 as needed) as a residuals management technique will be performed. In accordance with the ROD Amendment, sand cover will be considered suitable for management of post-dredge residuals meeting the following criteria:

- Arithmetic mean of all 0 to 6-inch samples within a given dredge area is equal to or less than 10 ppm
- Arithmetic mean of all samples within a given dredge area for layers below the upper 0- to 6-inch interval is equal to or less than 1.0 ppm

If the post-dredge sediment concentrations exceed the sand cover screening criteria outlined above, additional sampling and/or analysis may be performed to determine the appropriate extent of areas requiring additional response. An engineering evaluation will be conducted to determine the most appropriate residual management action(s). The engineering evaluation will consider:

- Calculation of the percent PCB mass removed to date and remaining PCB mass per unit areas within a given dredge area
- Practicability, technical feasibility, cost-effectiveness, and implementability factors (e.g., layer thickness, PCB concentration, and density)
- Consideration of the residual management (if any) in adjacent dredge areas

The determination of post-dredge contingency response decisions appropriate within all or a portion of a given dredge certification area will be performed as a collaborative undertaking among the Order Respondents, the Tetra Tech Team, and the Response Agencies. Possible residuals management actions include: additional production dredging passes or completion of a cleanup dredging pass; placement of an engineered isolation cap (see Section 6 of Volume 2) or placement of a thicker residuals sand cover (see Section 7 of Volume 2). As discussed in the CQAPP, such contingency response decisions will need to be made on an expedited basis.

4.7.3 Slope and Structural Considerations

Implementation of the OUs 2 to 5 remedy will involve removal of sediments in excess of 10 feet deep in some areas. Appropriately designed side slopes for these and all dredge cuts are necessary to ensure that dredge cut slopes do not fail during or after construction. Therefore, slope stability analyses were performed for the design of dredge cut slopes using data generated during RD geotechnical investigation programs including vane shear test (VST), unconsolidated undrained (UU) triaxial tests, and consolidated undrained (CU) triaxial tests. Appendix A, Attachment A-4 presents the results of this slope stability evaluation, which are summarized in this section.

The stability of cut slopes was evaluated for a range of slope angles and a range of cut depths using infinite slope methods for both cohesive and granular materials (Lambe and Whitman 1969). For purely cohesive sediments, the stability of the cut is a function of the height of the cut. For sediments with appreciable sand, the stability is also a function of the slope angle.

Evaluations made using the VST shear strength data indicate that more than 95 percent of the time, a factor of safety of 1.3 or better is achieved using a 3H:1V cut slope. Most importantly, the CU data, which are among the highest quality of the tests, all show adequate strength to achieve the target factor of safety.

The limit equilibrium slope stability analyses summarized above demonstrate that the Lambe and Whitman methods provide a conservative estimate of the strength required to achieve the target factor of safety. Based on this evaluation, the 3H:1V cut slope was selected for design.

As the design progresses through more detailed final iterations, the infrastructure and obstructions identified in the project area from planned bathymetric surveys, side-scan sonar surveys, sub-bottom profiling and site surveys (Tetra Tech and Boskalis 2008) will be superimposed onto the dredge prism. Shoreline structures and areas containing submerged features such as pipelines, cables, or ruins identified through RD surveys may limit the use of a dredge in that area. In addition, rock and debris may also inhibit dredging and may require removal prior to dredging when feasible. In areas of excessive debris and obstructions, dredging may not be possible and capping may be required.

As discussed in Section 2.1, supplemental sampling and field work was performed during the summers of 2006 and 2007 to support the RD in the vicinity of shoreline and in-water features such as structures, slopes, and utility crossings. In addition, desktop studies and RD field surveys have been undertaken to locate and obtain structural surveys and as-built record drawings for the numerous shoreline and in-river structural features, utility crossings, and overhead obstructions. These data were used to develop ground rules for RD surrounding these structures, as presented in Section 4.4.

4.7.4 Short-term Water Quality Considerations

During in-water construction activities, dredging operations will be required to comply with the substantive requirements of applicable water quality standards. Consistent with the substantive requirements of NR 102.05(3) and with the approved designs for the OU 1 and Phase 1 projects, it is anticipated that a total suspended solids (TSS) limit of no more than an 80 mg/L incremental increase above ambient conditions will be permitted outside of a 500 foot mixing zone extending from the point of dredging (or from the boundary of the dredge area if a silt curtain enclosure is utilized).

Section 3.3.6 of the BODR summarized an evaluation of potential short-term water quality impacts associated with the anticipated dredging and cap/cover placement activities relative to the anticipated water quality compliance criteria. This evaluation utilized the dredge plume models developed by the USACE (e.g., DREDGE) in conjunction with the results of site-specific Dredge Elutriate Tests (DRET) performed on representative samples from OUs 2 to 5 to simulate the dissipation and attenuation of the dredge plume through the mixing zone. Under the various scenarios modeled in the BODR, TSS was predicted to meet the water quality standard between 50 and 230 feet of the dredge. Thus, dredging operations are predicted to comply with the water quality standard before the mixing zone boundary is reached at 500 feet downstream from the dredge area.

Operational BMPs and controls discussed in Section 4.7.1 will be implemented, as necessary, to minimize the potential for deviations from water quality standards.

4.7.5 Noise and Air Quality Considerations

4.7.5.1 Noise

Noise emanating from industrial operations and other activities is generally regulated at the local level. Although local requirements are not ARARs (see UAEPA 1989), listed here for reference are the local ordinances that would otherwise be applicable. Noise is typically regulated in the City of Green Bay under City Code Chapter 27, Subchapter II, Section 27.201, Regulation of Noise. Brown County typically regulates noise under County Code Chapter 39, Section 39.01, Regulation of Noise. A review of these two ordinances indicates that the noise control requirements are essentially the same, with set noise levels based on zoning and time of day and with special exemptions for construction sites. Table 4-5 summarizes residential, commercial, and industrial guidelines for noise control during daytime and nighttime hours as specified by the City of Green Bay and Brown County codes.

Table 4-5
Maximum Recommended Sound Pressure Within and Between Zones

Octave Band Center	Within Residential (dBA)		Within Commercial (dBA)		Within Industrial (dBA)		Industrial into Commercial (dBA)		Industrial into Residential (dBA)		Commercial into Residential (dBA)	
Frequency (Hz)	7 AM to 10 PM	10 PM to 7 AM	7 AM to 10 PM	10 PM to 7 AM	7 AM to 10 PM	10 PM to 7 AM	7 AM to 10 PM	10 PM to 7 AM	7 AM to 10 PM	10 PM to 7 AM	7 AM to 10 PM	10 PM to 7 AM
31.5	70	69	80	72	86	81	80	75	79	74	75	72
63	69	68	79	71	85	80	79	74	78	73	74	71
125	64	62	73	66	80	75	74	69	73	68	69	65
250	58	54	65	60	75	70	69	64	67	63	64	57
500	52	48	59	54	69	64	63	58	61	57	58	51
1,000	47	42	53	49	63	58	57	52	55	51	52	45
2,000	42	36	47	44	58	53	52	47	50	46	47	39
4,000	38	31	42	40	54	49	48	43	46	42	43	34
8,000	35	29	40	37	51	46	45	40	43	39	40	32
A-Scale Levels	57	52	63	58	72	67	66	61	64	60	61	55

Note: Although local requirements are not ARARs (see USEPA 1989), listed here for reference are the local ordinances' maximum recommended sound pressure levels that would otherwise be applicable.

Dredging operations will generally be conducted 24 hours per day and 5 days per week (having the flexibility of working 6 days per week). This will minimize noise on the weekends (i.e., Saturdays and Sundays) when most families are at home. However, nighttime operations could adversely impact residences along the river. In an effort to minimize noise impacts during implementation of the OUs 2 to 5 activities, several BMPs have been developed to help reduce noise pollution:

- All dredge equipment will be equipped with hospital-grade mufflers.
- All booster pumps will be equipped with a residential-grade silencer located in the self-contained unit to reduce noise levels.
- The majority of dewatering and water treatment operations will be housed within enclosed buildings that will limit noise pollution generated at this facility.
- At the onset of full dredging activities, a noise survey will be conducted to determine the effectiveness of these measures and to identify any other areas where mitigation may be necessary.

4.7.5.2 Air Quality Management and Overall Protection of the Public

Under the substantive provisions of WDNR regulations NR 406 (pertaining to Construction Air Permits) and NR 407 (pertaining to Operation Air Permits), the requirement for further analysis could be triggered if emissions of either particulate matter and/or PCBs are projected to be greater than specified threshold rates. Air emissions of PCBs also are regulated by the WDNR under NR 445 pertaining to the control of state hazardous air pollutants. More specifically, air emissions of PCBs are required to meet the substantive requirements of Table A to NR 445.07 for PCB emissions. This table establishes a maximum emission rate for PCBs that was designed by WDNR to ensure that ambient air PCB concentrations do not exceed an acute (short-term) exposure concentration of 12 micrograms per cubic meter ($\mu g/m^3$) when expressed as a 24-hour average. Although these substantive air permitting requirements need to be considered as part of the operational design and air quality management effort, air permits will not need to be obtained for the OUs 2 to 5 RA due to the permit pre-emption under the CERCLA process.

Air monitoring for PCBs and other constituents was conducted during a series of previous sediment dredging and material handling actions in the Lower Fox River. These monitoring activities were described in the BODR and are listed and discussed below (in chronological order):

- **Deposit N Demonstration Project (1998–1999):** Real-time air monitoring was performed for particulates on all four sides of the onshore treatment facility where mechanical presses were operated and sediment loading occurred. The monitoring results showed no exceedances of the particulate threshold of 96 $\mu g/m^3$ that was established for this demonstration effort (Foth and Van Dyke 2001).
- **SWMU 56/57 Demonstration Project (1999):** Ambient air sampling for PCBs was conducted in 1999 at several locations both adjacent to and more distant from the sediment handling operations associated with this demonstration. Elevated concentrations of PCBs above baseline levels were primarily associated with the air monitoring stations that were within 200 to 250 feet of the sediment handling operations. Samples collected at monitoring stations located at distances beyond this range approached the indicated background levels for PCBs in the regional ambient air. Three air monitoring stations also were located near the landfill area, at distances ranging from 840 to 1,240 feet from the active landfill site. All of the samples collected from these landfill-related monitoring stations had measured concentrations at or below background concentrations (WDNR 2000). Based on these results, ambient air monitoring was not required during follow-on SMU 56/57 actions in 2000.
- **OU 1 Dredging Project (2004):** Four ambient air monitoring stations were located around the sediment dewatering and load-out pad with the closest monitor having been placed approximately 100 feet from the active operations. PCBs were not detected in the air at any of the stations (Foth and Van Dyke 2005).
- **OU 1 Dredging Project (2005):** Four ambient air monitoring stations were located around the sediment dewatering and load-out pad with the closest monitor having been placed approximately 100 feet from the active operations. PCBs were not detected in the air at any of the stations (Foth and Van Dyke 2006).

- **OU 1 Dredging Project (2006):** Four ambient air monitoring stations were located around the sediment dewatering and load-out pad with the closest monitor having been placed approximately 100 feet from the active operations. PCBs were not detected in the air at any of the stations.
- **OU 1 Dredging Project (2007):** Four ambient air monitoring stations were located around the sediment dewatering and load out pad with the closest monitor having been placed approximately 100 feet from the active operations. Concentrations of PCBs in the air averaged -0.00068 $\mu g/m^3$ with a maximum of 0.001 $\mu g/m^3$. The values detected during 2007 were well below the 24-hour average standard listed in WDNR NR 445.07, which is 12 $\mu g/m^3$.
- **Phase 1 (OU 4A) Dredging Project (2007):** Four high-volume air samplers were located adjacent to the sediment dewatering and load-out pad. The exact locations of these units were determined based on the location of residential receptors, site topography, site operations, and prevailing wind directions. Concentrations of PCBs in the air ranging from 0.0002 to 0.0262 $\mu g/m^3$ were detected (Shaw et al. 2008). The values detected during 2007 were well below the 24-hour average standard listed in WDNR NR 445.07, which is 12 $\mu g/m^3$.

This prior sampling provides a solid foundation for establishing the ambient air monitoring program, Community Protection Plan, and the Health and Safety Plan (see Appendices E and F) for OUs 2 to 5. Using this information, the Tetra Tech Team has developed draft air monitoring action levels to ensure the long-term protection of the public from emissions that may result from the OUs 2 to 5 RA, and has developed a process to ensure the surrounding community is protected from exposure day-to-day and over the longer duration of the remediation. This process, as well as the process for developing the action levels, is laid out in greater detail in the Community Protection Plan (see Appendix F). A summary of the process to be implemented for OUs 2 to 5 is as follows:

- Identify and characterize the air emission sources for OUs 2 to 5 during the remediation process that could impact the public.
- Identify the locations of the nearest potential public exposure points downwind of the primary emission source areas.

- Identify candidate locations for monitoring stations near the primary emission sources and/or near sensitive receptors to confirm modeling projections.
- Perform short-range air modeling for the area encompassed by the sources and near-field receptors to estimate the anticipated dispersion and dilution effects in the ambient air.
- Specify the monitoring station equipment and samplers (e.g., particle size cascading filters, remote logging, averaging time, detection limits).
- Install and test monitoring stations.
- Perform baseline air monitoring prior to the start of remediation activities to characterize potential seasonal and site-specific fluctuations.
- Refine the draft long-term exposure action levels based on new site-specific information (e.g., dispersion reduction fractions).
- Create a software tool (e.g., Excel workbook) for tracking day-to-day and long-term monitoring results for each monitoring station.

The results of the air monitoring for OUs 2 to 5 will be compared to the short-term exposure WDNR standard to verify, in near real-time, that the community is being protected and compliance with the substantive provisions of WDNR regulations is being achieved. Suitable air quality management responses will be identified and implemented to ensure that both of these goals are met during remediation.

5 MATERIALS HANDLING, TRANSPORT, AND DISPOSAL

This section presents the design of the materials handling, transport, and disposal operations planned for the OUs 2 to 5 RA. The mass balance used to select and size the dredging, desanding, dewatering, and water treatment equipment are summarized herein and presented in Appendix A, Attachment A-5.

5.1 2009 Transport of Debris and Dredged Material

During the 2009 dredging season, most of the material will be removed using hydraulic dredging equipment, as described in Section 4.2. As part of the hydraulic dredging process, sediment will be dislodged from the river bottom and entrained with water to create a slurry that will be pumped through a dredge pipeline running from the dredge location to the former Shell property staging and material processing facility located in OU 4. As discussed in Section 4, two primary dredge pipelines will be used to support dredging operations: an 8-inch-diameter HDPE pipeline connected to the *Fox River* and *Palm Beach* dredges and a 12-inch-diamter HDPE pipeline connected to the *Mark Anthony* dredge. The dredge pipelines will pass through several booster pump stations on route to the former Shell property to provide the necessary pumping power to convey the dredge slurry.

During the course of the 2009 Fox River dredging, it may be necessary to remove some sediment using mechanical methods, due to the presence of debris. During mechanical removal operations, all sediment and associated debris encased in sediment will be removed from the river and placed in open-top containers secured atop barges, which will minimize sediment or water releases. After open-top containers are filled to an acceptable level, the barges will be transported to the former Shell property staging and material processing facility for offloading of debris.

5.1.1 2009 Transport of Debris (Including Equipment Loading and Off-Loading)

In 2009, dredging will be conducted in OUs 2, 3, and 4. Figures 2-2 and 2-3 and Section 2.5.1 addresses characterization of debris for disposal purposes. All debris removed from areas in OUs 2, 3, and 4 by mechanical methods will be moved to the former Shell property for processing.

Debris removed from OUs 2 to 4 will be placed in open-top containers on the debris barges, which will prevent the release of turbid waters or re-introduction of debris to the river. All debris removed from non-TSCA areas that is too large to fit in a container will be placed directly within the material barge. All debris will be resized as necessary on shore to meet disposal requirements prior to off-site hauling.

5.1.2 2009 Transport of Dredge Materials (Including Equipment Loading and Off-Loading)

All sediment removed from OUs 2 to 5 will be moved to the former Shell property staging and material processing facility for sediment processing (e.g., sand separation and dewatering) and final load-out for disposal. Through the course of the OUs 2 to 5 RA, three separate methods, described below, will be used to facilitate transport of sediment from dredge locations to the former Shell property for processing.

8-Inch Hydraulic System – In 2009, sediments from OU 2 and upper OU 3 will be removed with the two 8-inch hydraulic systems working in tandem. The 8-inch hydraulic system will include the following components (as discussed in Section 4.2):

- Two 8-inch swinging articulated ladder dredges.
- Each of the dredges will operate on 4,500 feet of 8-inch-diameter DIPS HDPE plastic pipe. After 4,500 feet, both lines will converge (through a "Y" connection) into one 8-inch DIPS HDPE plastic line running the remainder of the 10 miles between OU 2 and the former Shell property staging area (see additional details of the pipeline in Section 5.2).
- Up to eight 8-inch-diameter booster pump stations, which will be employed as project hydraulics dictate.
- Buoys and marking systems, as detailed in Section 5.2, as required between OU 2 and the former Shell property.

Each 8-inch dredge will employ a cutterhead attachment (approximately 24 inches in diameter), as conditions mandate within OUs 2 and 3. After material is dredged, it will be transported to the first booster through a separate 8-inch-diameter pipeline connected to each dredge. Immediately prior to each of the two 8-inch pipelines entering the first booster pump station, the two pipelines will merge into a single common 8-inch-diameter pipeline (see Section 5.2). The combined pipeline will then enter the first booster and all subsequent boosters before the sediment reaches its final destination at the former Shell property.

In 2009, the 8-inch dredges will work in an upstream to downstream manner from OU 2 to OU 3. To facilitate optimal dredge production, boosters and pipelines will be sequentially eliminated from the 8-inch hydraulic system as the 8-inch dredges complete upstream dredging and progress downstream. During 2009 operations, the pipeline route from OU 2 to the former Shell property will be anchored to the river bottom in locations where the booster pumps will remain stationary for extended periods of time, and properly marked with a buoy system (see Section 5.2.2). The pipeline will be submerged and floated where the dredge is actively operating to allow the dredge to move. To mitigate noise levels from booster machinery, the 8-inch pipeline will be routed along the center of the river when residences exist on both river banks. When open areas are present on either side of the river, the 8-inch pipeline will be routed adjacent to non-residential areas, thereby furthering the distance between booster machinery and residents. The 8-inch-diameter pipeline will be routed adjacent to the De Pere Dam, parallel to the lock channel on the eastern side of the dam (see Appendix B for pipeline route).

12-Inch Hydraulic System – In 2009, a 12-inch hydraulic system will perform dredging operations in OU 4, beginning immediately downstream of the De Pere Dam. Due to the depth of required dredging in portions of OU 4, this larger dredge is better suited to perform material removal. The 12-inch hydraulic removal system will include the following pieces of equipment (as discussed in Section 4.2):

- One 12-inch swinging ladder dredge with traveling spud
- Two 12-inch-diameter booster pump stations as project requirements dictate
- A 12-inch inside diameter pipeline, safety orange colored, with lengths based upon project requirements
- Buoys and marking systems, as detailed in Section 5.2.2, as required between the De Pere Dam and the former Shell property

The 12-inch dredge will employ a serrated cutterhead (approximately 48 inches in diameter)to perform mass removal/production dredging of sediment in OU 4. Operations in 2009 with the 12-inch dredge will begin at the De Pere Dam and progress north towards the former Shell property, concurrent with sediment removal in OUs 2 and upper OU 3 with the two 8-inch dredges. Similar to the 8-inch dredge systems, booster pump stations will be removed from the 12-inch system as the dredge approaches the former Shell property.

The 12-inch dredge pipeline will generally be anchored in parallel to the river bottom bathymetry, adjacent the federal navigation channel, in locations where the booster pumps will remain stationary for extended periods of time. All marking of the dredge pipeline through OU 4 will be consistent with markings in OUs 2 and 3 (see Section 5.2).

Mechanical Dredging Plant – During the course of operations, there may be areas where mechanical excavation equipment is required to effectively remove material (see Section 4.2). Although the majority of material will be removed through hydraulic methods, mechanical dredge equipment will be available at all times on-site so that mechanical removal may be employed when required. As discussed in Section 4.4, mechanical dredge equipment will consist of either a barge-mounted crane and clamshell bucket or hydraulic excavator. In addition to the mechanical removal equipment, the following pieces of equipment will be used to transport dredged material to the former Shell property staging facility for off-loading and subsequent dewatering and disposal:

- Four 30-foot by 120-foot material barges, which will facilitate movement of material to the offloading facility
- One tugboat to facilitate movement of material barges to the offloading facility
- One 100-foot by 40-foot marine plant, from which the excavator or derrick will base operations

All material removed from OUs 2 to 5 by mechanical methods will be placed in open-top containers on the 30-foot by 120-foot material barges with combing for transportation to the former Shell property. Each open-top container will provide a secondary containment measure, minimizing releases of material to the river. Upon arrival at the former Shell property, open-top containers will be removed from the barges, by use of a crane, and replaced with empty containers.

During mechanical dredging operations, material barges will be managed so that one barge is berthed adjacent to the mechanical marine excavation plant. One barge will be in transit to or from the former Shell property, and one barge will be berthed at the former Shell property to facilitate off-loading. If operational realities show significant lag time for the mechanical excavation plan, additional material barges or boats may be added to increase production.

5.2 Dredge Pipeline

As discussed above, the two 8-inch dredges (the *Fox River* and the *Palm Beach*) will begin operations in OU 2, with each dredge connected to a separate 4,500-foot length of 8-inch-diameter, safety orange colored, HDPE pipeline. After 4,500 feet, both lines will converge into one 8-inch HDPE plastic pipeline, which will carry the combined flow the remainder of the distance to the former Shell property staging area. The convergence point will consist of an 8-inch-diameter steel Y connection, specially constructed by J.F. Brennan (see Figure 5-1). The Y will be constructed of Schedule 40 mild steel and will be equipped with valves so that one or two dredges can be operated at any given time. The Y will be installed on the deck of the first booster barge located 4,500 feet behind the dredges. As boosters are removed, the single line will be decoupled from the Y, the booster will be removed, and the line will be shortened as needed. In this manner, the two independent dredge lines will remain the same length (4,500 feet) throughout operations in OUs 2 and 3. Eight boosters will be installed at approximate 6,000-foot increments when dredging in OU 2.

This method allows for one common 8-inch pipeline, which can produce the required velocities needed to transport both silts and sand dredge material. The 8-inch dredges will each operate at about 800 to 900 gpm and combine in the common 8-inch pipeline at about 1,600 to 1,800 gpm. The resulting velocity in the common line will be between 10 and 12 feet per second (fps), which is a suitable flow rate for sand in an 8-inch pipeline. A spare dredge will always be on site in the event that one dredge needs to be shut down for any reason. This method has been used successfully at OU 1. It is important to note that both of the individual 8-inch dredges can also produce 1,600 to 1,800 gpm each; therefore, if heavy material is encountered, the system could be run with one dredge for a time, if needed.

In addition to the 8-inch dredge pipeline, the 12-inch hydraulic dredge *Mark Anthony* will operate on its own SDR 17 HDPE pipeline, which has an inside diameter of 12.32 inches. It will operate at a flow rate between 3,000 and 4,000 gpm, depending on the velocity needed at any given time.

Both the 8-inch pipeline and the 12-inch pipeline will run to the former Shell property staging area, where they will be incorporated into the sediment processing system. The dredge pipelines for the 8-inch and 12-inch systems will be routed onto shore along the north side of the Canadian Railroad bridge, immediately south of the former Shell property. This will be in between the south end of the sheetpile wall and the railroad bridge. The pipelines will run up onto the shoreline and lay on top of the ground in a 15-foot-wide offset south of the one-way road to be constructed at the former Shell property (see Figure 3-3). The pipelines will run parallel to the road until the east side of the stormwater pond. They will then cross the roads through a culvert and terminate in the southeast corner of the sediment processing building. In this way, the dredge pipelines will not affect the installation of the sheetpile wall.

Each of the dredge pipelines will be submerged, weighted every 50 feet, and maintained in a filled (slurry or water) state to ensure the pipeline does not develop buoyancy issues and rise to the surface. In portions of the river where both 8-inch and 12-inch pipelines will be placed, the pipelines will be tied together to aid in submerging and marking. Additional details of the specific configuration of the pipeline design and interfaces/connections will be presented in the 2009 RA Work Plan.

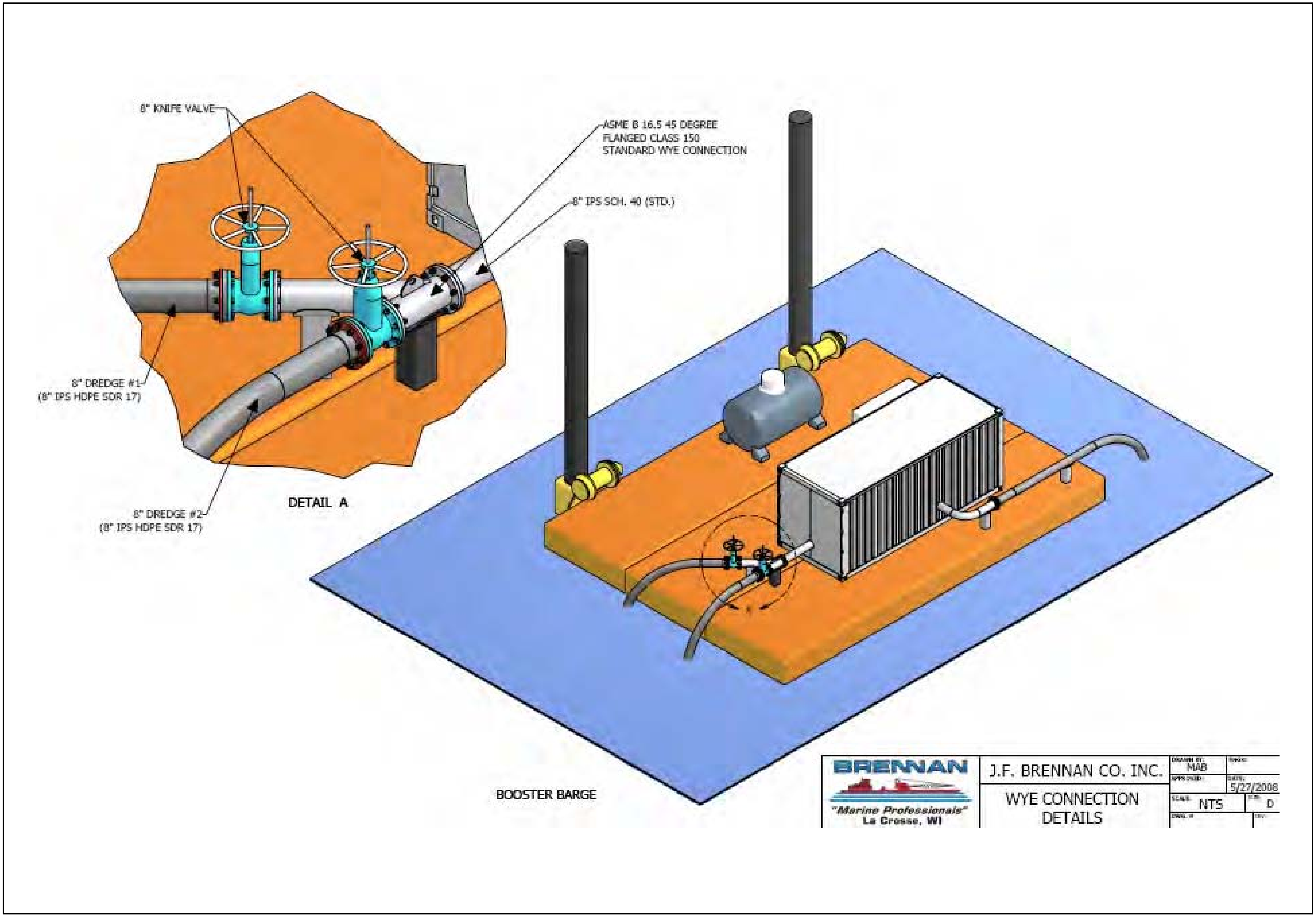

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Figure 5-1
8-Inch Dredge Pipeline – Y Connection Detail
Lower Fox River – OUs 2 to 5

5.2.1 Pipeline Design

SDR 17 HDPE pipe will be used for the dredge pipeline. The pipe will be colored orange for greater visibility, with a minimum 100 pounds per square inch (psi) rating. The individual HDPE segments will be thermal butt-fusion welded per ASTM 1248, ASTM 3350, and ASTM F714 standards.

5.2.2 Marking System

The dredge pipeline marking system was designed to allow for a high visibility of dangerous areas on the river for the benefit of boaters operating at high speeds. The system will consist of a series of different waterway markers:

- **Warning Buoys** – white stick buoys with black and orange reflective markings stating “Danger Pipeline”
- **Pipeline Delineators** – bright colored delineators, typically orange and yellow, with reflective tape and approximate diameters from 8 to 18 inches
- **Floating Shoreline Signage** – signs reading “Danger Pipeline” with reflective tape and mooring lights
- **Designated Crossing Channel Buoys** – navigational markers consisting of one red buoy and one green buoy with red and green blinking lights, respectively

The warning buoys will have the following configuration where the pipeline is floating:

- The warning buoys will be staggered at a distance of approximately 500 feet on either side of the dredge pipeline to allow boaters sufficient time to slow down prior to encountering the pipeline.
- Spacing will be every 500 feet on the same side of the pipeline and every 250 feet when considering buoys on opposing sides.
- Where applicable, the warning buoys will also be placed to enclose an area where the dredge and floating pipeline is working. This procedure would be used in place of staggering the warning buoys on either side of the pipeline.
- The warning buoys will be equipped with mooring lights to better identify the markers during low visibility periods.

The warning buoys will have the following configuration where the pipeline is submerged:

- The warning buoys will be spaced at a distance of approximately 500 feet attached directly to the dredge pipeline. This will notify boaters that there is a submerged dredge pipeline permanently weighted down.
- Spacing will be every 500 feet directly above the pipeline with two pipeline delineators spaced equally between them.
- The warning buoys will be equipped with mooring lights to better identify the markers during low visibility periods.

Cut-sheets and specifications for pipeline delineators are shown in Appendix C. The pipeline delineators will have the following configuration:

- The pipeline delineators will be secured to the pipeline and spaced every 170 feet, providing warning to vessels that may be operating in close proximity to the dredge pipeline.

Cut-sheets and specifications for floating and shoreline signage are shown in Appendix C. The floating and shoreline signage will have the following configuration:

- Navigational markers will be placed to designate the area where the dredge pipeline has been securely anchored to the river bottom to provide for safe passage.

Cut-sheets and specifications for designated crossing channel buoys are shown in Appendix C. The designated crossing channel buoys, consisting of one red buoy and one green buoy with red and green blinking lights, respectively, will have the following configuration:

- Buoys will be spaced every 300 feet.
- Buoys will be equipped with mooring lights to better identify the markers during low visibility periods.

Figures 5-2a through 5-2c outline the successful pipeline marking system used by J.F. Brennan at OU 1 and proposed for use on OUs 2 to 5.

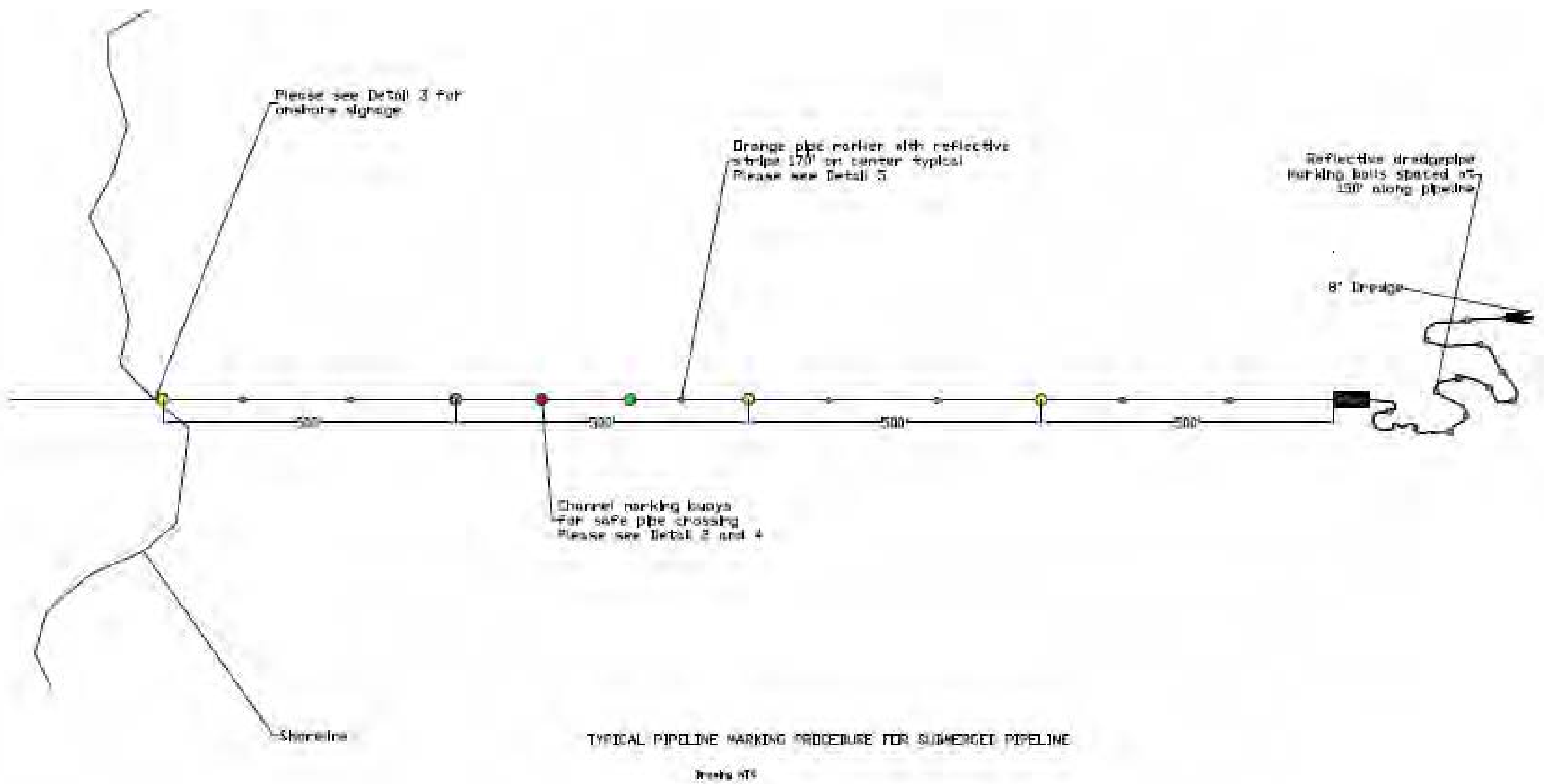

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Figure 5-2a
Dredge Pipeline Marking System
Lower Fox River – OUs 2 to 5

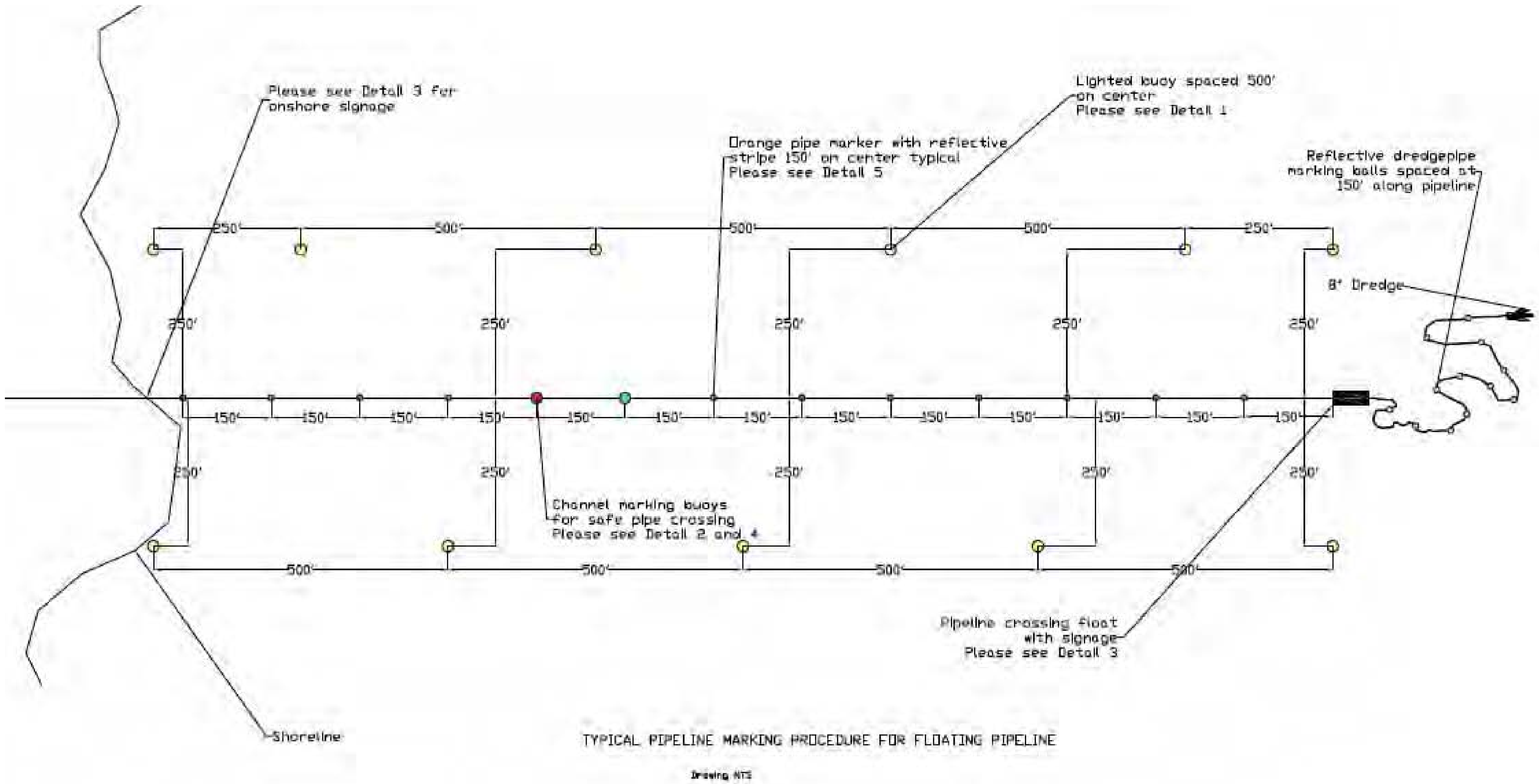

Figure 5-2b
Dredge Pipeline Marking System
Lower Fox River – OUs 2 to 5

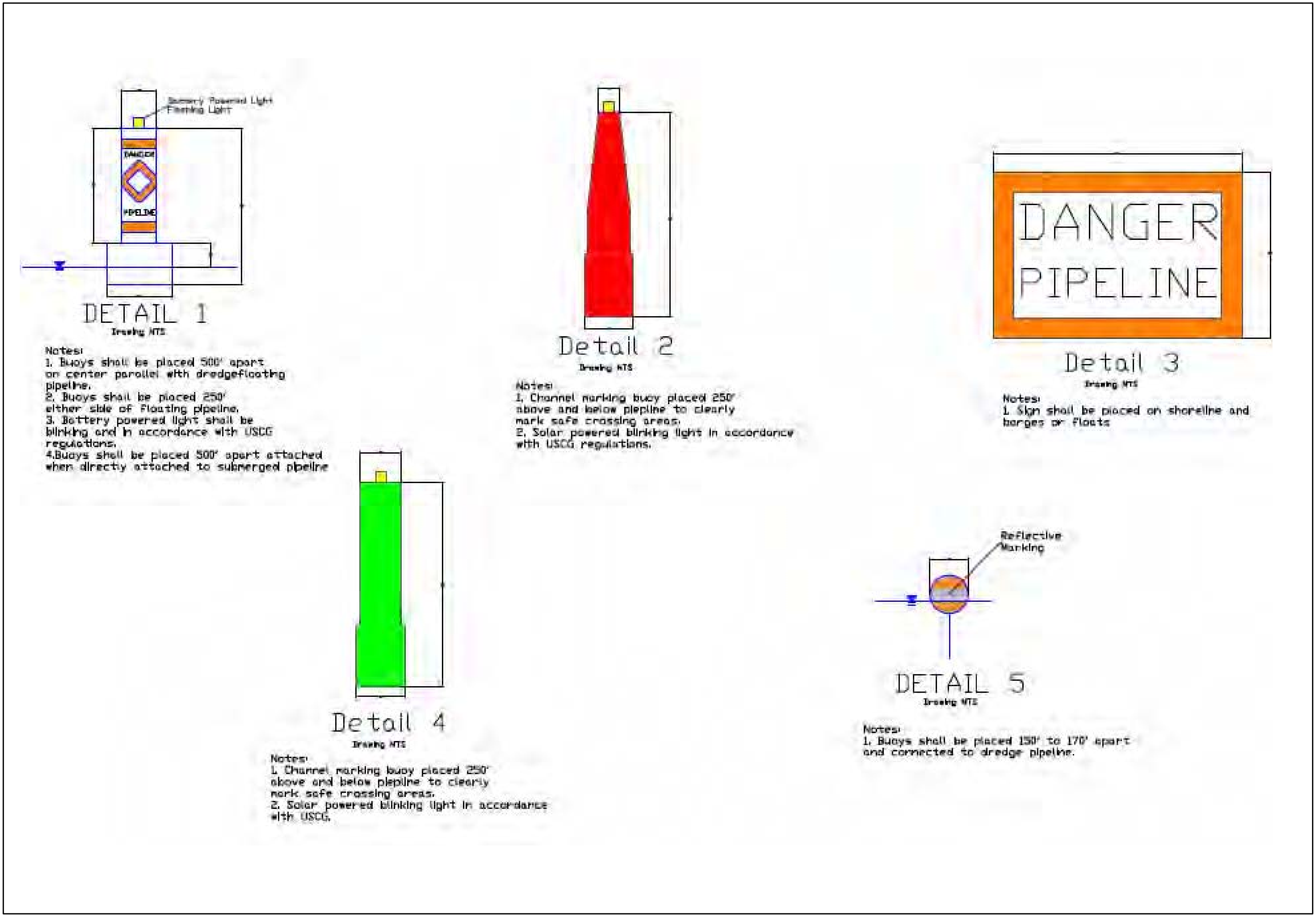

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Figure 5-2c
Dredge Pipeline Marking System
Lower Fox River – OUs 2 to 5

5.2.3 Booster Stations

Given the long length of the dredge pipelines, several booster stations are necessary to convey the dredge slurry to the dewatering plant. Considering a spacing of approximately 6,000 feet between booster stations, a series of eight booster stations are required to transport material from OU 2 to the former Shell property; two booster stations will be necessary for transporting dredge slurry during work north of the former Shell property in 2010 and beyond. The booster pumps will have the following specifications (see Appendix C, Attachment C-6 for additional details of the specifications of the booster pumps):

- Powered by a CAT C-9 industrial diesel engine, with residential-grade silencer, located in a self-contained unit placed on a floating barge.
- The booster pumps will have a continuous rating of 275 bhp at 1,800 to 2,400 revolutions per minute (rpm).

The dredging sequence includes removal of unnecessary dredge pipeline and booster pumps as the dredging operations proceed north of each booster station. These off-line boosters will serve as backups for the other on-line boosters. During down periods, the pumps can be securely locked within the self-contained units. The self-contained unit configuration for the booster pumps will also serve as an added measure for sound attenuation. Table 5-1 summarizes planned booster stations for the OUs 2 to 5 RA.

Table 5-1
Booster Station and Pump Information

Booster Station	Corresponding River Location	Details
South of Former Shell Property		
1	Station 214	Two pumps (one with 8-inch line and one with 12-inch line)
2	Station 287	Two pumps (one with 8-inch line and one with 12-inch line)
3	Station 366	One pump (8-inch line)
4	Station 403	One pump (8-inch line)
5	Station 464	One pump (8-inch line)
6	Station 522	One pump (8-inch line)
7	Station 571	One pump (8-inch line)
8	Station 637	One pump (8-inch line)
North of Former Shell Property		
1 North	Station 85	One pump (12-inch line)
2 North	Station 21	One pump (12-inch line)

5.2.4 Monitoring

Dredge pipeline monitoring procedures consist of:

- The dredge pipeline will be inspected daily for leaks and other problems. Observations will be logged and deficiencies will be corrected.
- Clear direction regarding chain of command during emergencies will be provided to all employees.

The booster station is comprised of a control package consisting of a programmable logic controller (PLC), user interface, and various transmitters. Procedures for booster station monitoring consist of:

- The booster control panel will have start/stop switches for the main pump and service water pump as well as a booster mode switch and touch screen.
- The operator will be provided with operating data, alarms, and the means to adjust control and alarm set points.
- The booster pumps will be capable of operating in either automatic or manual mode. The automatic mode is controlled through the inlet and discharge pressure, while the manual mode requires an operator to function.
- Each booster station will be manned during hours of operation to ensure optimal operational performance and quick response to maintenance items.
- Clear direction regarding chain of command during emergencies will be provided to all employees.

5.3 Dredge Sediment Handling

In 2009, two 8-inch hydraulic dredges and one 12-inch hydraulic dredge will be used for removal of TSCA and non-TSCA sediments at OUs 2, 3, and 4. The dredges will remove the sediment to the neatline in OUs 2 and 3 and pump the material through the pipeline and accompanying floating booster stations to the upstream De Pere Dam easement (see Appendix B for pipeline route), crossing into OU 4 on the parcel owned by USACE between the De Pere Dam and lock and proceeding through OU 4 to the dewatering facility at the former Shell property staging and material processing facility. Mechanical dredging will be used as an option only if hydraulic dredging cannot be conducted in certain areas. Dredging BMPs will be conducted as explained in the previous section.

5.3.1 Hydraulically Removed Sediment Transport

In 2009, the following sequence will be performed to transport hydraulically removed non-TSCA sediment:

- The two 8-inch dredges will be deployed to OU 2 to begin dredging of non-TSCA material. These dredges will be capable of removing non-TSCA sediment from the area south of Booster Station 8 through Booster Station 5 (see Figure 4-3).
- The 12-inch hydraulic dredge will operate from the De Pere Dam north to D31a, initially removing non-TSCA sediment (see Figure 4-4).
- During the later part of the 2009 dredging season, approximately 33,000 cy of TSCA dredging will be conducted using the two 8-inch dredges and the 12-inch dredge at the former Shell property to facilitate buildout.
- There will be no crossover between non-TSCA and TSCA material at the dewatering plant. The dredge, dewatering plant, and WTP will be flushed clean by passing pure river water (no entrained sediment) through the entire system (dredge pipeline to WTP) at the conclusion of the 2009 dredging season following completion of TSCA dredging and prior to processing the non-TSCA material at the start of the 2010 season. The discharge of the pipeline will be monitored at the dewatering plant until no visible material is seen entering the plant. This is consistent with what has been used in the OU 1 and Phase 1 projects.

5.3.2 Contingency for Mechanically Removed Sediment Transport

If mechanical dredging is necessary because hydraulic dredging in a particular area is infeasible, the following procedures for removed sediment transport will be followed:

- Sediments from OU 2 and upper OU 3 will be mechanically dredged and placed onto shallow draft barges (approximately 200 to 300 cy capacity each).
- The dredging production rate for mechanical dredging is lower than rates assumed for hydraulic dredging.
- Mechanically dredged sediment will be transported to the former Shell property staging area for processing using transport barges, and will be processed as described in Section 5.4.3.

5.4 Mechanical Dewatering Operations

5.4.1 Dewatering Plant

In 2009, the dredged material will initially be processed through the following stages to enable subsequent mechanical dewatering of the fines using filter presses (see Figure 5-3):

- Coarse debris separation
- Coarse and fine sand separation
- Pre-thickening

The dewatering plant will include three adjacent buildings that have been sized based on available information with respect to dredge volumes, production rates, and chemical/physical sediment properties. Boskalis conducted sediment sampling in OUs 2 to 5 in October 2007. The intention of this effort was to examine sediment behavior during processing and to perform treatability tests. This work was completed in close cooperation with filter press manufacturers to enable optimal sizing of the dewatering plant. As only a limited number of samples were tested, additional sampling is being conducted in 2008 to check and further refine the sizing of the separation and dewatering plant.

The separation and dewatering plant is designed to be operated 24 hours per day and 5 days per week—the sixth day is planned for maintenance and repair work. The entire plant will consist of the following major structures, as depicted on Figure 3-1:

- 100,000-square-foot building housing the mechanical operations (including 6,150 square feet for maintenance activities)
- 36,000-square-foot debris and sand staging area
- 16,500-square-foot filter cake area
- 260,000-gallon total surplus water tank storage in addition to stormwater/overflow storage area

Drawings of the separation and dewatering equipment are shown in Appendix B. A schematic of the dewatering plant area is also shown in Appendix B.

5.4.2 Processing of Hydraulically Dredged Sediment

Sediment dredged using hydraulic means will be transported to the dewatering plant via submerged 8-inch and 12-inch dredge material transfer pipelines. The flow from the two separate dredge lines will flow to the single deck vibrating screen, which is sized (through the mass balance calculations presented in Section 5.4.8) to accommodate flow from both lines. The sand separation system has two end points for sand, segregating coarse-grained and fine-grained material. The designed segregation of sand has been included to significantly reduce equipment wear and with the intention of beneficial reuse of this material. There is a high reuse potential for the coarse-grained sand, while the reuse potential for fine-grained sand is still being evaluated. By segregating the sand, the quantity of material available for reuse will be optimized in the event that the fine-grained sand portion does not meet regulatory standards for reuse. This design also allows additional flexibility to cope with sediment changes fed to the plant from dredging operations.

The dewatering plant will process the sediment via the processes shown on Figure 5-3 and summarized in Table 5-2. Note: the capacity of all equipment shown on Figure 5-3 and listed in Table 5-2 were sized based on the mass balance presented in Section 5.4.8 and the estimated dredging production rates. Based on the dredging production rates provided in Table 4-1, the estimated production for the two 8-inch hydraulic dredges operating at 65 percent uptime in OUs 2 and 3 and the 12-inch dredge operating at 80 percent uptime (likely to be the maximum uptime per J.F. Brennan) will be approximately 220 in situ cy per hour. Additionally, the Tetra Tech Team will have the ability to temporarily modify dredge production rates based on available dewatering plant capacity. Throughput of the dewatering plant will be closely monitored and frequent communication will be maintained with the dredge operators to control solids flow into the system. The sediment desanding and dewatering plant is sized to accommodate a maximum flow rate of 250 in situ cy per hour of sediment, or about 14 percent higher than the anticipated maximum flowrate. The material derived from mechanical dredging operations, which will be limited and sporadic, will be fed into the system during periods when the system is operating at less than maximum production (e.g., during hydraulic dredging downtime because of required movement or maintenance).

Additional capacity is included in the sediment dewatering facility, as shown on the Process Flow Diagram presented on Figure 5-3 and as described in the notes on the drawing. This additional capacity is provided in an overflow basin, additional tank capacity, and the area reserved for the addition of two additional membrane filter presses.

MAJOR EQUIPMENT LISTING

NOMENCLATURE	SIZE	CAPACITY
SLURRY TANK 1	TBD	TBD
SLURRY TANK 2	TBD	TBD
SLURRY TANK 3	TBD	TBD
OVERFLOW BASIN	TBD X 4 M HT	1256 m^3 (1643 CY)
SLURRY THICKNER TANK	TBD	100 m^3 (26400 GALLON)
RESIDUE TANK	TBD DIA X 5 M HT	200 m^3 (52835 GALLONS)
PRE–THICKENERS (4 EACH)	18 M DIA X 5 M HT	473 m^3 (125000 GALLONS)
PROCESS WATER TANK	8 M DIA X 4 M HT	200 m^3 (52835 GALLONS)
WATER BUFFER TANK (2 EACH)	20 M DIA X TBD	1000 m^3 (265,000 GALLON)
SLUDGE HOLDING TANK (4 EACH)	TBD DIA X 8.5 M HT	453 m^3 (120000 GALLON)
FILTRATE TANK	TBD	TBD
CLEAN WATER TANK	TBD	TBD
OVERFLOW TANK (SUPERNATANT) (2 EACH)	TBD	TBD
WASH WATER TANKS (4 EACH)	TBD	10 m^3 (2650 GALLONS)
MEMBRANE PRESSES (8 EACH)	ENGINEERED	17.8 m^3 (23.3 CY)
PUMPS		
SLURRY HOLDING TO SLURRY THICKNER (2 EACH)	TBD	3300 GPM
THICKENS SLURRY TO COARSE SAND SEPARATOR (2 EACH)	TBD	500 m^3/HR
RESIDUE TANK TO PRE–THICKENER TANKS (4 EACH)	TBD	TBD
SLUDGE TANK TO PRESSES (4 EACH)	TBD	150 m^3/HR

NOTES:

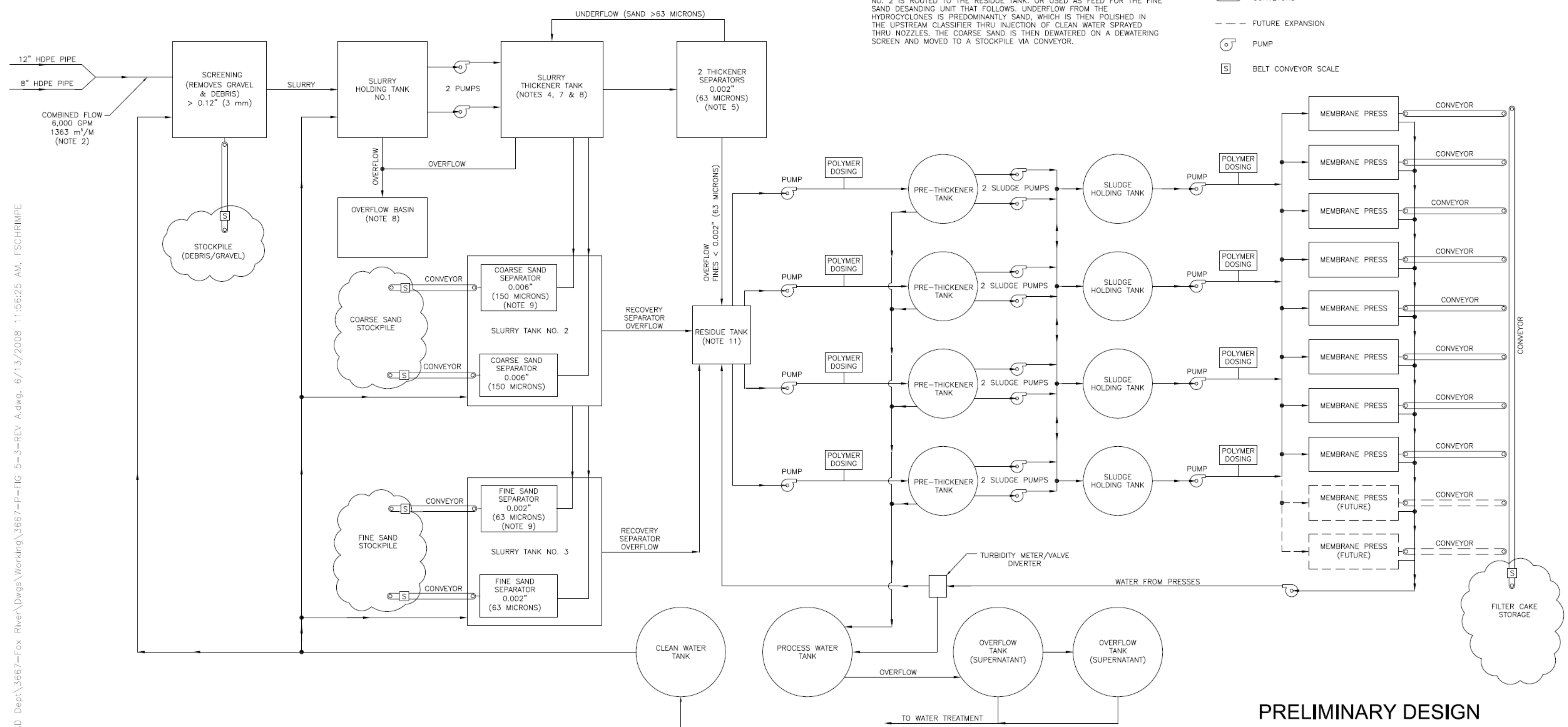
1. UNITS SHOWN ARE NOT TO SCALE AND REPRESENT PROCESS FLOW ONLY.
2. THE 6,000 GPM (1363 m^3)/M FLOW RATE SHOWN REPRESENTS PEAK FLOW RATE FOR SEDIMENT SLURRY FROM ALL THREE DREDGE LINES. THIS FLOW RATE CORRESPONDS TO REMOVAL OF APPROXIMATELY 250 CY (191 m^3) OF SEDIMENT (AS MEASURED IN–SITU) PER HOUR.
3. CONVEYORS INCLUDE A BELT WEIGHING DEVICE AS SHOWN.
4. THE SLURRY THICKENER TINK IS DESIGNED TO ATTENUATE ANTICIPATED SHORT TERM DENSITY VARIATIONS AND PROVIDE A MINIMIZED BUT CONSTANT HYDRAULIC LOAD TO THE DESANDING EQUIPMENT.
5. WHEN PROCESSING RELATIVELY DENSE, SANDY SEDIMENT, THE FLOW OF 654 CY^3/HR (500 m^3/HR) WILL BE PUMPED TO THE THICKENER SEPARATORS. UNDERFLOW (PRIMARY SAND) IS RETURNED TO THE SLURRY THICKENER TANK.
6. WHEN PROCESSING RELATIVELY FINE, SOFT SEDIMENT, THE SOLIDS LOAD TO THE DESANDING STEP IS SO LOW THAT ONE OF THE TWO DESANDING LINES WILL BE SUFFICIENT TO HANDLE THE FLOW.
7. THE SIZE OF THE SLURRY THICKENER TANK WILL PROVIDE AN AVERAGE RESIDENCY TIME OF 4 TO 5 MINUTES. THIS ALLOWS A SMOOTHING OF SHORT–TERM DENSITY VARIATIONS FOR SEDIMENT SLURRY FROM THE DREDGES.
8. OVERFLOW WEIRS IN THE SLURRY THICKENER TANK AND SLURRY TANK NO. 1 REDIRECT INCOMING FLOW TO THE OVERFLOW BASIN IN CASE OF AN EMERGENCY PLANT SHUTDOWN. THIS MATERIAL WILL BE PUMPED BACK TO THE SLURRY HOLDING TANK AFTER RESUMPTION OF THE PROCESS.
9. THE COARSE SAND DESANDING UNIT CONSISTS OF TWO PARALLEL LINES WITH 0.006" (150–MICRON) HYDROCYCLONE SEPARATORS, A CONE–SHAPED (T–TYPE) UPSTREAM CLASSIFER, AND DEWATERING SCREEN CONSTRUCTED OVER OPEN–TOP SLURRY TANK NO. 2. OVERFLOW FROM SLURRY TANK NO. 2 IS ROUTED TO THE RESIDUE TANK. OR USED AS FEED FOR THE FINE SAND DESANDING UNIT THAT FOLLOWS. UNDERFLOW FROM THE HYDROCYCLONES IS PREDOMINANTLY SAND, WHICH IS THEN POLISHED IN THE UPSTREAM CLASSIFIER THRU INJECTION OF CLEAN WATER SPRAYED THRU NOZZLES. THE COARSE SAND IS THEN DEWATERED ON A DEWATERING SCREEN AND MOVED TO A STOCKPILE VIA CONVEYOR.

NOTES CONTINUED:

10. THE FINE SAND DESANDING UNIT CONSISTS OF TWO PARALLEL LINES WITH 0.002" (63–MICRON) SEPARATORS, AND USES THE SAME COMPONENTS AND PROCESS DESCRIBED IN NOTE 9 FOR THE COARSE SAND DESANDING UNIT.
11. THE RESIDUE TANK WILL BE EQUIPPED WITH A FLOW/DENSITY MEASUREMENT SYSTEM, WHICH WILL BE USED TO ADJUST THE POLYMER DOSING.
12. SETTLED SLUDGE WILL BE REMOVED FROM THE PRE–THICKENER TANKS USING A BOTTOM SCRAPER SYSTEM THAT MOVES THE SLUDGE TO A CENTER SUMP WITHIN EACH TANK, FROM WHICH THE THE SLUDGE IS PUMPED TO THE SLUDGE HOLDING TANK. THE SLUDGE PUMPS AND POLYMER SYSTEMS ARE EACH DESIGNED TO HANDLE 1/3 OF THE TOTAL FLOW, SO THAT THE TOTAL FLOW IS HANDLED EVEN IF ONE PUMP IS OUT.
13. PRE–THICKENED SLUDGE IS PUMPED INTO THE PRESSES USING TWO CENTRIFUGAL PUMPS, WITH POLYMER DOSED BEHIND THE PUMPS TO OPTIMIZE THE SEDIMENT DEWATERING CHARACTERISTICS.
14. THE INCREASING PRESSURE IN THE PRESS AND THE TOTAL FLOW AND AMOUNT OF SOLIDS PUMPED INTO THE PRESS ARE MEASURED CONTINUOUSLY. AFTER THE RELEVANT SET–POINTS ARE REACHED, THE FILLING OF THE PRESSES WILL STOP AUTOMATICALLY. ADDITIONAL PRESSURE IS THEN DEVELOPED USING A MEMBRANE INFLATION SYSTEM TO SQUEEZE THE FILTER CAKE. THE PRESSURE IS THEN LOWERED TO RELEASE THE FILTER CAKE ONTO A CONVEYOR BELT SYSTEM WITH A BELT WEIGHING DEVICE.
15. THIS PROCESS FLOW DIAGRAM IS BASED ON INFORMATION PROVIDED BY BOSKALIS DOLMAN.

LEGEND

- CONVEYORS
- — — — FUTURE EXPANSION
- PUMP
- [S] BELT CONVEYOR SCALE



ALL DIMENSIONS/UNITS SHOWN ARE IN ENGLISH SYSTEM. ALTERNATE UNITS ARE IN METRIC, AS PROVIDED IN BRACKETS.

PRELIMINARY DESIGN
NOT FOR CONSTRUCTION
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Figure 5-3
Sediment Desanding and Dewatering Process Flow Diagram
Lower Fox River – OUs 2 to 5

Table 5-2
Sediment Dewatering Process Overview

Operating Process	Description
Scalping Screen	Initially, sediment slurry will pass over a single deck vibrating screen, allowing material less than 1/8-inch-diameter to pass through. Following rinsing, coarse particles such as rock, gravel, and debris greater than 1/8-inch-diameter will be deposited on a conveyor and stacked for transport at the staging area. All remaining material (i.e., sand and silt) will pass through the screen and enter Slurry Tank #1. After screening, the sand and silt flow will be handled using an extra primary sand separation step in the Slurry Thickener Tank. Sand will be removed as underflow and returned to Slurry Holding Tank No. 1 for input into the coarse and fine sand Separator (or Desanding) Unit.
Sand Separation	Coarse-Grained Sand The slurry will be pumped through a 150-micron coarse sand separation unit to separate potentially reusable, clean sand from the slurry. Three heavy-duty slurry pumps (including a spare) will be used to feed the 650 cy/hr hydro-cyclones. After polishing through an upstream clarifier, the separated sand will be dewatered using a dewatering screen and stacked on the Staging Area via a conveyor. The hydro-cyclone overflow, consisting of all sands and fines below 150 micron (100 mesh), will be collected in Slurry Holding Tank #2. Fine-Grained Sand The slurry from Slurry Holding Tank #2 will be processed in two parallel fine sand separation units to separate the fine sand down to 63 micron (325 mesh) from the initial slurry. Each unit will be equipped with two heavy-duty slurry pumps to feed each of three hydro-cyclones at a rate of 160 cy/hr. The separated fine sand will be dewatered using dewatering screens and stacked on the staging area via a conveyor. An upstream clarifier can be used to polish the fine sand for reuse, if necessary. The hydro-cyclone overflow, consisting of fines below 63 micron (325 mesh), will be collected in Slurry Tank No. 3 and routed to the Residue Tank.
Pre-Thickening	A total of four 50-foot-diameter Pre-thickener Tanks are included to handle the flow collected in the residue tank. These tanks are fitted with a bottom slope towards the center and have an approximate capacity of 125,000 gallons. The tanks will have a center well in which the slurry is pumped, following in-line polymer addition, and thoroughly mixed using an in-line mixing device. An integrated control module will be used to continuously monitor the polymer injection rates, sludge density, and sludge flow rates to optimize the polymer addition process. A rotating rake at the bottom of the tanks pushes the settled sludge to the center of the tank, further compacting and consolidating this material. Once a sufficient bed of material has been formed, underflow pumps will be activated to pump the thickened sludge (with an estimated 25 percent solids) towards the thickened Sludge Holding Tanks. The supernatant water remaining after the sludge has been settled out will flow over a weir encircling the entire circumference of the tank and out through a discharge pipe to the Process Water Tank and surplus water basin. Water exiting the Pre-thickener Tanks will have a TSS load averaging approximately 50 ppm.
Mechanical Dewatering	Eight membrane-type filter presses are planned for this plant, with a total volume of approximately 130 cy, to dewater the thickened sludge into a firm filter cake. The presses will be equipped with 6.5-foot by 6.5-foot filter plates and a total of 188 press chambers with a width of approximately 1 inch. From the Sludge Holding Tanks, the thickened sludge is pumped into the filter presses using four 650 cy/hr pump system. During this filtration process, operated up to a pressure

Operating Process	Description
	of 115 psi, excess water is released through the filtration membranes. Additives (e.g., polymer, optional lime, and/or a small volume of fine-grained material as a filter aid) will be added to the thickened sludge in-line and/or in the thickened Sludge Holding Tank. After the filtration phase, the remaining free water will be squeezed from the sludge by adding additional pressure (up to 225 psi) through the filter press membranes. After squeezing, the pressure is released and the filter press opens, allowing the filter cake to fall down into the filter cake conveyor system that will be situated directly below the filter press. The conveyor system will transfer the filter cake to an area for stacking, transportation, and subsequent disposal.
Process Water System	Surplus water from the Pre-thickener Tanks and water from the presses will be collected in two large Overflow Tanks and a Process Water Tank, awaiting final treatment through the water treatment system prior to discharge back to the Fox River. A separate Water Supply Tank will be used for feed to the sand polishing and other processes used in the dewatering plant. These processes include polymer makeup, counter-current washing, and spraying and jetting.
Control Room and System	The dewatering plant will be equipped with several measuring and control devices and a centralized computer system to guarantee smooth and efficient operations. This includes measurement and control of flows, pump speeds, holding tank levels, sludge blanket levels in the pre-thickener tanks, polymer addition, excess water turbidity, etc.
Polymer Addition	As part of the October 2007 design sampling, limited dewatering tests were conducted to study sediment dewatering characteristics. Several polymer types were tested to define the type of polymer that will produce the best dewatering results. Further testing will be conducted to ensure that the best and most successful polymer is being used for the Lower Fox River Project; however, Krysalis FC 2202 from Ciba Polymers has initially been selected. This is a powder-type polymer that will be diluted in special polymer dilution and dosing stations. Using a Boskalis Dolman-developed dilution system with a high energy flash mixing device, a relatively dense polymer dilution can be established. Dosing will be checked and adjusted automatically based on sludge density in the dewatering system, using mass/flow measurements, to ensure an optimal polymer dosing level. Special high-performance in-line mixing devices will be used to obtain a thorough mixing of the polymer both for pre-thickening and filter pressing. The polymer will be transported to the dewatering plant in large bags and stored under dry conditions. Polymer addition to the dilution system will be performed using a vacuum transport system, adding it directly from the bags. For employee safety, no direct contact with the polymer will be required.
Handling of Output Materials	All dewatered output materials will be stockpiled awaiting transport and disposal or transport and beneficial reuse. Large conveyor belts will be used to stockpile these materials on two different staging areas, one for the filter cake material and one for the screened materials and separated coarse and fine sands. Water that might drain onto the staging areas will be collected using line drain equipment into one or more sumps, from which it will be redirected into the dewatering plant. Stacked materials will be loaded onto trucks for transport using a front end loader.

5.4.3 Processing of Mechanically Dredged Sediment

Although mechanical dredging is planned only as a contingency means of dredging in OUs 2 to 5, the design of the dewatering plant has considered the potential need for processing mechanically dredged material. Mobilization of this portion of the dewatering plant will not initially be conducted; future mobilization of this equipment will be dependant on field conditions encountered during dredging. If necessary, processing mechanically dredged sediment will include the following:

- Mechanically dredged sediment will be transported to the processing facility using transport barges.
- To off-load this material into the sediment processing plant, a dredged sediment coarse screening and pumping station will be installed on shore or on a pontoon.
- The off-loading station will include an off-loading excavator, an input hopper (complete with grizzly to separate very coarse debris and a robust steel slab to protect against any form of spillage), a rotating wash and screening drum, a slurry tank, a slurry pump, and a water jet system.
- A shore- or pontoon-based excavator will offload the barges into the input hopper.
- Process water will be used to slurry the sediment and flush it into the wash and screening drum. This rotating drum (trammel) is fitted with approximately 1-inch-round openings through which the slurry flows into the slurry hopper located underneath the trammel.
- Remaining particles, larger than 1 inch, will be transported to the front end of the trammel to be stacked for disposal. During transport, jet water will be sprayed onto these particles for cleaning.
- The remaining slurry, free from larger particles, will be pumped from the off-loading station to the sediment processing plant.
- Process water will be pumped from the sediment processing plant to the off-loading station to facilitate wet screening, cleaning, and pumping of the mechanically dredged sediments.
- The off-loading station may be fitted with a separate generator or power supply. However, communication lines between the off-loading station and the dewatering plant will secure safe operations between both locations. The off-loading station area will be fitted with a water-tight floor, complete with bund wall and sewer pit(s), to ensure minimal spillage.

5.4.4 Segregation of Sand

The use of coarse- and fine-grained sand separation before dewatering is important to reduce the amount of equipment wear on the filter presses and also has the potential to provide material suitable for beneficial reuse, thereby reducing disposal weight and costs. Value engineering is currently underway to determine potential beneficial reuse options for the sand. Beneficial reuse options are contingent on approval from the Response Agencies and may be held to specific standards or locations for reuse. Beneficial reuse may be limited to the following conditions:

- Coarse sand fraction, depending on washed sand characteristics
- Regulatory standards to be met (e.g., NR 538)

Additional bench-scale and pilot testing will have to be performed to determine suitability of segregated sand for reuse. Testing planned for 2008 as part of the Phase 2A work pursuant to the Order includes:

- Separation tests to study PCB concentrations in different grain size fractions (coarse and fine sand)
- Further treatment tests:
  - Scrubbing and/or attrition to study the relationship between organic matter content and PCB concentration

If beneficial reuse of the coarse and/or fine sand appears to be impractical or prohibited, the debris and sand separation stages of the process may be redesigned to further optimize the dewatering approach.

5.4.5 Monitoring

The Tetra Tech Team will monitor key aspects of the sand separation and dewatering operations during dredge material processing. The sand will be tested as described in Section 2.5.2. The filter cake will be tested for PCBs and geotechnical strength properties also as described in Section 2.5. Each individual component of the dewatering and water treatment processes will be monitored as follows:

- Influent flow rates and/or sediment properties
  - Flow in the 8-inch and 12-inch sediment transfer pipelines, monitored via meters

  - Overall volumetric flow rates
  - Percent solids in the dredge slurry line
- Outgoing production rates or tonnage
  - Debris removed in initial screening operation (3 to 5 millimeter or greater)
  - Sand removed during first sand screening
  - Sand removed during the second screening process
  - Filter cake produced for disposal
- Outgoing flow rates
  - Sediment flowing from the Sludge Holding Tanks to the membrane presses
  - Water directed to the water treatment systems
- Relevant tank levels and associated flow rates
  - Allowance for different flow levels to adjust equipment use
- Sludge in sludge tanks
  - Sludge density
  - Rate of polymer addition (anticipated at 0.5 to 1.0 Kg/ton)
  - Remaining capacity in the event of a filter press shutdown for maintenance
- Sludge blanket level in pre-thickener tanks
  - Number of presses in use
  - Remaining capacities in tanks
- Process tank
  - Water levels
  - Flow to WTP
- Filter press cycle
  - Fill capacity remaining
  - Pressure build-up on membranes
  - Cycle time

All monitoring information will be linked to the PLC system, which is the instrumentation system that controls flows, pressures, and volumes. This information will be continually monitored by the plant operator through the monitors in the control room. The operator will also monitor a series of cameras to check the status of operating equipment. Instrumentation and controls will be monitored and adjusted, as needed, to equalize sludge levels in the tanks. Physical properties of the materials, such as grain size distribution, organic matter content, and densities, may also be tested using "wet screening" and other simplified test methods to verify process operations are within the expected range. Samples will be collected daily to check and monitor the mass balance over the system and control its proper functioning.

5.4.6 Best Management Practices for Dewatering Operations

Optimal plant uptime and efficiency are necessary to ensure the overall project schedule is met. In an effort to minimize downtime, the following features have been incorporated into the dewatering system design and subsequent operation:

- Plant uptime and efficiency will be optimized by the introduction of a primary sand separation step, followed by input of the sand into the coarse and fine sand separation plant. The primary sand separation is accomplished in the Pre-thickener Tank, where lighter silt and clay material is removed in the overflow and sent to the Residue Tank, while the heavier sand particles are returned to Slurry Holding Tank No. 1, which feeds the Desanding Units. The primary sand separation step ensures a higher sand content (and lower content of fines) in the sediment flowing to these Desanding Units. Removal of the sand increases plant uptime and efficiency because the sand is abrasive and causes heavier wear on a system, particularly one such as this, which is scheduled to operate for several years. Less maintenance and downtime should result from removal of the sand.
- The sediment processing plant will incorporate two parallel fine sand separation systems that can be operated independently of one another.
- Pre-thickeners and filter presses will be cross linked so that each pre-thickener can be serviced and maintained with minimal overall plant capacity loss.
- The maximum hydraulic plant load will be able to be handled using three of the four pre-thickeners.
- The pre-thickeners will feed two separate filter presses, providing the ability to clean and repair each press without having to shut down additional equipment.
- At all locations in the system where pumps, tanks, and pipes could plug with debris and/or settled sand, a proven jet water system will be installed to enable plant operators to unplug and restart the system.
- The sediment processing plant will be equipped with automatic PLC systems, to allow for automatic adaption to changing process situations. At critical points,

cameras will be installed to enable the operators to regularly check these points through the use of television monitors in the control room.

- An easily accessible cleaning water system and a sewer system for management of runoff water will be incorporated into the RD. In each shift, extra personnel are anticipated to keep up with plant cleaning and housekeeping activities.
- Operations and maintenance plans will be developed for the sediment dewatering plant and WTP, to describe all required routine maintenance work to be performed throughout the plant environment and the schedule for performing this maintenance.

5.4.7 Physical Characteristics of Processed Material

Sand separated through the various process stages will be dewatered using dewatering screens prior to stacking. The anticipated physical characteristics of the sediment during the dewatering process are as follows:

- On the conveyor, the water content is expected to be between 15 and 20 percent by weight.
- Free water in the segregated sand will gravity drain and will be redirected to the dewatering plant through the staging area drain system. The actual water content at the time of transport is dependant on the total sand storage (and drainage) time as well as the grain size distribution.
- Under normal circumstances, water content of the sand ready for transport will be less then 15 percent by weight.
- With all sand separation stages in place, the cake from the filter presses is expected to have a solid content of approximately 50 to 55 percent by weight. This material can be described as a firm filter cake, and will be ready for transport and disposal at the designated landfill facility immediately after production.
- Without beneficial reuse of the (fine) sand and an optional higher cut-point, the solid content of the filter cake may increase, up to approximately 60 percent by weight.

Table 5-3 summarizes the estimated quantities of processed sediment material anticipated to be generated through the dewatering system.

Table 5-3
Estimated Daily Sediment Dewatering Production

Material	Production Based on Average Sediment Composition
Average Sand and Gravel Production	60 tons/hr or 1,440 tons/day
Average Filter Cake Production	70 tons/hr or 1,680 tons/day
Peak Sand and Gravel Production	115 tons/hr or 2,760 tons/day
Peak Filter Cake Production	130 tons/hr or 3,120 tons/day
Total Average Output	3,300 tons/day
Total Peak Output	6,000 tons/day

Notes:
1. Total outputs include output of sand plus filter cake.
2. "Average" output is estimated based on the average sediment composition observed in composite samples obtained by Boskalis Dolman in the fall of 2007; see Table 5-6.
3. Outputs shown are on a "per day" basis.

5.4.8 Preliminary Mass Balances

A preliminary mass balance was developed for the sediment and water processed with the equipment designed for the OUs 2 to 5 RA as outlined above. Tables 5-4 through 5-6 summarize six different mass balances for dewatering equipment sizing calculations based on the physical properties of six composite samples collected by Boskalis in 2007. As noted in Section 2.5.2, the grain size distribution analysis method used by Boskalis varied from that used during the RD. Therefore, additional sediment data collection is planned for 2008 to refine the definition of physical properties and revise these preliminary mass balance calculations, as appropriate. The updated mass balances, process flow diagrams, certain equipment specifications, and operations and maintenance plans will be incorporated into the 2009 RA Work Plan.

As discussed previously in Sections 4.2.3.1 and 5.4.2, the sediment desanding and dewatering plant is sized to accommodate a maximum flow rate of 250 in situ cy per hour of sediment, or about 14 percent higher than the anticipated maximum operating flow rate of 220 in situ cy per hour coming from the three hydraulic dredges. The 250 in situ cy per hour is considered a maximum solids flow rate for the sediment processing system. Note: the capacity of all equipment shown on Figure 5-3 and listed in Table 5-2 were sized based on the mass balance presented in Tables 5-4 through 5-6. Based on the dredging production rates provided in Table 4-1, the estimated production for the two 8-inch hydraulic dredges operating at 65 percent uptime in OUs 2 and 3 and the 12-inch dredge operating at 80 percent uptime (likely to be the maximum uptime per J.F.

Brennan) will be approximately 220 in situ cy per hour. Additionally, the Tetra Tech Team will have the ability to temporarily modify dredge production rates based on available dewatering plant capacity. Throughput of the dewatering plant will be closely monitored and frequent communication will be maintained with the dredge operators to control solids flow into the system. The material derived from mechanical dredging operations, which will be limited and sporadic, will be fed into the system during periods when the system is operating at less than maximum production (e.g., during hydraulic dredging downtime because of required movement or maintenance).

Table 5-4
Preliminary Mass Balance for Site Process Water

	Composite Number						Average	Total
	1	2	3	4	5	6		
Total estimated in situ sediment volume per composite (m^3)	106,000	70,000	500,000	430,000	1,150,000	317,000		2,573,000
	4%	3%	19%	17%	45%	12%		100%
In situ Material Characteristics								
Dry solids, %, in situ	45.7%	31.9%	57.1%	59.9%	40.8%	69.0%	50.7%	
Organics, % of dry solids, in situ	9.8%	15.7%	9.1%	6.2%	12.8%	5.7%	9.9%	
Specific Gravity, mtons/m^3	2.52	2.45	2.53	2.57	2.48	2.58	2.52	
Density, mtons/m^3 in situ	1.38	1.23	1.53	1.58	1.32	1.73	1.46	
Particle size distribution conform BRAUN 2007								
Total Sand (+63 micron)	58.6%	31.4%	66.1%	81.8%	42.6%	89.6%	61.7%	
Coarse Sand (+150 micron)	30.8%	18.6%	27.8%	51.5%	11.6%	52.7%	32.2%	
Fine Sand (+63 - 150 micron)	27.8%	12.8%	38.3%	30.3%	31.0%	36.9%	29.5%	
Process Design Characteristics Dredging and Desanding								
Design capacity, cy/hr in situ	250	250	250	250	250	250	250	
Design capacity, m^3/hr in situ	191	191	191	191	191	191	191	
Total Volume Input in gpm	6,000	6,000	6,000	6,000	6,000	6,000	6,000	
Total Volume Input in m^3 per hour	1,368	1,368	1,368	1,368	1,368	1,368	1,368	
Process Input Characteristics								
Input solids per hour in mtds/hr	121	75	167	181	103	228	146	
Input organics in mtds/hr	12	12	15	11	13	13	13	
Input minerals in mtds/hr	109	63	152	169	90	215	133	
Total Sand Load (+63 micron) in mtds/hr	64	20	100	139	38	193	92	
Coarse Sand Load (+150 micron) in mtds/hr	34	12	42	87	10	113	50	
Fine Sand Load (+63 - 150 micron) in mtds/hr	30	8	58	51	28	79	43	
Fine Minerals Load in mtds/hr	45	43	51	31	52	22	41	
Organics in mtds/hr	12	12	15	11	13	13	13	
Total Residue Load (Fine + Organics) in mtds/hr	57	55	67	42	65	35	53	
Total Process Volumes (maximized)								
Total Flow in m^3/hr	1,368	1,368	1,368	1,368	1,368	1,368	1,368	
Total Flow Solids in mtds/hr	121	75	167	181	103	228	146	
Total Flow Solids Volume in m^3/hr	48	31	66	70	42	89	57	
Total Flow Water Volume in m^3/hr	1,320	1,337	1,302	1,298	1,326	1,279	1,311	
Total Flow Mixture Density in mton/m^3	1.053	1.032	1.074	1.081	1.045	1.102	1.065	

Table 5-5
Equipment Load Summary Analyses

Equipment Loads (SI units)

m^3/hr to desanding	500	500	1,000	1,000	500	1,000

Slurry Tank 1

Composite	1	2	3	4	5	6
m3/hr	1,368	1,368	1,368	1,368	1,368	1,368
tds/hr	121	75	167	181	103	228
% solids	8%	5%	11%	12%	7%	15%
ton/hr	1,441	1,412	1,469	1,478	1,430	1,508
ton/m3	1.05	1.03	1.07	1.08	1.05	1.10

Slurry Tank 2

Composite	1	2	3	4	5	6
m3/hr	1,500	1,500	1,500	1,500	1,500	1,500
tds/hr	243	116	217	249	176	323
% solids	15%	7%	13%	15%	11%	19%
ton/hr	1,647	1,569	1,631	1,652	1,605	1,698
ton/m3	1.10	1.05	1.09	1.10	1.07	1.13

Thickener Cyclone 63 micron

Composite	1	2	3	4	5	6
m3/hr	1000	1000	500	500	1000	500
tds/hr	162	77	72	83	117	108
% solids	15%	7%	13%	15%	11%	19%
ton/hr	1,098	1,046	544	551	1,070	566
ton/m3	1.10	1.05	1.09	1.10	1.07	1.13

Cyclones 150 micron

Composite	1	2	3	4	5	6
m3/hr	500	500	1,000	1,000	500	1,000
tds/hr	81	39	145	166	58	215
% solids	15%	7%	13%	15%	11%	19%
ton/hr	549	523	1088	1101	535	1132
ton/m3	1.10	1.05	1.09	1.10	1.07	1.13

Classifier 150 micron

Composite	1	2	3	4	5	6
m3/hr	169	138	185	243	138	281
tds/hr	35	13	47	89	13	116
% solids	18%	9%	22%	30%	9%	33%
ton/hr	190	145	214	298	146	352
ton/m3	1.13	1.05	1.15	1.22	1.06	1.25

Dewatering Screen

Composite	1	2	3	4	5	6
m3/hr	44	16	55	114	14	148
tds/hr	31	11	40	82	10	106
% solids	50%	50%	50%	50%	50%	50%
ton/hr	63	22	79	164	20	213
ton/m3	1.43	1.42	1.43	1.44	1.43	1.44

Slurry Tank 3

Composite	1	2	3	4	5	6
m3/hr	603	614	1,098	1,076	615	1,063
tds/hr	51	28	107	88	49	114
% solids	8%	4%	9%	8%	8%	10%
ton/hr	634	630	1163	1130	644	1133
ton/m3	1.05	1.03	1.06	1.05	1.05	1.07

Thickener cyclone 63 micron

Composite	1	2	3	4	5	6
m3/hr	250	250	250	250	250	250
tds/hr	22	11	24	21	21	27
% solids	8%	4%	9%	8%	8%	10%
ton/hr	263	256	265	263	262	267
ton/m3	1.05	1.03	1.06	1.05	1.05	1.07

Cyclones 63 micron

Composite	1	2	3	4	5	6
m3/hr	500	500	1,000	1,000	500	1,000
tds/hr	45	21	98	82	41	109
% solids	8%	4%	9%	8%	8%	10%
ton/hr	527	513	1,059	1,050	525	1,067
ton/m3	1.05	1.03	1.06	1.05	1.05	1.07

Classifier 63 micron

Composite	1	2	3	4	5	6
m3/hr	163	133	205	202	156	241
tds/hr	31	9	61	59	26	87
% solids	17%	7%	25%	25%	15%	30%
ton/hr	182	138	242	238	171	294
ton/m3	1.11	1.04	1.18	1.18	1.10	1.22

Dewatering screen 63 micron

Composite	1	2	3	4	5	6
m3/hr	39	11	77	76	32	113
tds/hr	28	7	55	55	23	82
% solids	50%	50%	50%	50%	50%	50%
ton/hr	57	15	110	109	46	163
ton/m3	1.43	1.42	1.43	1.44	1.43	1.44

Residue Tank

Composite	1	2	3	4	5	6
m3/hr	1,849	1,872	1,829	1,778	1,864	1,778
tds/hr	60	56	69	38	68	38
% solids	4%	3%	4%	2%	4%	2%
ton/hr	1,710	1,730	1,695	1,626	1,729	1,626
ton/m3	0.93	0.92	0.93	0.91	0.93	0.91

Pre-thickener Tank

Composite	1	2	3	4	5	6
m3/hr	1,849	1,872	1,829	1,778	1,864	1,778
tds/hr	60	56	69	38	68	38
% solids	4%	3%	4%	2%	4%	2%
ton/hr	1,710	1,730	1,695	1,626	1,729	1,626
ton/m3	0.93	0.92	0.93	0.91	0.93	0.91

Equipment Loads (Common units)

gpm to desanding	2,203	500	1,000	1,000	500	1,000

Slurry Tank 1

Composite	1	2	3	4	5	6
gpm	6,026	6,026	6,026	6,026	6,026	6,026
(short-)tds/hr	133	83	184	199	114	252
% solids	8%	5%	11%	12%	7%	15%
(short-)ton/hr	1,588	1,557	1,619	1,630	1,576	1,662
(short-)ton/cy	0.89	0.87	0.91	0.91	0.88	0.93

Slurry Tank 2

Composite	1	2	3	4	5	6
gpm	6,608	6,608	6,608	6,608	6,608	6,608
tds/hr	268	128	239	275	194	356
% solids	15%	7%	13%	15%	11%	19%
(short-)ton/hr	1,815	1,729	1,798	1,821	1,769	1,871
(short-)ton/cy	0.93	0.88	0.92	0.93	0.90	0.95

Thickener Cyclone 63 micron

Composite	1	2	3	4	5	6
gpm	4,405	4,405	2,203	2,203	4,405	2,203
tds/hr	179	85	80	91	129	119
% solids	15%	7%	13%	15%	11%	19%
(short-)ton/hr	1,210	1,153	599	607	1,179	624
(short-)ton/cy	0.93	0.88	0.92	0.93	0.90	0.95

Cyclones 150 micron

Composite	1	2	3	4	5	6
gpm	2,203	2,203	4,405	4,405	2,203	4,405
tds/hr	89	43	159	183	64	237
% solids	15%	7%	13%	15%	11%	19%
(short-)ton/hr	605	576	1,199	1,214	590	1,248
(short-)ton/cy	0.93	0.88	0.92	0.93	0.90	0.95

Classifier 150 micron

Composite	1	2	3	4	5	6
gpm	744	607	817	1072	609	1239
tds/hr	39	14	52	98	14	128
% solids	18%	9%	22%	30%	9%	33%
(short-)ton/hr	209	160	236	328	161	388
(short-)ton/cy	0.95	0.89	0.97	1.03	0.89	1.06

Dewatering Screen

Composite	1	2	3	4	5	6
gpm	193	70	244	501	61	650
tds/hr	35	12	44	90	11	117
% solids	50%	50%	50%	50%	50%	50%
(short-)ton/hr	69	25	87	180	22	234
(short-)ton/cy	1.21	1.20	1.21	1.21	1.20	1.21

Slurry Tank 3

Composite	1	2	3	4	5	6
gpm	2,656	2,704	4,839	4,740	2,707	4,683
tds/hr	57	31	118	97	54	126
% solids	8%	4%	9%	8%	8%	10%
(short-)ton/hr	699	695	1,282	1,246	710	1,249
(short-)ton/cy	0.89	0.87	0.89	0.89	0.88	0.90

Thickener cyclone 63 micron

Composite	1	2	3	4	5	6
gpm	1,101	1,101	1,101	1,101	1,101	1,101
tds/hr	25	12	27	23	23	30
% solids	8%	4%	9%	8%	8%	10%
(short-)ton/hr	290	283	292	289	289	294
(short-)ton/cy	0.89	0.86	0.89	0.89	0.88	0.90

Cyclones 63 micron

Composite	1	2	3	4	5	6
gpm	2,203	2,203	4,405	4,405	2,203	4,405
tds/hr	49	24	108	91	46	120
% solids	8%	4%	9%	8%	8%	10%
(short-)ton/hr	581	565	1,167	1,158	578	1176
(short-)ton/cy	0.89	0.86	0.89	0.89	0.88	0.90

Classifier 63 micron

Composite	1	2	3	4	5	6
gpm	718	584	903	890	688	1061
tds/hr	34	10	67	65	28	96
% solids	17%	7%	25%	25%	15%	30%
(short-)ton/hr	200	152	267	263	189	324
(short-)ton/cy	0.94	0.88	1.00	0.99	0.93	1.03

Dewatering screen 63 micron

Composite	1	2	3	4	5	6
gpm	174	46	338	335	143	499
tds/hr	31	8	61	60	26	90
% solids	50%	50%	50%	50%	50%	50%
(short-)ton/hr	62	16	121	121	51	180
(short-)ton/cy	1.21	1.20	1.21	1.21	1.20	1.21

Residue Tank

Composite	1	2	3	4	5	6
gpm	8,146	8,248	8,055	7,832	8,209	7,832
tds/hr	66	61	76	42	75	42
% solids	4%	3%	4%	2%	4%	2%
(short-)ton/hr	1,885	1,907	1,869	1,793	1,906	1,793
(short-)ton/cy	0.78	0.78	0.78	0.77	0.78	0.77

Pre-thickener Tank

Composite	1	2	3	4	5	6
gpm	8,146	8,248	8,055	7,832	8,209	7,832
tds/hr	66	61	76	42	75	42
% solids	4%	3%	4%	2%	4%	2%
(short-)ton/hr	1,885	1,907	1,869	1,793	1,906	1,793
(short-)ton/cy	0.78	0.78	0.78	0.77	0.78	0.77

Table 5-6
Dewatering Equipment Sizing Analyses

Composite	1	2	3	4	5	6	Sum	Avg	Comments
Composite volume	106,000	70,000	500,000	430,000	1,150,000	317,000	2,573,000		
Part of total project volume	4.1%	2.7%	19.4%	16.7%	44.7%	12.3%	100.0%		
Necessary number of streets	1	1	2	2	1	2		1.48	
One street production, 500 m3/hr to desanding	106,000	70,000	0	0	1,150,000	0	1,326,000		
Two street production, 2x500 m3/hr to desanding	0	0	500,000	430,000	0	317,000	1,247,000		
Screening and Conditioning Unit Sizing									
Process Design Characteristics									
Design capacity, cyard/hr in situ	250	250	250	250	250	250		250	
Design capacity, m3/hr in situ	191	191	191	191	191	191		191	
Design capacity, maximal flow in gpm	6,000	6,000	6,000	6,000	6,000	6,000		6000	
Design capacity, maximal flow in m3/hr	1,368	1,368	1,368	1,368	1,368	1,368		1368	
Pre-Thickener Tank Sizing									
Process Design Characteristics									
Design capacity, cyard/hr in situ	250	250	250	250	250	250		250	
Design capacity, m3/hr in situ	191	191	191	191	191	191		191	
Sizing									
Total Flow from Sludge Tank, m3/hr	1,849	1,872	1,829	1,778	1,864	1,778		1,831	imported
Total Load from Sludge Tank, tds/hr	60	56	69	38	68	38		59	imported
Extra water from cleaning and spillage	0	0	0	0	0	0		0	already incl
Design Surface Load, m3/m2/hr	2	2	2	2	2	2		2	design value
Total necessary Tank Surface, sq meter	925	936	914	889	932	889		916	calculated
Surface per Tank, 18m diameter, in sq meter	254	254	254	254	254	254		254	calculated
Number of Pre-Thickener Tanks necessary	3.6	3.7	3.6	3.5	3.7	3.5		3.6	calculated
Filter Press Sizing									
Process Design Characteristics									
Design capacity, cyard/hr in situ	180	180	180	180	180	180		180	
Design capacity, m3/hr in situ	138	138	138	138	138	138		138	
Sizing									
Filter cake dry solids, %	52.5%	52.5%	52.5%	52.5%	52.5%	52.5%		52.5%	imported
Cake density, mtons/m3	1.447	1.447	1.447	1.447	1.447	1.447		1.447	imported
Dewatering Load Total Residue, mtds/hr	43	40	50	28	49	28		42	imported
Filter Cake Production, mtons/hr	83	76	94	53	93	53		81	calculated
Filter Cake Production, m3/hr	57	53	65	36	64	36		56	calculated
Cycle time, minutes	75	75	75	75	75	75		75	design value
Press size, m3	17.7	17.7	17.7	17.7	17.7	17.7		17.7	design value
Compression factor membrane press	1.3	1.3	1.3	1.3	1.3	1.3		1.3	design value
Capacity per press in m3 per drop	13.6	13.6	13.6	13.6	13.6	13.6		13.6	calculated
Nr of Drops per press per hour	0.8	0.8	0.8	0.8	0.8	0.8		0.8	calculated
Capacity per press in m3 per hour	10.9	10.9	10.9	10.9	10.9	10.9		10.9	calculated
Uptime factor	75%	75%	75%	75%	75%	75%		75%	design value
Net Capacity per press in m3 per hour	8.2	8.2	8.2	8.2	8.2	8.2		8.2	calculated
Number of Presses necessary	7.0	6.5	8.0	4.5	7.9	4.5		6.8	calculated

5.5 2009 Water Treatment Operations

5.5.1 Water Treatment System Overview

The water treatment system for the OUs 2 to 5 RA has been designed to provide adequate capacity for processing and treating wastewater generated by the dewatering and desanding operations and with sufficient redundancy to allow those operations to continue uninterrupted.

The treatment process design includes multimedia sand filtration, bag filtration, cartridge filtration, and GAC adsorption. Figure 5-4 presents a process flow diagram of the water treatment system, designating interconnections of the individual unit processes.

The cartridge filtration has the flexibility to be operated in two modes: 1) upstream of the GAC adsorption to enhance the solids filtration and further protect the carbon vessels from solids loading; or 2) downstream of the GAC adsorption to prevent the discharge of carbon fines to the effluent flow. The system is envisioned to operate 24 hours per day, 5 days per week, and to be staffed 100 percent of the operational time by trained and qualified WTP operators.

Water treatment will be performed through a two-stage pumping process. The first stage is from the dewatering system water buffer tanks; through the multimedia, bag, and cartridge filtration as well as the GAC adsorption; into an intermediary effluent holding tank. The second pumping stage is from the effluent holding tank through discharge piping into a multi-port diffuser located in OU 4. All piping in the first pumping stage will be Schedule 40 carbon steel. Piping in the second stage will be predominantly HDPE.

5.5.1.1 Design Flow and Influent Concentration

The water treatment system has been designed to process a peak flow of 6,000 gpm. The average flow rate is projected to be substantially less and typically range from 3,000 to 5,000 gpm. In addition, extra process pumps and process vessels have been included in the design to provide reserve capacity should any pumps or vessels need to be taken offline for maintenance.

The filtration components of the water treatment system have been designed to reduce TSS from approximately 50 ppm to nondetectable levels. The majority of PCBs and mercury are associated with the suspended solids and should be reduced as well. Activated carbon is included to remove any dissolved-phase PCBs.

5.5.2 Treatment Components

5.5.2.1 Water Transfer from Dewatering System

The water treatment system begins at the main process pumps. Although these pumps will be housed in the WTP, it is anticipated that their location will be in close proximity to the water buffer tanks located within the dewatering and desanding area. The two water buffer tanks are part of the Dewatering System Design (refer to the Dewatering and Desanding Design for a description of water buffer tanks). The WTP will have a dedicated level control system within the water buffer tanks to control the main process pumps. In addition, to prevent buffer tank overflow, the dewatering system will also have an independent level alarm acting as an interlock to the dewatering process should the water buffer tanks ever reach a high-high level condition.

The main process pumps will consist of three 150-hp Gorman Rupp end suction centrifugal pumps each capable of 3,000 gpm. Each pump motor will be controlled by an interconnected variable frequency drive (VFD). For flow rates up to 3,000 gpm, a single pump will be operated with the motor speed being controlled by a single VFD based upon maintaining a pre-set low level within the water buffer tanks. As the water level within the tank increases, indicating that the preset level cannot be maintained with a single pump in operation, a second pump will turn on so that both pumps will begin to operate in parallel. The VFDs will be linked so that both pumps will be run at the same speed when in parallel operation. The pumps will be operated in this manner for flows up to 6,000 gpm.

The third redundant pump will be installed as a reserve in case of a failure of one of the other two pumps. A single magnetic flow meter on a common discharge line will measure the total combined flow into the WTP. Appendix C presents a complete water balance and flow diagram for the water treatment system.

5.5.2.2 Multimedia Sand Filtration

Sand filtration will consist of 24 10-foot-diameter vessels with an approximate media capacity of 10,000 pounds. These vessels will be TIGG Model CS-500 or equivalent. The sand vessels will contain multimedia consisting of sand, gravel, and garnet, which will result in approximately 5-micron nominal filtration efficiency.

These vessels will be laid out in three treatment trains of eight vessels per train. Piping and valving will be arranged to allow as few or as many vessels to be online at one time. A complete treatment train can be isolated and kept in reserve or each individual vessel can be isolated as needed.

The maximum hydraulic capacity of the sand vessels will be 500 gpm each. At 6,000 gpm and 16 vessels online, the filtration rate is a maximum of 4.78 gpm/square foot, which is consistent with standard practice and within the hydraulic capacity of these vessels. Placing more vessels online (up to a total of 24) will result in increased efficiency, less frequent backwash, and reduced head loss.

As described in the process flow description in Table 5-2, water exiting the Pre-thickener Tanks will have a TSS load averaging 50 ppm. Backwash will be performed either automatically based on differential pressure or manually by the operator. Backwash supply water will be pumped from the effluent tank using dedicated backwash pumps at 15 to20 gpm/square foot equivalent to 1,175 to 1,575 gpm. Valves will be air actuated, and backwash will be called for automatically by the control system when the high differential pressure switch is actuated. Only one vessel will be backwashed at a time. Alternatively, the plant operator can initiate a backwash from either a local control panel or the system PLC. Backwash water will be returned to the dewatering facility for further processing.

5.5.2.3 Bag Filtration

Bag filtration will consist of six multi-bag filter vessels. Each vessel will contain 17 individual bag filters. These vessels will be Rosedale Model No. 42 or equivalent. Bag filter efficiency rating will be 5 micron nominal or less. Actual efficiency rating of the bag filters will be determined in the field to balance maximum filter efficiency with a reasonable operation and maintenance time for filter change-out.

The multi-bag filter vessels will be arranged in three treatment trains of two vessels each. Piping and valving will be arranged to allow any number of vessels to be operated simultaneously. An entire treatment train can be isolated and kept in reserve, or individual vessels can be isolated as needed.

The maximum hydraulic capacity of each multi-bag filter vessel is 1,700 gpm. Under normal operations, at least one of the six vessels will be offline for filter change-out. When indicated by a high differential pressure in any of the online vessels, a switch will be made to place the offline vessel with clean bag filters into operation and take the vessel with spent bag filters out of operation, allowing for bag change-out. This will be a manual vessel switchover initiated by the operator; however, a high differential pressure switch on each vessel will activate an annunciator on the PLC to notify the operator that a switch over is required.

5.5.2.4 Cartridge Filtration

Cartridge filtration will consist of three high-flow cartridge filter vessels. Each vessel will contain seven individual cartridge filters. These vessels will be Cuno Model No. 7HF60H or equivalent. Cartridge filter efficiency ratings will range from 1 to 70 microns, absolute. Actual efficiency ratings of the cartridge filters will be determined in the field to balance maximum cartridge filter efficiency with a reasonable operation and maintenance time for filter change-out.

The cartridge filter vessels will be arranged in three treatment trains of one vessel each. Each vessel will be rated for a maximum hydraulic flow of 3,500 gpm. Any number of cartridge filter vessels can be operated simultaneously, or individual filter vessels can be isolated as needed. In addition, piping and valving will be arranged to allow the cartridge filters to be operated either upstream or downstream of the activated carbon adsorbers.

Under normal operations, at least one of the three vessels will be offline for filter change-out. When indicated by a high differential pressure in any online cartridge filter vessel, a manual switch will be implemented to put the offline vessel with new cartridge filters into operation and take the vessel with spent cartridge filters out of operation for change-out. This will be a manual vessel switchover initiated by the operator; however, a high differential pressure switch on each vessel will activate an annunciator on the PLC to notify the operator that a switchover is required.

5.5.2.5 Granular Activated Carbon Adsorption

The activated carbon process will consist of nine dual-unit carbon adsorbers. Each dual-unit carbon adsorber consists of two vessels containing 20,000 pounds of carbon each and can be operated in parallel or series. Each dual-unit is rated for a maximum hydraulic capacity of 1,400 gpm in parallel or 700 gpm in series.

Series Operation

The carbon adsorption system has been sized to run in series at the peak design flow rate of 6,000 gpm. Series operation has the advantage of being able to monitor for breakthrough of contaminants at the midpoint between the primary and secondary vessels. In the case of breakthrough of the primary carbon vessel, the breakthrough will be detected and a change-out of the primary carbon vessel can be initiated. Contaminants that break through the primary vessel will be captured on the secondary vessel instead of being discharged to the river.

At the peak design flow of 6,000 gpm, all nine dual units can be operated in series. At lower flows, units can be taken offline and put into reserve, or alternatively all nine dual units can be operated at lower flow rates increasing the contact time and performance.

Backwash

The carbon adsorbers will be piped and valved to allow the vessels to be manually backwashed if it becomes necessary due to solids loading. Differential pressure will be measured at each carbon vessel, and a high differential pressure switch will activate an annunciator on the PLC to notify the operator that a backwash is required. When indicated by a high differential pressure in any carbon vessel, the operator will manually switch the valving and operate the backwash pump to initiate a backwash. Backwash water will be returned to the dewatering system for further treatment.

Carbon Change-out

If it becomes needed, carbon change-out can be conducted using either dry carbon delivered in 1,100-pound super sacks or by means of carbon/water slurry delivered in a 20,000-pound load by a tractor trailer unit. The layout of the carbon vessels has been designed so that a tractor trailer unit can approach to within 20 feet or less of each dual carbon vessel unit. Using the carbon slurry method, pressurized air will be used to push the spent carbon out of the vessel and into a waiting empty tractor trailer unit for off-site regeneration or disposal. New carbon from a second tractor trailer will then immediately push material into the empty carbon vessel.

5.5.2.6 Effluent Tanks, Effluent Pumps and Discharge Diffuser

Subsequent to filtration and carbon adsorption, the treated water will enter a 260,000-gallon effluent holding tank. The effluent holding tank will be a Modutank Model MS4920 ModuStor or equivalent and will be an approximately 49-foot-diameter by 20-foot-high bolted steel tank with a 45 mil polypropylene reinforced liner. The tank will be housed inside the WTP.

Treated water will be pumped from the effluent holding tank into a 12-inch-diameter HDPE discharge line where it will be transported approximately 2,000 feet to a submerged multi-port diffuser for discharge into OU 4 of the Lower Fox River.

Discharge pumping will be performed by three Gorman Rupp 100-hp (Model VGH8D31-B) or equivalent end suction centrifugal pumps. The pumps will be controlled based upon level switches in the effluent holding tank. For flows up to 3,000 gpm, a single pump will be operated with the pump on/off cycling being controlled by high and low level switch. As the level within the tank increases above the high level switch and cannot be maintained with a single pump in operation, a second pump will turn on upon the level reaching a high-high level switch so that both pumps will begin to operate in parallel. Pumping will return to single pump operation upon the level reaching a low level switch. A high level interlock will shut the system down and prevent tank overflow.

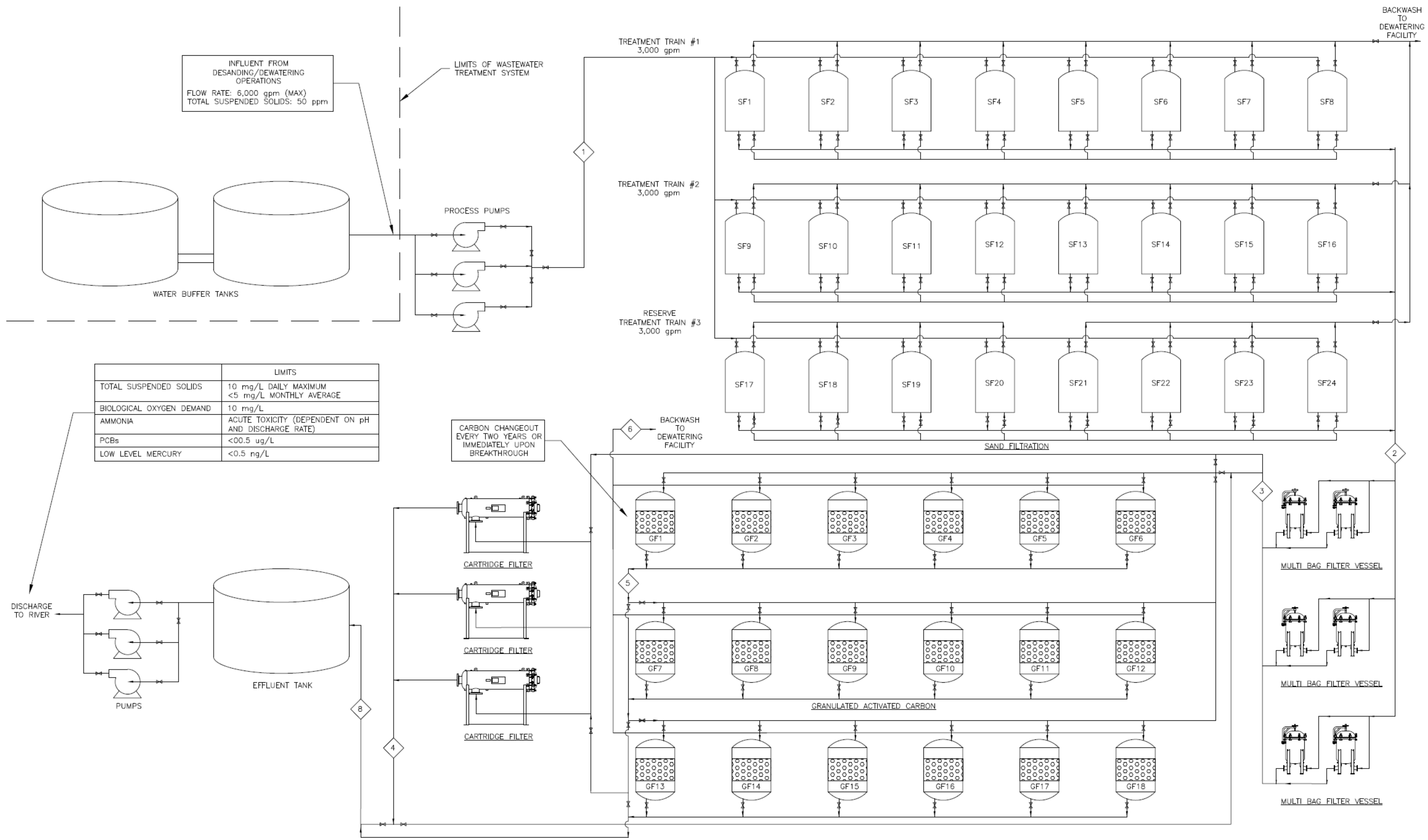
5.5.2.7 Instrumentation Description

The components of the water treatment system will be monitored by appropriate instrumentation. Each of the 24 sand filters, 6 bag filters, and 3 cartridge filters will be equipped with local pressure indicators and differential pressure transmitters. The differential pressure transmitters will include a high pressure cutoff switch and communicate with the plant control system. The GAC adsorber units will be monitored by local pressure indicators and differential pressure transmitters, similar to the filters.

Additional instrumentation will provide real time monitoring of pH and TSS on the effluent water line. These data will be transmitted to the control system.

Indicating flow totalizers will track current and cumulative flow at the influent and effluent water lines.

The water treatment system effluent will be monitored for the contaminants of concern as identified in the discharge criteria. This monitoring will be accomplished through the monitoring of real-time data for pH and TSS as well as collection of effluent water samples using an ISCO flow proportional auto sampler. The samples will be analyzed by the on-site analytical laboratory for PCBs, mercury, biochemical oxygen demand (BOD), and ammonia.



	LIMITS
TOTAL SUSPENDED SOLIDS	10 mg/L DAILY MAXIMUM <5 mg/L MONTHLY AVERAGE
BIOLOGICAL OXYGEN DEMAND	10 mg/L
AMMONIA	ACUTE TOXICITY (DEPENDENT ON pH AND DISCHARGE RATE)
PCBs	<00.5 ug/L
LOW LEVEL MERCURY	<0.5 ng/L

WTP Mass Balance

Parameter	1	2	3	4	5	6	7	8
Max Water Flow Rate (gpm)	6000	6000	6000	6000	6000	281	NA	5719
Total Suspended Solids (mg/L)	50	10	2	0	0	0	0	0
PCBs (ug/L)	NA	NA	NA	5	0	0	0	0
pH (S.U.)	NA	NA	NA	NA	NA	NA	NA	NA
Ammonia (mg/L)	NA	NA	NA	NA	NA	NA	NA	NA
BOD (mg/L)	NA	NA	NA	NA	NA	NA	NA	NA
Hg (ng/L)	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
NA Data Not Available
0 indicates "non-detectable levels"

Discharge Criteria
10 mg/L (daily maximum) 5mg/L (monthly average)
0.5 ug/L
6-9 S.U.
8.41 mg/L times dilution ratio
867 lbs/day
0.5 ng/L

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Figure 5-4
Process Flow Diagram of Water Treatment System
Lower Fox River – OUs 2 to 5

5.5.2.8 Control System Description

The WTP will be controlled by a PLC-based digital and analog control system, as shown above. Monitoring instrumentation, such as pressure, level, and flow transmitters, valve position transmitters, and pump signals will communicate with a PLC. In turn, the information in the PLC is made available to the operator via a human-machine interface (HMI) program. By using this program, the status of the WTP can be displayed in real time in an easily understood series of graphical and tabular screens to the plant operator.

The HMI also has the capability of accepting operator commands, such as starting or stopping a pump, by simple mouse clicks or touch screen points. These commands are communicated back to the PLC, which then issues the appropriate commands to the plant equipment.

Process set points, such as maximum flow rates, high or low tank levels, or acceptable pressure ranges, will be defined in the programming. This ensures that the plant will operate within normal parameters. If any of the monitored parameters moves out of the normal operating limits, the plant operator will be immediately notified, and corrective actions can be taken.

Logging and trending capabilities are available in the HMI. This information can be used to optimize the operation of the facility and is often used in documenting operation for regulatory purposes.

The control system will be on uninterruptible power supplies. Should a loss of power occur, the control system will be operational long enough to assist in a sequential and controlled shutdown of the plant.

5.5.3 Effluent Performance Standards

Per discussion with the WDNR-Northeast Region Wastewater Engineer of the Lakeshore Basin Team, OU 1 effluent performance standards are applicable to the OUs 2 to 5 treated wastewater discharge for all parameters except for ammonia and BOD, which are dependent on pH and flow rate, respectively. If necessary, WDNR may be willing to work with Tetra Tech to "fine tune" the treatment process/discharge rate to attempt to better meet the performance standards.

Ammonia: WDNR has developed ammonia limits for various effluent pH levels, and has forwarded a spreadsheet to Tetra Tech that contains the associated Daily Maximum NH_3 criteria and limits based on effluent pH. The NH_3 criterion are typically used to calculate the Daily Maximum NH_3 Performance Expectation (a substantive regulatory requirement) when applying the ZID. The Daily Maximum NH_3 Performance Expectation equals the dilution ratio (receiving water:effluent) times the criterion.

An effluent pH value of 8.0 has been recommended by the WDNR for designing appropriate effluent discharge equipment as a reasonable assumption for the OUs 2 to 5 RA. This value is consistent with similar design calculations and data collected during the recent Phase 1 project (Shaw et al. 2008). Based on the recommended pH of 8.0, the NH_3 Criterion was calculated to be 8.41 mg/L using the spreadsheet provided in Appendix C-0 with the WTP design drawings.

Recent dredging projects performed on the Fox River, Phase 1 and OU 1, utilized a ZID of 30:1 and 24:1, respectively. Tetra Tech anticipates that a similar dilution ratio will be applied for the OUs 2 to 5 RA. Once the ZID is determined during subsequent RD, the Daily Maximum NH_3 Performance Expectation will be calculated. As noted above, the Daily Maximum NH_3 Performance Expectation is calculated by multiplying the dilution ratio times the NH_3 Criterion. For example, assuming a dilution ratio of 10:1, the NH_3 Performance Expectation equals 10 times 8.41 mg/L, or 84.1 mg/L.

Biochemical Oxygen Demand*:* Discharge data from the Phase 1 project conducted in 2007 indicates a maximum BOD level of 12 mg/L (Shaw et al. 2008). Using this maximum measured value from the Phase 1 project, which utilized a similar water treatment system, and the anticipated flow rate of 6,000 gpm for the OUs 2 to 5 project, an equivalent daily maximum limit of 867 pounds/day was estimated. Waste load allocation transfer is described in Section 5.5.5.

5.5.3.1 Diffuser Modeling

Dispersion due to the treatment plant diffuser (i.e., under the current design) in the Fox River will be predicted using EPA UDKHDEN modeling software. This is a software system for the analysis and prediction of aqueous toxic or conventional pollutant discharges into diverse water bodies. EPA UDKHDEN will be used to evaluate the impact of the existing diffuser on the river. It is anticipated that a low flow 7Q10 ambient flow condition will be used. Alternatively, a range of ambient stream flow conditions can be evaluated (e.g., minimum, maximum, and average).

Based on the existing diffuser configuration (assumed to be a multiport diffuser), ammonia concentrations and ammonia toxicity will be evaluated. Levels will be compared to allowable mixing zone requirements. EPA UDKHDEN simulations will be used to estimate at what depth full vertical mixing is occurring from the diffuser. In the event that mixing zone requirements are not met, different diffuser configurations can be tested.

5.5.4 Effluent Discharge Monitoring Requirements

Information regarding effluent discharge monitoring requirements is presented in the CQAPP in Appendix D.

5.5.5 Waste Load Allocation Transfer

WDNR regulations require dischargers of BOD to the Lower Fox River to limit discharge to maintain waste load allocations, which are based on daily maximums in units of pounds per day. The WDNR-Northeast Region Wastewater Engineer of the Lakeshore Basin Team has requested that the OUs 2 to 5 project obtain waste load allocations to support any BOD discharge from the project; specifically, WDNR has suggested that Tetra Tech utilize a portion of the Georgia-Pacific mill's waste load allocation for BOD discharge, since the mill uses only a few percent of the total BOD allocation in its wastewater discharge permit from the WDNR. WDNR stated that the mill's permit does not require formal modification.

The Respondents do not agree that the requirement to obtain waste load allocations is a substantive requirement with which the project must comply; instead, the Respondents believe that the waste load allocation requirement is a procedural mechanism designed to ensure that water quality standards are met. Nonetheless, the Tetra Tech Team will use reasonable efforts, in conjunction with Georgia-Pacific's mill, to develop a "Letter of Agreement" for submittal to the WDNR. The purpose of the letter would be to document that the mill agrees to allow the wastewater discharge from this project to utilize a portion of the mill's waste load allocation for BOD.

5.6 2009 Transport and Disposal of Dewatered Sediment and Debris

5.6.1 Introduction

This section discusses the traffic planning for outgoing materials and wastes for the project.

All trucking will be in accordance with Wisconsin and Department of Transportation (DOT) regulations. Drivers and trucks hauling hazardous materials will be in compliance with the additional requirements related to hauling those materials.

Trucks hauling materials in or away from the site will abide by restrictions for truck traffic and will travel on approved truck routes.

If trucking is performed by subcontractors, the subcontractors will be evaluated for safety and past DOT compliance. Tetra Tech will oversee subcontractor activities and will perform truck inspections.

5.6.2 General Traffic Controls

The project will work with the appropriate city and county authorities to mitigate the effects of the project trucks on the local highways and roads. Since the trucks will be traveling on currently designated truck routes, no additional controls are expected for the majority of the roadways. Local areas at the Little Rapids staging facility and the former Shell property will be the most affected. To make current users aware of the new and later increasing traffic, "Truck Entering" signs will be provided, if requested. The facility roads will also be designed to provide space for trucks to fully exit the highway before stopping for gates or other vehicles to prevent trucks standing on the highways.

The project will also work with the authorities to determine if any additional actions are required.

Traffic at the former Shell property and the Little Rapids staging facility will be controlled with typical traffic control signs (stop, yield, directional, etc). Traffic planning will include use of one-way traffic whenever possible, providing off-road areas for turning, etc., to eliminate the need for trucks to backup. Figure 3-3 shows traffic flow patterns at the former Shell property. The access to the Little Rapids site has not been completed at this time but would be similar to the stockpile areas at the former Shell property.

Truck scales will be available at the former Shell property staging and material processing facility for weighing trucks for operational safety and for manifesting purposes.

All TSCA waste trucks will be manifested in accordance with DOT requirements. All non-TSCA trucks will be weighed and provided a bill of lading for tracking and accounting purposes. Prior to shipping of any TSCA wastes, the project will notify the appropriate state and USEPA officials.

All trucks that will be transporting waste will be externally cleaned and tarped or covered. Truck bodies will be tight with no leakage from the contents allowed.

5.6.3 Truck Cleanliness and Decontamination

Trucks leaving the former Shell property with waste will be externally clean. As part of the loading process, trucks will pass through a truck wheel wash station. Any spillage elsewhere on the vehicle will be cleaned prior to the truck being released from the site.

To prevent tracking of materials across the site or onto public areas, the areas will be maintained to minimize mud in the loading and haul routes. Roads will be hard surfaced and will be washed and or swept on a regular basis.

Trucks hauling TSCA or other wastes will not be allowed to haul other materials without a thorough decontamination of the interior of the truck bed. Trucks being released from waste hauling to other work will be decontaminated on the former Shell property decontamination pad. During hauling operations of this material, the trucks will be covered and have sealed tailgates to minimize the possibility of any potential release. Truck beds will be lined with Teflon, plastic liner, or other acceptable non-stick material to enhance dumping of the filter cake at the landfill

5.6.4 OU 4 Former Shell Property Staging and Material Processing Facility Outbound

5.6.4.1 Non-TSCA Materials

The dredged materials will be treated, and excess moisture removed and disposed of, either at a non-TSCA landfill (see Section 5.6.7) or for beneficial reuse.

The following assumptions are used: Operations: 5 days per week, 24 hours per day process operations for approximately 7 months per year (April 15 through November 15). Trucks are assumed to carry 20 tons per load in accordance with WDOT regulations.

The dredging and subsequent process treatment is expected to generate the following amounts of material shown in Table 5-7.

Table 5-7
Estimated Daily Sediment Dewatering Production

	Production Based on Average Sediment Composition	Average Truck Loads Per Day (20 tons per load)
Average Sand and Gravel Production	60 tons/hr or 1,440 tons/day	72 loads per day
Average Filter Cake Production	70 tons/hr or 1,680 tons/day	84 loads per day
Peak Sand and Gravel Production	115 tons/hr or 2,760 tons/day	138 loads per day
Peak Filter Cake Production	130 tons/hr or 3,120 tons/day	156 loads per day
Total Average Output	3,300 tons/day	165 loads per day
Total Peak Output	6,000 tons/day	300 loads per day

1. Total outputs include output of sand plus filter cake and are shown are on a "per day" basis
2. "Average" output is estimated based on the average sediment composition observed in composite samples obtained by Boskalis Dolman in the fall of 2007.
4. The sediment dewatering plant and associated storage (2 days of storage capacity for filter cake under roof) have the ability to even out peaks and valleys in sediment flowrate, to some extent, and minimize swings in filter cake production. The number of trucks can be increased or decreased through communication with the subcontractor. Details will be provided in the Traffic Control Plan, which will be provided as part of the 2009 RA Work Plan.

During 2009, approximately 220,000 ± 40,000 tons of non-TSCA filter cake will require disposal. The filter cake after leaving the presses will be conveyed in to stockpiles within the sediment processing building to await loading onto disposal trucks. The material will be loaded onto the trucks with a wheeled loader. The number of trucks scheduled will be increased or decreased, as needed, based on anticipated increases or decreases in production. A Traffic Control Plan will be provided as part of the 2009 RA Work Plan.

Sand and gravel materials segregated from the dredge slurry may be stockpiled outside the sediment processing building, in a bermed area constructed with low permeability materials, while awaiting characterization. The SWPPP includes best management practices for control of surface water from these storage areas. The material may be reused provided it satisfies regulatory requirements. If the materials are reused, they will be trucked and stockpiled at those locations/facilities as the material is generated by the treatment process. Additional information can be found in the Beneficial Use Section 5.6.6 of this report. Stormwater runoff from the sand storage stockpiles will be initially characterized and appropriately managed in accordance with the SWPPP.

5.6.4.2 TSCA Wastes

TSCA wastes (delineated as described in Section 2.5.4) are expected to be generated and will require disposal. While on the former Shell property, these materials will be stored in accordance with TSCA storage requirements within the sediment processing building. After leaving the filter presses, the dewatered filter cake will be conveyed to stockpiles within the sediment processing building to await loading onto disposal trucks. The material will be loaded onto the trucks with a wheeled loader.

Currently it is estimated that 30,000 to 35,000 tons of filter cake will be TSCA controlled and require disposal during 2009 in a TSCA permitted landfill. Given the distance to potential TSCA disposal facilities (see Section 5.6.7), some on-site storage of TSCA wastes will likely be necessary at the former Shell property staging area; however, this is not anticipated to exceed 30 days, and trucking will continue at the end of each dredging season after dredging and processing have been completed until all wastes have been removed.

It is currently estimated, based on sediment sampling, that up to 1,800 trucks (at 20 tons per truck) of TSCA filter cake wastes will require disposal in 2009.

5.6.4.3 River Debris

Debris in the river within the dredging management units and capping management units that interferes with the dredging and/or capping process will be removed, to the extent practicable, using a barge and excavator. Non-TSCA and TSCA debris will be kept separate. Debris will be segregated into porous and non-porous categories. Porous debris from non-TSCA dredge areas will be disposed of as non-TSCA waste and porous debris from TSCA dredge areas will be disposed of as TSCA waste since porous debris can not be decontaminated. All non-porous debris will be decontaminated in accordance with Section 02 81 00 of the Project Plan in Appendix C, Attachment C-0. Non-porous materials with surface PCB concentrations of less than 100 µg per 100 square centimeters based on wipe sampling of surfaces after decontamination may be disposed as non-TSCA waste, subject to Response Agency approval. Non-porous materials with surface PCB concentrations of 10 µg per 100 square centimeters or less based on wipe sampling of surfaces after decontamination may be released for unrestricted use and will be recycled, subject to Response Agency approval. The standard wipe test per 40 CFR 761.123 will be used. Based on work at other similar sites, the majority of the non-porous debris is expected to be disposed as non-TSCA waste or to be recycled. Debris greater than 1 cy will be resized as required by the non-TSCA landfill disposal contract. Debris and recyclable material will be staged and containerized in designated areas at the former Shell property staging facility prior to shipment off-site for disposal or recycling. Any wastewater generated by decontamination operations will be processed by the WTP.

There is no estimate at this time on the amount of debris that may be removed.

5.6.5 OUs 2 and 3 Little Rapids Staging Area

5.6.5.1 Outbound TSCA Wastes

No TSCA waste will be processed at the Little Rapids staging facility.

5.6.5.2 Non-TSCA Outbound Wastes

Site preparation will generate broken concrete, brick, trees, and brush debris. This material will be disposed of as non-TSCA wastes at a local landfill. No other wastes are expected.

5.6.6 Beneficial Use Considerations

Beneficial reuse is defined as the reuse of dredge material (or some portion of it) as a resource instead of disposing of it as a solid waste. This involves using the dredge material in a productive manner, such as habitat creation or restoration, landscaping, soil/material enhancement, construction fill, or land reclamation. The benefits can be derived from the dredge material itself or from the placement of it on a site. By definition, beneficial reuse does not include disposal into a landfill or other permitted facility such that disposal capacity is used by the material. In order to meet the definition of beneficial reuse, the material has to have some benefit for construction or operation, or allowing for facility expansion.

Dredge material can have significant value if applied for beneficial reuse. These benefits can be realized through planning and coordination between the regulatory agencies, potential users of sand, and other interested stakeholders. Selecting the most appropriate beneficial reuse alternative for the sand requires an evaluation of the physical and chemical characteristics of the material, defining how the material can be safely used, and understanding how various stakeholders interests can be integrated into the project.

Approximately 1,372,000 tons of sand may be generated through the dredging, desanding, and dewatering process. Desanding and beneficial use volumes will continue to be refined throughout the project.

5.6.6.1 Beneficial Reuse Suitability Criteria

The suitability of separated sand for beneficial reuse will be evaluated on a case-by-case basis using the guidance and criteria below.

Dredge material is regulated as solid waste in Wisconsin. WDNR approval of the beneficial use of separated sand under a Wisconsin Statue 289.43 low hazard exemption will be requested.

Initial suitability of material for beneficial reuse will be determined by the PCB concentration thresholds in the separated sand, as described in Table 5-8.

Table 5-8
Initial Suitability Criteria for Beneficial Reuse

Sand PCB Concentration	Action to be taken
PCB > 1.0 ppm	Need to determine reuse potential
PCB < 1.0ppm	Can be used for beneficial reuse
PCB > 0.25 ppm	Requires capping or covering
PCB < 0.25 ppm	Does not require capping or covering
PCB < 0.05ppm	Unrestricted reuse

Additional beneficial reuse suitability requirements include:

- Any proposed beneficial reuse alternative for the sand would be in a non-residential setting, thereby minimizing direct contact.
- Any proposed beneficial reuse project would need to meet the NR 500 performance standards of not causing an adverse effect on wetlands, surface water, groundwater, or endangered/threatened species.
- No other chemical parameters are present at levels of concern, and physical parameters are defined. These parameters are an abbreviated list of NR 347 parameters (see Table 5-9).
- The contaminant concentration in NR 538 will be used as a guideline for deciding if this sand would need to be covered, and if so, whether it would require covering with clean soil or some sort of capping soil.
- Sand with PCB concentrations greater than 0.25 ppm would require some sort of capping or covering.
- Sand with PCB concentrations of less than 0.25 ppm would generally not require any sort of capping.

- Sand with PCB concentrations less than 0.05 mg/kg, or less than the level of detection (with a level of detection of less than 0.05 ppm), would be considered clean relative to PCBs and available for relatively unrestricted use, assuming no other parameters were present at levels of concern.

Table 5-9
Additional Analyses to Determine Reuse Suitability

Beneficial Reuse Criteria/Guidance	Test Method	Test Frequency	Acceptable Range
Chemical Parameters		One sample/1,000 cy for the first 10,000 cy then One sample/10,000 cy for 10,000 to 50,000 cy then One sample/50,000 cy thereafter	TBD for all parameters *
Total 2,3,7,8 TCDD			
Total 2,3,7,8 TCDF			
DDT			
Arsenic	EPA 6000/7000		
Barium			
Cadmium	EPA 6000/7000		
Chromium	EPA 6000/7000		
Copper	EPA 6000/7000		
Cyanide			
Iron			
Lead	EPA 6000/7000		
Manganese			
Mercury	EPA 6000/7000		
Nickel	EPA 6000/7000		
Selenium			
Zinc	EPA 6000/7000		
Physical Parameters			
Grain-Size	SOP-Appendix D/Sieve and Hydrometer		
Percent Solids			
Total Organic Carbon	Walkley-Black/ EPA 415-1		
Moisture Content	SOP-Appendix D		
Settleability	SOP-Appendix D and E		

* Determined by uses approved by WDNR

Testing of the sand as part of the pilot sand separation/washing process, to be performed in 2008, will provide an indication of the expected chemical characteristics and will be useful in the evaluation of beneficial reuse alternatives. However, analysis of full-scale production separated sand will be required and will be used for the final acceptability determination of the various beneficial use options.

Section 5.6.6.4 provides detailed information on the currently identified potential beneficial reuse alternatives.

5.6.6.2 Desanding and Rewashing Technologies

Dredge material will be screened to remove debris, and then screened to separate the sand fraction from PCB-contaminated fractions as described in Section 5.4.4. The remaining slurry consisting of PCB-contaminated fractions (finer than No. 200 sieve) material will be pumped to the dewatering facility for further processing. The resultant sand fraction is the material slated for beneficial reuse.

Rescreening of sand or use of alternate size screens to meet a specific beneficial reuse alternative's gradation criteria may be performed.

Rewashing to achieve lower PCB concentrations in the separated sand will be evaluated during bench-scale and pilot testing planned as part of the Phase 2A activities.

5.6.6.3 Materials Potentially Suitable for Beneficial Use

A primary reference source for information regarding beneficial use is *Testing and Evaluating Dredged Material for Upland Beneficial Uses: A Regional Framework for the Great Lakes* (Great Lakes Commission, September 2004). Appendix A of this reference summarizes case studies regarding beneficial use. The document also includes contaminant criteria for various beneficial use applications for many of the Great Lakes States. However, specific contaminant levels are not presented for the State of Wisconsin. Most of the regulatory PCB concentrations that would typically apply for a given beneficial reuse application are less than or equal to 1.0 ppm. However, many of the beneficial use applications allow higher concentrations.

Beneficial reuses of dredge material commonly include shoreline stabilization, habitat development, beach nourishment, parks and recreation uses, agriculture uses, construction/industrial uses, and road sanding in winter months. These general alternatives are then tailored to accommodate the particular project needs and logistics taking into account the following factors:

- Physical characteristics of the material

- Chemical characteristics of the material
- Local project/needs
- Regulatory criteria and approvals
- Environmental concerns
- Stakeholder concerns

As part of the recent 2008 value engineering efforts, current and upcoming beneficial reuse opportunities for the sand and coarser materials contained in the dredge material have been identified and are being evaluated. Table 5-10 lists these opportunities. Generally, approximately 572,000 tons of the segregated sand is planned to be used for fill behind the sheetpile wall constructed at the former Shell property, and only a portion of this total (160,000 ± 110,00 tons) will be placed behind the wall in 2009 to 2011. The remaining approximately 800,000 tons of segregated sand is available for other beneficial reuse alternatives in later years.

Table 5-10
Beneficial Reuse Opportunities

Beneficial Reuse Opportunity	Description of Opportunity	Quantity of Material that Could Be Reused as Part of This Opportunity	Opportunity Specific Material Gradation and Other Requirements
Staging Area Backfill at former Shell property	Sand can be used to fill in behind the sheetpile wall to be constructed at the former Shell property	Approximately 572,000 tons (total for project)	TBD

5.6.7 Upland Disposal Facilities

During 2008 and early 2009, no wastes other than general sanitary wastes are expected to be generated. When dredging operations and dredge material treatment are initiated in April 2009, it is anticipated that two types of waste will be generated; non-TSCA and TSCA wastes. This section summarizes the current status of landfill selection for the OUs 2 to 5 work.

5.6.7.1 TSCA landfill

TSCA wastes, delineated as described in Section 2.5, will be disposed of at a landfill permitted for this type of waste. Currently, disposal of the TSCA filter cake is anticipated to be either at Wayne Disposal located in Belleville, Michigan, or Peoria Disposal Company in Peoria, Illinois.

5.6.7.2 Non-TSCA Landfill

Non-TSCA PCB wastes, including filter cake and river debris with less than 50 ppm of PCBs will be disposed of at a permitted non-TSCA landfill. Much of the sand segregated from the dredge slurry is expected to be suitable for beneficial reuse and therefore will not require landfill disposal. Sand that is not suitable for beneficial reuse, along with gravel and other minor debris, will need to be disposed at the Veolia Hickory Meadows landfill.

The Veolia Hickory Meadows landfill near Hilbert, Wisconsin (see Figure 5-5) has been selected as the non-TSCA landfill for the OUs 2 to 5 project. Hickory Meadows is a non-TSCA PCB sediment disposal and Subtitle D facility. It has been in business since 1999. It is approximately 34 miles away from the treatment facility, and the materials would be transported by truck.

5.6.8 Spill Prevention Measures

Trucks will take a one-way route to be loaded with dewatered sediment and debris. They will enter the former Shell property from State Street and enter the processing plant from the south end of the western side. Once loaded, they will be processed through a decontamination pad where an automated spray will be used to remove loose material from the wheels. As necessary, a power washer will be used to wash the exterior of the loaded trucks. Lined trucks and secure covers will be used to minimize the potential for the loss of sediments for disposal spilled on public roads. All trucks will be inspected prior to leaving the site to ensure no gross contamination on the trucks. Trucks will exit on the north end of the facility back onto State Street. The second facility will be set up similar to the former Shell property staging and material processing facility. The trucks will access the site via a one-way route, once loaded will go through a decontamination pad, and will be inspected prior to exiting the site.

Once the trucks have left the site, the hauling company will be responsible for responding to and cleaning up any material released during transportation to the disposal facility. Prior to selecting waste hauling vendors, Tetra Tech will require each vendor to provide information about their emergency response plan for spill cleanup. For haulers transporting DOT-regulated shipments of PCB-contaminated sediments or debris (i.e., loads containing equal to or more than 1 pound of PCBs), Tetra Tech will require the transporters to confirm their company has prepared a DOT Hazardous Materials Security Plan.

5.7 Handling of Clean Import Materials

5.7.1 Former Shell Property

5.7.1.1 Construction Materials

Inbound construction materials and equipment are expected at the treatment site during late 2008 and early 2009. These include fill material, concrete, structural steel, process equipment, and the like to complete site preparation work required as part of the Phase 2A work pursuant to the Order and prepare equipment for treatment of the dredge materials starting April 15, 2009. Deliveries to the site will be sporadic based on the construction progress.

It is also expected that materials that will be delivered by truck to support the dredging operations will also be staged at the site to support the April 2009 start date.

5.7.1.2 Sand Cover Engineered Capping Materials

The sand cover and engineered capping materials will be delivered to the former Shell property and stockpiled to support the sand cover and capping operations on the river beginning in 2010. Limited stockpile space is available on the site, requiring trucks to deliver materials as the stockpiles are consumed. Figure 3-3 depicts the planned location of material stockpiles at the former Shell property staging area. Further details are provided in the Site Development Plan (Anchor et al. 2008).

During the capping and cover operations, it is expected that from 40 to 50 cy per hour will be used. Due to the type of work, the capping and sand cover operations are planned for 12 hours per day, 5 days per week. This will require from 2,000 to 3,000 cy (1,000 to 1,500 tons) of these materials per week to support the use. At 20 tons per load, the project will need to receive from approximately 50 to 75 loads of material per week. The planned stockpiles (see Figure 3-3) provide enough storage that deliveries of this material to the site can occur outside the placement times. Sand cover and capping operations are anticipated to occur during the same times as the dredging (April 15 to November 15) starting in 2010 and continuing during the dredging seasons through completion of the project. However, cold weather in November may limit capping to a greater extent than dredging.

Several local suppliers of sand and gravel have been identified. They include: Kiel Sand and Gravel, Daanen & Janssen, McKeefry & Sons, and Faults Bros. The Tetra Tech Team has obtained quotations from these firms and believes each is capable of supplying the quantity of capping materials needed for the project. It is expected that other potential sources will be identified in the future.

5.7.2 OUs 2 and 3 Staging Area

The primary purpose of the Little Rapids staging facility will be the staging and loading of barges with capping and sand cover materials. Cover and capping materials are available from numerous local sand and gravel providers including, but not limited to, Kiel Sand and Gravel, Daanen & Janssen, McKeefry & Sons, and Faulks Bros. The material sources are dispersed, and road traffic would not increase until trucks reached within a few miles of the site.

6 CONSTRUCTION SCHEDULE AND SEQUENCING

The project construction schedule (showing needed RA activities) was developed to support full-scale dredging beginning on or about April 15, 2009. Development of the schedule included consideration of the time needed to complete the RD and procure long-lead items required to complete the construction of the process facility, such as the filter presses and operations building, as required by the Order. Information from the Tetra Tech Team was used to develop the schedule for dredging, dewatering, water treatment, and disposal efforts.

Dates for the completion of RD were dictated by the AOC. Timely completion of RD (including agency reviews and approvals) is required to meet the schedule for full-scale remediation (scheduled to begin in 2009).

Using the target start date for dredging and the requirement to complete the sediment processing building in time to test the process equipment prior to the start of full-scale operations, a schedule was developed for site characterization, geotechnical testing, and operations facility construction.

Production rates for marine operations (e.g., dredging and capping) were provided by J.F. Brennan. These rates were used by Boskalis Dolman and the membrane filter press manufacturer to size the filter presses, and were used by Tetra Tech to size the water treatment system needed to support the dredging operations. With the dredge production rates, a mass balance was created to estimate the amount of sand, silt, and waste water that would be generated by the dredging process. The mass balance was then used to calculate the size of the processing equipment, as described in Section 5.

An onsite lab will be required to support 24-hour turnaround times for verification sampling and analysis of samples collected during dredging operations, as detailed in the CQAPP. The use of a PCB Rapid Turn Analytical process is planned to support this effort.

These factors and the April 15, 2009 target start date for dredging were all inputs to the project construction schedule (see Figure 6-1 for inputs and Figure 6-3 for the integrated construction and operations schedule). The work scope for 2008–2009, completed as part of Phase 2A under the Order, is shown in Figure 6-2.

6.1 Operations Sequencing

The planned operations are sequenced to support all phases of the work, from site development to the completion of dredging activities in 2009 and interim demobilization for winter. Figure 6-2 illustrates the key operational sequence for activities in 2008–2009. Detailed time-phasing of each activity is found in the schedule shown on Figure 6-3.

6.2 Construction Schedule

The construction schedule through 2009 is shown in Figure 6-3. Figure 6-1 illustrates inputs to the schedule and Figure 6-2 shows the sequence of construction and operations activities for 2008 and 2009.

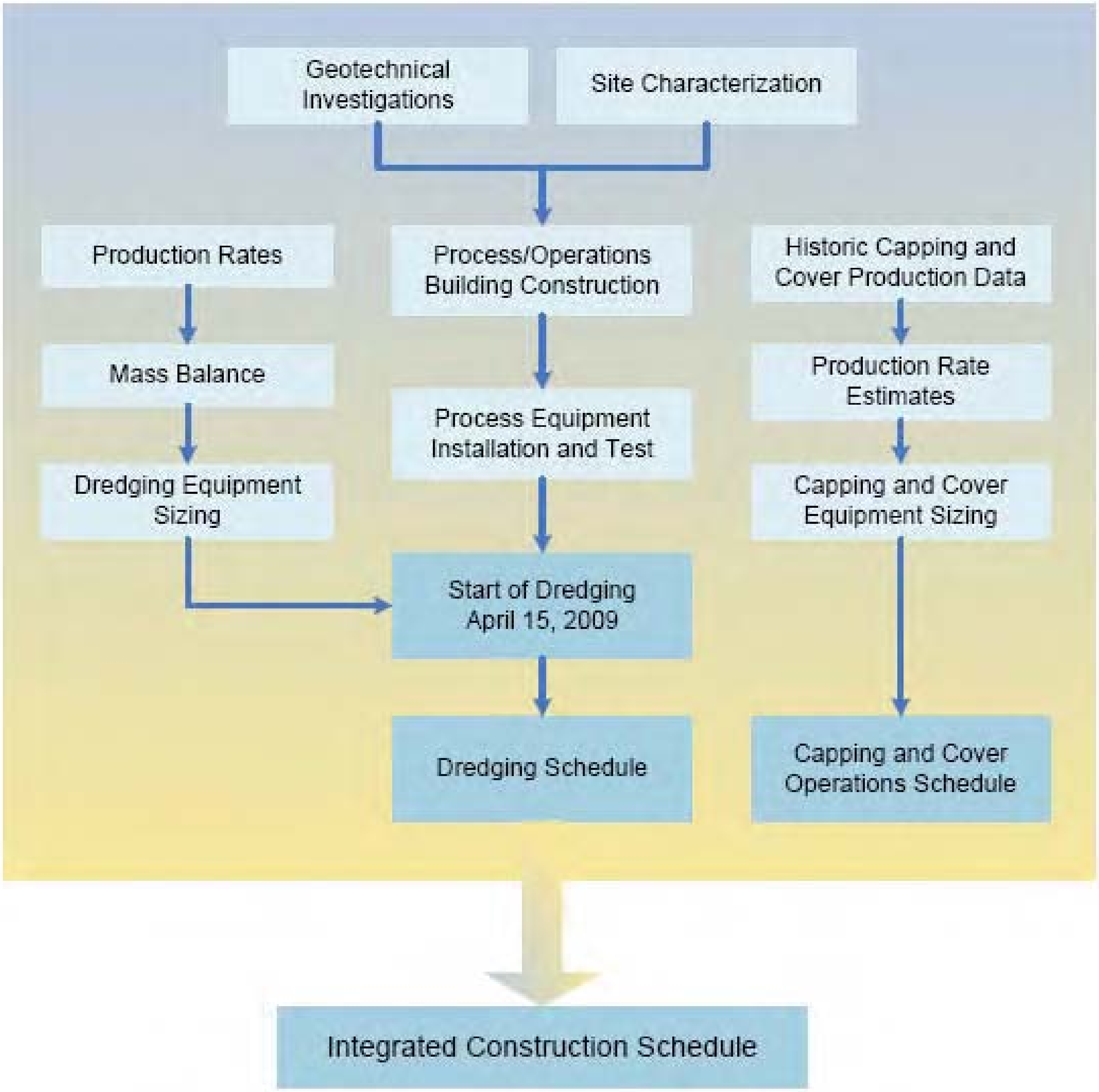

Figure 6-1
Inputs to Construction and Operations Integrated Schedule
Lower Fox River – OUs 2 to 5

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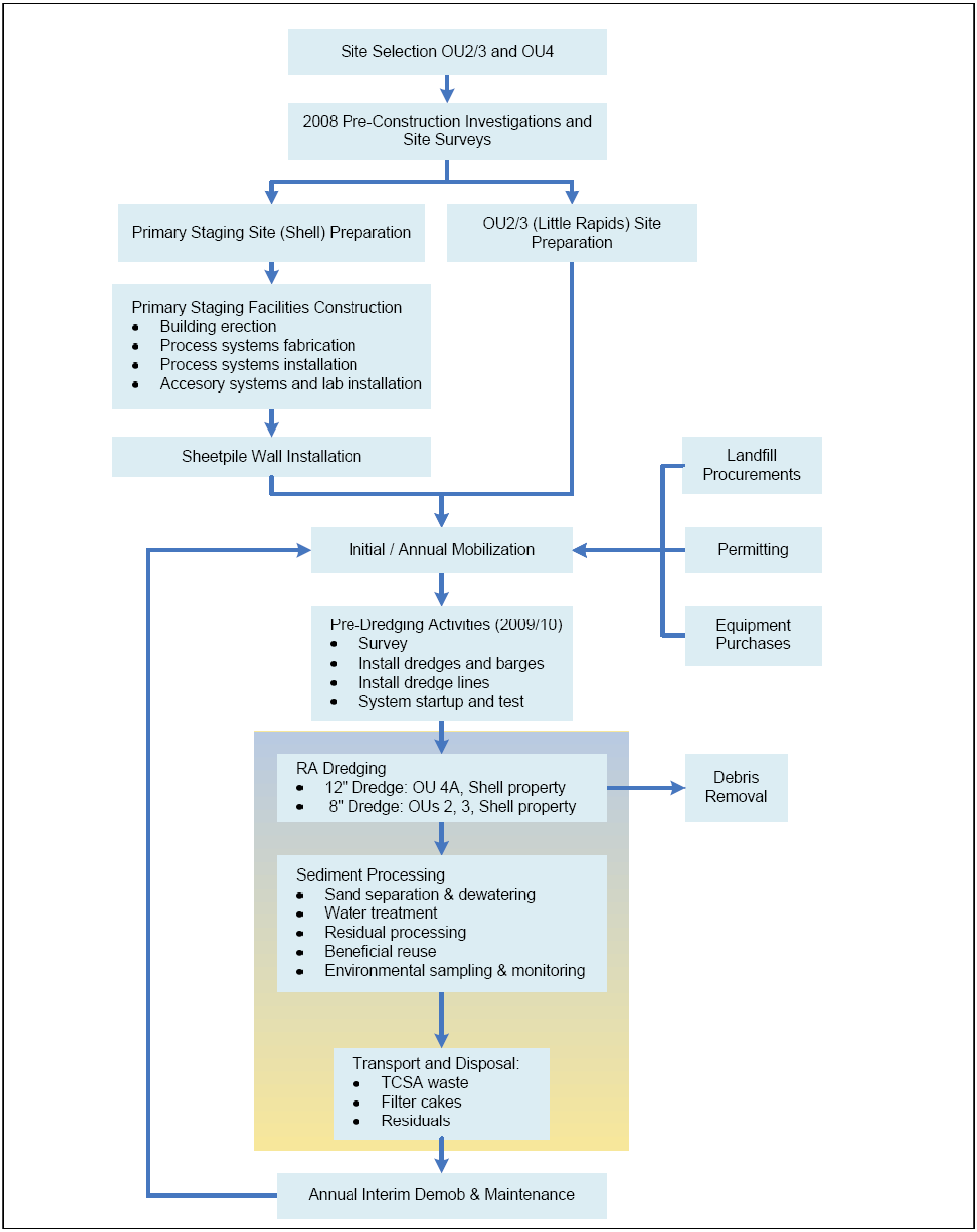

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Figure 6-2
Sequence of Construction and Operations Activities for 2008-2009
Lower Fox River – OUs 2 to 5

Fox River Integrated Schedule, 2008-2009 Activities

ID	Task Name	Start	Finish
1	Fox River Project	11/30/07	4/25/20
2	Remedial Design	11/30/07	5/11/09
124	Phase 2A Activities	12/31/07	4/25/20
125	Phase 2A Work Plan	12/31/07	4/23/08
133	Phase 2A HASP	5/5/08	6/4/08
136	Phase 2A Contingency Plan	5/5/08	6/18/08
140	Phase 2A Construction Quality Assurance Project Plan (CQAPP)	3/24/08	6/18/08
147	Enhanced Fox River Method for Quick-Turn PCB Analysis	5/5/08	10/24/08
155	2008 Pre-Construction Investigations and Site Surveys	4/15/08	11/21/08
203	Phase 2A Site Surveys Report	11/30/08	11/30/08
205	Primary Staging Area (OU 4) Selection	3/28/08	10/15/08
241	Secondary Staging Area (OU 2/3) Selection	3/24/08	8/11/08
267	Landfill Procurement	1/1/08	11/3/08
274	Primary Staging Area (OU 4) Site Preparation	5/8/08	6/13/08
285	Secondary Staging Area (OU 2/3) Site Preparation	7/17/08	10/13/08
298	Phase 2B Documentation	4/28/08	1/15/09
311	Infrastructure	3/14/08	5/1/09
653	2009 RA	3/17/08	5/28/13
654	Equipment Purchases	3/17/08	4/1/10
734	Sheet Pile Wall	4/28/08	5/28/13
745	Mobilization	7/4/08	11/13/09
772	Pre-Dredge Activities	11/3/08	4/14/09
791	Commence Full-Scale RA	4/15/09	4/15/09
792	2009 Dredging	4/15/09	11/10/09
793	Dredging in OU4	4/15/09	11/10/09
794	Dredging OU4B (8" Dredges)	4/15/09	5/13/09
805	Transport 8" Dredge to OU 2	5/13/09	5/13/09
806	Dredging OU4A (12" Dredge)	5/13/09	10/20/09
814	Dredging OU 2	5/14/09	6/22/09
828	Dredging OU 3	6/23/09	11/10/09
872	2009 Sediment Processing	4/15/09	11/13/09
873	Dredging in OU4	4/15/09	11/13/09
1235	Debris Removal	4/15/09	11/10/09
1238	Procurement of Sand Cover Materials	9/1/09	10/26/09
1241	Annual Interim Demobilization & Equipment Maintenance	11/14/08	3/8/10
1255	2010 RA	1/7/10	3/10/11
1738	Remaining Phase 2B RA (2011 and Beyond) And Annual Items	4/28/08	6/29/18
2074	Agency Coordination and Reporting	4/26/08	4/25/20
2076	EPA Closeout Report and Record Retention	4/26/08	4/25/20
2078	Agency Coordination	4/28/08	1/2/09
2080	Public Involvement	4/28/08	12/29/17

Project: Fox River 4-27-08 CashFlow S
Date: 5/1/08

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

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Figure 6-3
Integrated Construction and Operations Schedule, 2008-2009
Lower Fox River – OUs 2 to 5

7 LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section presents location-specific ARARs for project activities. Table 7-1 presents the associated regulatory agency/local authority approvals and related submittals required to obtain these approvals. Although not ARARs, mariner and landowner notification activities associated with project activities are also described in this section.

The project activities are being conducted in accordance with CERCLA. As such, the permit exemption under CERCLA Section 121(e) applies to all on-site activities associated with this remediation, although any such activities will comply with the substantive requirements of any applicable or relevant and appropriate federal or state environmental laws. This means that although the permits themselves are not required, the project activities will meet all substantive standards. For example, although the WPDES permit for wastewater discharge is not required, the treated wastewater discharge will meet the wastewater discharge limits established by WDNR for this remediation project.

7.1 Federal Clean Water Act and WDNR Chapter 30 Shoreline Fill Requirements

The Clean Water Act requires the establishment of guidelines and standards to control the direct or indirect discharge of pollutants to waters of the United States. The Clean Water Act also regulates the excavation of shoreline materials and the placement of fill material below the ordinary high water elevation of waters of the United States.

Under Section 404 of the Clean Water Act, no discharge of dredged or fill material shall be allowed into waters of the United States if it causes or contributes to violations of water quality standards, pursuant to Section 401 of the Clean Water Act. The guidelines in 40 CFR 230.10(c) require that no discharge will be authorized that contributes to significant degradation of the waters of the United States. Where there is no practicable alternative to a discharge, the use of appropriate mitigation measures to minimize potential adverse impacts of the discharge on the aquatic ecosystem are required.

The Rivers and Harbors Act of 1899 prohibits unauthorized activities that obstruct or alter a federal navigable waterway. Section 10 of the Rivers and Harbors Act requires approval from USACE for dredging and filling work performed in navigable waters of the United

States. However, the proposed construction on the former Shell property would not involve filling within the federal waterway or beyond the federally recognized bulkhead line (see below).

Chapter 30 of the Wisconsin Statutes requires a permit to deposit any material or place any structure where no bulkhead line has been established or beyond the established bulkhead line. The proposed development and shoreline fill at the former Shell property are behind the bulkhead line established by USACE on April 19, 1940, and by the 1963 City of Green Bay Ordinance, so the substantive requirements of a Section 30.12 Fill Permit do not apply. However, the project will be conducted in compliance with the substantive requirements of a WDNR-issued Water Quality Certification under Section 401 of the Clean Water Act for facilities subject to USACE jurisdiction. In part, the project includes filling behind the established bulkhead line; therefore, these substantive requirements are applicable to the fill activities at the former Shell property.

7.2 Treated Wastewater and Stormwater Discharge Requirements

WDNR, through the Bureau of Watershed Management, regulates the discharge of pollutants to waters of the state. The Runoff Management Section regulates stormwater permits. To meet the requirements of Section 402 of the federal Clean Water Act, WDNR has developed a state Stormwater Discharge Permit Program under Wisconsin Administrative Code NR 216. Two of the three categories of discharges to be regulated by WPDES stormwater permits are applicable to the former Shell property construction site: 1) erosion control during the initial construction of the facility; and 2) industrial stormwater discharge after the water treatment facility is constructed.

The former Shell property is located in Green Bay, Wisconsin. The City of Green Bay has a stormwater management ordinance (Chapter 30 – Stormwater Management) that establishes stormwater requirements and criteria that will prevent and control water pollution and diminish the threats to public health, safety, welfare, and aquatic life due to runoff of stormwater from development or redevelopment. The City's ordinance requires 80 percent removal of suspended solids from stormwater prior to discharge and the discharge rate cannot exceed pre-development discharge for a 2-year 24-hour storm. The engineering design requirements for the stormwater management and erosion control plans from the

City are more restrictive than the Wisconsin Administrative Code NR 216. The City of Green Bay Chapter 30 requirements will be used for the project plans for the former Shell property.

7.3 Waterway Marker Requirements

Chapter 30 of the Wisconsin Statutes outlines the requirements for waterway markers. Pursuant to Section 30.74 (2) - Uniform Navigation Aids, WDNR has established uniform marking of the water areas of this state through the placement of aids to navigation and regulatory markers. The marking system is compatible with the system of aids to navigation prescribed by USCG. The associated substantive requirements will be met prior to initiation of in-water construction in 2009.

7.4 Cultural Resource Requirements

The preservation of cultural resources is regulated by 36 CFR 800 – Protection of Historic and Cultural Properties. The regulation is administered by the Wisconsin SHPO. A yearly review and analysis of the project site(s) is required to ensure potential offshore cultural resources are identified and avoided during dredging operations. No disturbance should occur until the substantive requirements of Section 106 of the National Historic Preservation Act process have been met. Potential in-river cultural resources locations need to be located and avoided, if possible. The SHPO will be contacted to develop project-specific substantive requirements to minimize any impacts.

7.5 Endangered Species Requirements

National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS) share responsibility for implementing the federal Endangered Species Act. Generally, USFWS manages land and freshwater species, while NMFS manages marine and "anadromous" species. The WDNR Bureau of Endangered Resources is responsible for identification and management of any in-water or on-shore endangered or threatened species. Prior to beginning any project work, a request should be made to USFWS and WDNR to provide a list of federally listed threatened or endangered species or other species of special concern known from the project area. USFWS and WDNR will be contacted to confirm if any listed threatened or endangered species or other species of special concern are present in the project area and to develop project-specific substantive requirements to minimize impacts.

7.6 Waste Management Requirements

TSCA regulations for the disposal of PCB remediation waste (40 CFR 761.61) are applicable to the remediation of PCB-contaminated sediments at the Site, and to the disposal of removed sediments at a State licensed landfill. These regulations provide cleanup and disposal options for PCB remediation waste. PCB sediment with concentrations equal to or greater than 50 ppm will be managed in accordance with TSCA.

PCB sediment with concentrations less than 50 ppm will be managed as a solid waste in accordance with Wisconsin Statutes Chapter 289 and Wisconsin Administrative Code Chapters NR 500 to 538.

Wisconsin Administrative Code Chapter NR 157 – Management of PCBs and Products Containing PCBs establishes procedures for the storage, collection, transport, and disposal of PCB-containing materials, which apply to RAs at the Site.

Solid Waste Management Statutes and Rules (Chapter 289, Wisconsin Statutes and Chapters NR 500 to 520 and NR 600 to 685, WAC) establish standards that apply to the collection, transportation, storage, and disposal of solid and hazardous waste.

7.7 Substantive Regulatory Requirements at the Little Rapids Staging Facility

The federal and state regulatory requirements that apply to the staging area preparations at the Little Rapids facility are: 1) stormwater requirements in WDNR NR216 and NR151; 2) WDNR Section 30.12 Fill Permit (if the proposed fill or structure is placed where no bulkhead line has been established, or is placed beyond any bulkhead line established by USACE—as well as any established by a Town of Lawrence ordinance); 3) WDNR Water Quality Certification under Section 401 of the Clean Water Act for facilities subject to USACE jurisdiction (if the fill is placed behind the established bulkhead line); 4) WDNR Waste Management testing requirements applicable to potentially contaminated building materials (e.g., asbestos, lead) generated from demolition activities prior to on-site disposition/re-use/off-site disposal; and 5) WDNR Waste Management site characterization requirements applicable to reuse/off-site disposal of on-site soils disturbed by site preparation activities.

7.8 Notifications to Local Mariners and Adjacent Property Owners

7.8.1 Notification to Local Mariners

OU 4 of the Fox River, north from the De Pere Dam north to Green Bay, includes a federally managed and maintained channel. Because of the channel's federal status, compliance with USCG guidelines regarding navigational notices is mandatory. In addition, due to the extensive nature of this project outside the navigation channel, the use of submerged pipelines and anchored equipment, and the limited maneuverability of some of the dredging equipment during operations, notices will be expanded to include work outside the navigational channel. Prior to the start of work, the Tetra Tech Team will meet with USCG officials to review upcoming work so that the USCG may issue accurate notices throughout the work year. Also, periodic update meetings with the USCG will occur so that the accuracy of notices is not compromised. USCG navigational notices are typically effective measures for the dissemination of information to commercial vessel traffic moving through the Port of Green Bay.

Recreational vessels, however, may not monitor marine frequencies where notices are conveyed, and remedial work will also occur outside the federal navigation channel (in OU 2, OU 3, and outside the navigation channel in OU 4). Therefore, additional measures to notify the general public of ongoing safety considerations associated with the remedial activities will be taken and will include:

- Posting notices at area boat landings and marinas informing the public of the extent and type of work, and the presence of buoys and dredge pipeline
- Distribution of public safety hand-outs, which can be carried by mariners for continual reference
- Meetings with local WDNR Wardens and the County Sheriffs to discuss safety markers, dredging operations, and previously observed public safety concerns that may have compromised boater safety with law enforcement agencies
- Release of project information to local television and print media for public release

- Public safety informational meetings prior to work each season where citizens will be informed of boater safety issues in the vicinity of project operations

Finally, prior to the 2009 construction season and throughout the season, the project team will meet with officials from the Port of Green Bay to inform them of ongoing work. Information received will be disseminated by the Port to their commercial tenants and will specifically inform commercial mariners of work at berthing locations.

Safety actions to be implemented, information to be provided, and channels for conveyance of information to the general public are consistent with those employed for work on Little Lake Buttes des Morts (OU 1).

7.8.2 Notification to Adjacent Property Owners

Prior to the start of work, owners of property adjacent to the work areas will be notified by mail of the upcoming work or by door-to-door visits and will be encouraged to attend the public safety informational meetings for local mariners, as discussed in Section 7.8.1 above.

Table 7-1
Regulatory Agency/Local Authority Approvals & Submittals

Regulatory Agency/Local Authority	Submittals & Approvals
WDNR/USACE re: Clean Water Act Sections 10, 401 & 404; Rivers and Harbors Act – Section 10	Documentation of compliance with substantive requirements of USACE Sections 10, 401 & 404; Joint State/Federal Application for work in or around navigable waterways; WDNR Chapter 30 Approval
WDNR/USACE re: Wisconsin Statute Chapter 30 Dredging & Filling Plan	Documentation of compliance with substantive requirements of WDNR Chapter 30 & USACE Sections 10, 401 & 404 Applications
USEPA re: Disposal of TSCA-regulated PCB Waste in accordance with 40 CFR Part 761	Name/location of disposal facilities permitted/authorized by USEPA in accordance with TSCA PCB disposal facility requirements (submitted to USEPA Remedial Project Manager)
USEPA re: Disposal of CERCLA Waste containing CERCLA hazardous substances in accordance with USEPA's Off-Site Rule	Name/location of proposed disposal facility, volume/type of CERCLA waste and approximate shipping period (submitted to the USEPA Remedial Project Manager for acceptability determination by the USEPA Regional Off-Site Coordinator)
USFWS and WDNR re: Endangered Species Act – Section 7	Correspondence demonstrating coordination with USFWS and WDNR
USFWS and WDNR re: Wisconsin Administrative Code NR 27 Identification & Management of an In-water or On-shore Endangered or Threatened Species	Correspondence demonstrating coordination with USFWS and WDNR
SHPO re: 36 CFR 800 – Cultural Resources Management	Correspondence and Reviews demonstrating coordination with the SHPO
WDNR re: Wisconsin Statute Chapter 281.41 Wastewater Treatment Plan	WDNR approval of WTP design
WDNR re: Wisconsin Statute Chapter 283.31 WPDES Effluent Limits	WDNR approval of treated wastewater discharge limits
WDNR re: Wisconsin Administrative Code NR 151 & 216 – WPDES Storm Water Discharge associated with Construction & Operation Activities	SWPPP and Erosion Control Plan; Notice of Intent for stormwater discharges associated with land disturbance activities
Wisconsin-licensed Solid Waste Disposal Facility re: Wisconsin Administrative Code NR 157, 500 & 600 Waste Management (PCB-containing Materials, Solid Waste & Hazardous Waste)	Waste acceptance approval from licensed disposal facilities
City of Green Bay, WI re: Stormwater Management	SWPPP and Erosion Control Plan; Notice of Intent for stormwater discharges associated with land disturbance activities
Brown County, WI re: Environmentally Sensitive Areas, Floodplain regulations	Correspondence demonstrating coordination with appropriate Brown County authorities
Town of Lawrence, WI re: Construction of Buildings	Correspondence demonstrating coordination with appropriate Town of Lawrence Zoning authorities
USCG and WDNR re: Protection of Maritime Navigation WDNR NR 5.09 Dredging	Correspondence demonstrating coordination with USCG and any required submittals.

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