Concept Design Documentation Report Kinnickinnic River, Wisconsin Milwaukee Estuary Area of Concern Sediment Removal

Prepared for
U.S. Army Corps of Engineers
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1.0 Study Authority

The Wisconsin Department of Natural Resources (WDNR) has proposed to remove sediments within a portion of the Kinnickinnic River, Wisconsin to address the contaminant contact issue with a view toward optimizing recreational and navigation opportunities. The WDNR requested U.S. Army Corps of Engineers (USACE) assistance for the planning and engineering portion of this effort under the Great Lakes RAP (GLRAP) program in accordance with Section 401(a) of the Water Resources Development Act (WRDA) 1990 as amended. An agreement to provide the assistance was executed August 13, 2002. A delivery order for this project under an existing contract between USACE and Barr Engineering Company, Ann Arbor, Michigan, was issued to Barr Engineering on September 20, 2002.

2.0 Study Purpose and Scope

The purpose of this Concept Design Documentation Report (CDDR) is to provide conceptual level evaluations of cost, short- and long-term impacts, residual risk, technical feasibility, implementability, reliability, and constructability of a variety of remedial alternatives for contaminated sediments within the portion of the Kinnickinnic River from Becher Street (upstream) to Kinnickinnic Avenue (downstream). These evaluations will allow stakeholders to make informed decisions regarding the most appropriate remedial alternatives for the site. The CDDR was prepared in accordance with the *Scope of Work: Great Lakes Remedial Action Plans (RAP) – Section 401, Kinnickinnic River, Wisconsin – Milwaukee Estuary Area of Concern: Sediment Removal Concept Design (Revised),* issued by the USACE, dated September 20, 2002. This CDDR targets the removal of contaminated sediments for navigational purposes and considers recreational, commercial, and environmental restoration goals for the study area.

3.0 Resource and Study Area Inventory

3.1 Resource Inventory

An existing-conditions inventory was performed to identify physical, social, natural, and cultural resources within the Kinnickinnic River study area. The information and data for the inventory was gathered from existing documents obtained from local, county, state, and federal government agencies. Key documents include the following:

- *Toxic Organic Contaminants in the Sediments of the Milwaukee Harbor Estuary: Phase III – Kinnickinnic River Sediments* (Li et al., 1995)
- *Sediment Sampling From the Kinnickinnic River, Milwaukee, Wisconsin* (Altech, 2003)
- *Subsurface Investigation for Kinnickinnic River, Milwaukee Wisconsin* (Coleman, 2002)

The complete list of documents included in the Resource Inventory is provided in Appendix A.

3.2 Seawall Evaluation

The stability of the river bank within the study area may be affected by the sediment removal alternatives considered in this CDDR and therefore represent a significant cost consideration. The purpose of the seawall evaluation was to qualitatively assess the condition of the existing seawalls along a portion of the Kinnickinnic River in Milwaukee, Wisconsin, assess whether dredging the river in the vicinity of these walls would adversely affect their stability, and identify areas where seawall replacement may be needed. The seawall evaluation was based on field observations made by Barr Engineering on October 4, 2002 and on available construction records. Conceptual design computations are based on broad assumptions. A copy of the *Seawall Evaluation Report* is provided in Appendix B.

The seawalls along the Kinnickinnic River between Becher Street (upstream) and Kinnickinnic Avenue (downstream) are in poor to excellent condition. There are four types of walls: steel sheet pile (SSP) wall, Wakefield timber wall, Wakefield timber wall with concrete cap, and concrete wall. The assumptions used for conceptual design computations in the seawall evaluation report were that 6 to 8 feet of sediment would be removed approximately 10 feet away from the existing seawalls, these assumptions were also used in computing the estimated volume of sediment removed in

Section 6. Based on the assumptions, the following conclusions were made: the SSP wall sections and concrete walls are stable for the load conditions after dredging the channel; and the Wakefield timber walls would need to be replaced as part of any dredging activity. A detailed description of the methodology used for determining which sections of seawall would most likely need to be replaced or installed for the evaluated dredging alternatives is provided in Section 5.12. A summary of the seawall conditions is provided below.

Seawall Condition Summary Table

Parcel Number	**Wall Type**	**Length (feet)**	**Depth (feet)**	**Condition**
429	SSP	385	34	Good
428	Unprotected	83	NA	NA
427	Unprotected	256	NA	NA
426B	Wakefield	292	28	Fair
426A	Wakefield w/ concrete cap	385	28	Fair to Good
426	Bridge abutment	NA	NA	Excellent
425	Timber w/ concrete cap	693	Unknown	Poor
432	SSP	51	Unknown	Excellent
433	SSP	556	25 or 46	Good
436	Unprotected	233	NA	NA
437	Concrete	152	Unknown	Good
438	Bridge Abutment	NA	NA	Excellent
439	Unprotected	238	NA	NA
440, 441, 442, 443	Unprotected	519	NA	NA

3.3 Scoping Meeting

A scoping meeting was held on November 13, 2002 at The Port of Milwaukee office to discuss the scope of the development of concepts and recommendations in the Concept Design Documentation Report. During this meeting the following items were discussed: study area extent and description; features/obstructions in the study area; dredging history; navigation and environmental issues associated with sediments in the study area; possible remediation options; local property owner needs; funding issues; and sediment quality objectives.

4.0 Plan Formulation

4.1 Existing Conditions

4.1.1 Site Location and Description

The study area is located immediately upstream from the federal navigational channel portion of the lower Kinnickinnic River in Milwaukee, Wisconsin, between Becher Street and Kinnickinnic Avenue. The limits of the study area are presented in Figure 1. The lower Kinnickinnic River discharges into the Milwaukee Harbor of Lake Michigan, which is located approximately 2 miles downstream of the project area

4.1.2 Site History and Background

The Kinnickinnic River is located within the Milwaukee Estuary Area of Concern (AOC) in Milwaukee, Wisconsin. The lower Kinnickinnic River is slowly making the transition from industrial use to recreational and commercial uses. This stretch of the river was dredged to create a channel depth of 18 to 21 ft below the Lake Michigan Chart Datum until sometime between 1936 and 1944, see Appendix C for historic navigation charts. Dredging operations for this stretch of the river were discontinued when the boundaries of the federal navigation channel were established downstream of Kinnickinnic Avenue. The Federal Navigation Channel is currently maintained at 21 feet below the Lake Michigan chart datum water level (577.5 feet) as referenced to the International Great Lakes Datum 1985 (IGLD85) from Kinnickinnic Avenue to Lake Michigan.

4.1.3 Site Characterization

Sediment studies in the portion of the Kinnickinnic River located between Becher Street and Kinnickinnic Avenue (University of Wisconsin – Milwaukee, 1995 and Altech, 2003) identified elevated levels of PCBs and polycyclic aromatic hydrocarbons (PAHs) as compared to sediment samples that were collected upstream of the study area by the WDNR in February 2003. An attempt has been made by the WDNR (Appendix C) to identify the sources of PAH and PCBs in the sediments. It is concluded that the high concentrations of PCBs and PAHs in the sediment were related to the historical development and industrialization in the area, particularly between early 1940s and late 1970s. Discharges from industries and the non-point sources combined with the lack of environmental regulations in general have caused the high concentrations of PCBs and PAHs in the sediment. At present time, with the change in the type of industries and implementation of the regulations, there are no significant existing sources that will contribute substantial amount of PCBs and PAHs into the area to recontaminate the sediment (WDNR, 2003)

The sediments observed in the study area consist of inorganic silts and fine sands. Sediment deposition occurs within the study area since the width of the river increases (stream velocity decreases) and there is a bend in the river. Radionuclide dating of sediment cores (*University of Wisconsin – Milwaukee, 1995)* indicates that sediment deposition within the study area occurs at an average rate of 2 to 10 cm/year. Soft sediment thickness upstream of the study area is approximately 0.5 ft thick, underlain by gravel. Soft sediment thickness in the study area was approximately 10 to 25 feet thick in 2002, based on sediment core logs (Coleman, 2002). Assuming that dredging stopped sometime between 1936 and 1944 and that all soft sediment observed in 2002 had been deposited since 1944, the average deposition rate would be approximately 5 to 13 cm/year, which is similar to the average deposition rate determined by radionuclide dating. This suggests that the majority of the soft sediments observed in 2002 were deposited since the last dredging of the channel. A more detailed analysis of sediment deposition is provided in Appendix C.

Stream velocity data does not exist for this portion of the River. Based on general observations, the average base flow for this stretch of the river is relatively low. However, because this stretch of river is relatively narrow, confined by seawalls, and is surrounded by an impervious drainage area, stream velocities could dramatically increase during storm events and may disturb sediments in this stretch of the river.

An abandoned tugboat is located in the study area. Coordination has been initiated with the Wisconsin Historic Preservation Office regarding the historical significance of the vessel. Further coordination will be conducted during the process of acquiring a US Army Corps of Engineers dredging permit. For the purposes of this report, it is assumed that the vessel has no historical significance due to its advanced state of dilapidation.

There are multiple authorized crossings (e.g. utilities, pipelines, sewers, and bridges) exist in the project area that may hinder dredging operations. During the design phase, resolution of this issue will require coordination with the US Army Corps of Engineers Regulatory Office to identify these crossings.

The following conditions are anticipated that may affect dredging: 1) Debris, stones, gravel, cobbles, wood from trees and industrial sources and abandoned pilings and piers; 2) Sloughing of side slopes; 3) Low water levels may result in some dredging required to be done in shallow water or from land;

and 4) Water levels and bridge clearances, piers and other obstacles in the river may affect the type and size of dredging equipment.

4.1.4 Nature and Extent of Contamination

Data from the 2002 sediment sampling event (*Altech, 2003 and Coleman, 2002*) are summarized in cross-sections of the study area, which are located in Figures 2 through 8. Sediment cores were collected over elevations that ranged from a maximum top of sediment elevation of 575 feet msl (2.5 ft below the Lake Michigan Chart Datum IGLD85) down to a minimum bottom of borehole elevation of 550 feet msl (27.5 ft below the Lake Michigan Chart Datum IGLD85). The total organic carbon content of the sediments ranges from 0.03 % to 10.5%. The concentration of PCBs and PAHs varies with depth and there does not appear to be a significant correlation between organic content/soil type and contaminant concentrations. PCB concentrations range from non-detect to 35.5 mg/kg and PAH concentrations range from 0.33 mg/kg to 243.5 mg/kg (Figures 3 through 8). TCLP results indicate that dredged material from the study area is not considered hazardous waste according to the Federal Rules for Protection of the Environment (40 Code of Federal Regulations 261.24). In addition, the PCB levels in the collected sediment samples did not exceed the PCB waste characterization criteria (50 mg/kg) under the Toxic Substance Control Act (TSCA). In this regard, the proposed dredged material is suitable for either the USACE CDF or a Subtitle D industrial landfill.

4.1.5 Average PCB Concentrations in Surficial Sediment Samples

As a baseline for assessing dredging alternatives, the average concentrations of PCBs in the surficial sediment (0 to 2 feet) upstream of the project area (background) and within the project area were calculated using the arithmetic mean of PCB concentrations in sediment from the 2002 investigation (Altech, 2003) and the 2003 upstream investigation (Appendix C). The average concentrations of PCBs in the surficial sediment were calculated for each section of the project area (Appendix D) and are summarized below.

Upstream of Project Area:	0.87 mg/kg PCBs
Section 1 of Project Area:	1.5 mg/kg PCBs
Section 2 of Project Area:	1.4 mg/kg PCBs
Section 3 of Project Area:	3.4 mg/kg PCBs

The WDNR has evaluated possible PCB source areas for the project area and have determined that there are no significant existing contaminant sources upstream of the project area that could recontaminate the project area after implementation of a sediment deepening/restoration plan (Appendix C).

4.2 Future without Project Conditions

The no action alternative is included as a baseline comparison to the proposed alternatives listed below. If no action is selected as an alternative contaminated PCB and PAH contaminated sediments would not be removed and the negative environmental effects associated with exposure of the aquatic biota to the contaminants would continue. The project area also exhibits areas of exposed (visible above the water line) sediments. A no action alternative would leave the exposed areas. Although no analytical data is available, these exposed sediments could provide a contaminant pathway of exposure to the environment, including humans and should be evaluated if a no action alternative is selected.

No action would also maintain current project area water levels (0 to 10 feet below Lake Michigan chart datum: 577.5 feet IGLD85) and limit recreational and commercial navigation use of project area.

4.3 Problem and Opportunities

Contaminated sediments containing persistent organic substances like PCBs and PAH compounds contribute to most of the beneficial use impairments in the Milwaukee Estuary Area of Concern. Near record low Lake Michigan water levels have caused many areas in this River segment to be completely exposed and available to direct human and wildlife contact. Water depths over the remaining sediments vary, but are generally shallow. The exposed sediments along with increased recreational boating traffic on the River also add to the possibility of contaminant contact. In addition, contaminated sediment from the project area may transport downstream into the federal navigation channel. The transport of contaminated sediments in the water column would continue to impair beneficial uses in the areas, including the harbor and Lake Michigan.

The project area has received increased attention due to discussions among federal, state, and local governments and adjacent landowners regarding the need to deepen the river for navigation as well as implement remediation. Implementation of a restoration plan would eliminate or reduce future exposure to contaminants and allow greater beneficial use of the area.

4.4 Planning Objectives

The primary objective of this study is to develop a technically sound, environmentally acceptable, and economically reasonable implementation plan to improve water quality and commercial and recreational navigation conditions within the study area. Specific planning objectives include:

- Restore the study area to a depth suitable for the recreational and commercial navigation use needs of the area.
- Reduce human and wildlife, including aquatic biota, exposure to contaminated sediments

4.5 Planning Constraints

Planning constraints are conditions that exist which could affect the implementation of a given alternative. For the Kinnickinnic River study area, the following planning constraints exist:

- The project must be complete within itself. This means that the project must solve a specific problem and not require a subsequent project to complete the solution.
- The project must meet the navigation requirements for the study area.
- The project must reduce contaminants within the study area.
- The project must minimize environmental impacts.
- Successful project implementation will require stakeholder buy-in and contribution.
- Limit remediation options to proven technologies and methods.

5.0 Development of Alternatives

The focus of developing alternatives for this study area was to use proven technologies for dredging and treating sediments. Therefore, experimental or non-proven technologies were not considered in this section. There are several alternatives available for handling the contaminated sediments located within the study area. Components of the alternatives considered include: dredging, site control and barriers, sediment and water transport, dewatering/stabilization, staging area, disposal of dredged material and decanted water, capping, and regulatory/permitting requirements. After analysis of the methods involved with environmental dredging, six alternatives were developed and are discussed in detail in Section 6. Described below are the components of the environmental dredging that were evaluated.

5.1 Selection of Dredging Equipment

The following factors need to be considered when selecting dredging equipment:

- ***Solids Concentration*** – It is advantageous to deliver sediments at high solids concentration so costs for handling, treating, and disposal of water and sediment are minimized.

- ***Dredging Production Rate*** – A high production rate is useful for large dredging areas and a low production rate may be useful for areas where sediment resuspension needs to be limited and large debris (> 0.5 m) may be encountered.

- ***Dredging Accuracy*** – It is important to have precise dredging accuracy when the sediment removed requires expensive treatment and disposal costs or known underwater hazards or utilities exist.

- ***Water Depth*** – Needs to be considered to accommodate the draft of the dredging vessel.

- ***Ability to Handle Large or Dangerous Debris*** – Mechanical dredging is the most feasible method for removing large/dangerous debris. Hydraulic dredging with a cutterhead may be able to cut and remove wood debris, but size of debris that can be removed is limited by the diameter of the suction pipe.

- ***Sediment Resuspension, Release, and Residual Concentration*** – These are typically the overriding factor for selecting a dredge. The type of dredge and how it is operated influences resuspension. Specialty dredge buckets have been designed to limit resuspension. However, it is still critical that an experienced operator be used to limit sediment resuspension.

- ***Site Restrictions*** – Channel widths, authorized underwater crossings (e.g. utilities, pipelines, sewers, and bridges), overhead restrictions (e.g. bridges and overhead utilities), river structures (e.g. docks and boat lifts), and land access restrictions (e.g. equipment loading/unloading areas and sediment storage areas) may limit the type and size of equipment that can be used in the project area. Specifically, docks and boat lifts constructed on steel piles exist in the project area and may require replacement/removal or specialized dredging equipment to maneuver around or near the structures. Prior to dredging, the USACE permitting office should be contacted for locations of authorized crossings in the project area.

- ***Compatibility*** – It is important to evaluate the overall compatibility of dredging equipment with the transport, treatment, and disposal requirements for the dredged sediment and process water. In most cases it is preferred to use a dredging technique that provides material with a high solids concentration to minimize the costs of handling, treating and disposing of sediment, and the treatment of effluent water.

- ***Distance to Treatment or Disposal Sites*** - The distance from the dredging site to the treatment, disposal, or re-handling site affects the method of transport and the type of dredge used. A pipeline can be used for transporting hydraulically dredged sediments and is dependant upon elevation and distance to the treatment or disposal site. If pipeline transport is not feasible, high solids content material can be transported by barge.

5.2 Dredging Operations

There are generally three categories of dredging methods used to remove sediments: 1) mechanical dredging, 2) hydraulic dredging, and 3) pneumatic dredging. Of these three methods, mechanical and hydraulic dredging are the most common. The following subsections describe the most commonly used dredging methods and the advantages and disadvantages of each method.

5.2.1 Mechanical Dredging

Mechanical dredging is the method used for dredging the federal navigation channel just downstream of the study area and is the method that is most readily available in the study area. Mechanical dredging consists of lowering a mechanical bucket into the water to remove sediments. The primary advantage of using the mechanical dredging method is that sediments are removed at nearly the same solids content as *in-situ* sediments, thus the volume of contaminated material and process water from the dredged sediments that requires disposal, management, and/or treatment is minimized.

Another advantage of mechanical dredging is that the dredging equipment can be equipped with location devices, such as a GPS receiver, to determine the location and depth of the dredging device, which is useful for removing hot spots and for limiting the amount of overdredged material. One disadvantage of mechanical dredging is that sediments can be resuspended during dredging operations; therefore, control measures are necessary to minimize the offsite migration of excessive suspended solids.

For areas located near shore or areas that have exposed sediments, another option for mechanical dredging is using a backhoe from shore or a barge. This alternative may be effective in the exposed sediment areas located at the bend of Section 2 and the south shore of Section 2 (Figure 2). Mechanical dredging would most likely be the method used to dredge the study area because of the availability of equipment, and contractor experience.

5.2.2 Hydraulic Dredging

Hydraulic dredges use water to transport sediments as slurry and may be equipped with rotating blades, augers, or high-pressure water jets to loosen the sediment. Because water is used to move the sediments, the total volume of sediments that needs to be disposed, managed, and/or treated is greatly increased. One advantage to this method is that sediment resuspension is typically less than mechanical dredging.

Portable hydraulic dredges hauled by flat bed trucks are also available in the upper Midwest. They are small in size and have their own pipeline equipment and they are relatively low in cost to operate. However, they do require a nearby disposal/handling area and significantly larger volumes of slurry material is generated as compared to mechanical dredging.

Historically hydraulic dredging has not been used in the Milwaukee Harbor area and therefore, the infrastructure (i.e. pipelines) does not exist. This method would require installation of a pipeline or a portable hydraulic dredge. Therefore, hydraulic dredging is not feasible for CDF disposal since it is not possible to pump sediment directly into the CDF. Because of the large volume and low solids content of sediment produced by this method, the disposal costs would greatly increase the cost of dredging and treatment and therefore, would not add any value. This dredging method will not be considered in the study area.

5.2.3 Pneumatic Dredging

Pneumatic dredges use compressed air and/or hydrostatic pressure to remove sediments. Pneumatic dredging produces slurry with a higher solids concentration than hydraulic dredges, but still less than mechanical dredging. This method does have limitations: a minimum average water depth of 7.5 ft is required for operation, large debris is not removed, the cost is greater than hydraulic and mechanical dredging, and the availability of pneumatic dredges is limited. Historically pneumatic dredging has not been used in the Milwaukee Harbor. In general, this method is used less frequently than mechanical or hydraulic dredging. This method will not be considered further for environmental dredging of the study area because the costs are greater than mechanical dredging and lower solids content is produced.

5.3 Site Controls and Barriers

Site controls and physical barriers are often needed in dredging operations to prevent the migration of resuspended sediments that occurred during dredging operations. Physical barriers commonly used for dredging operations include: oil booms, silt curtains, silt screens, sheet-pile walls, and cofferdams. A brief description of each physical barrier is provided below.

- ***Oil Booms*** – are used for dredging activities in sediments that may release oil or floatables. The booms typically consist of a series of floats and fabric that are connected by a cable or rope. The booms can also be supplemented with oil adsorbent material to increase oil removal efficiency. However, it should be noted that these booms do not remove the soluble portion floatable contaminants released during dredging operations (i.e. PAHs). Because of the physical and chemical properties of PCBs and PAHs it is likely that contaminants will remain sorbed to the sediments and therefore, it is most likely that an oil boom will not be necessary in the study area.

- ***Silt Curtains*** – are impermeable flexible barriers that hang down from the waters surface and is anchored along the river bottom. Silt curtains are most effective in relatively shallow undisturbed water. It is recommended that silt curtains not be used in water deeper than 6.5 m or in currents greater than 50 cm/s. Because dredging depths will most likely be less than 6.5

m and currents in the study are typically low, this would be a viable option as a sediment barrier in the study area.

- ***Silt Screens*** – are permeable flexible barriers made of a geotextile material that allows water to pass through the screen leaving the majority of the sediment behind. As with silt curtains, silt screens are not effective in high currents, high winds, and changing water levels. Because dredging depths will most likely be less than 6.5 m and currents in the study are typically low, this would be a viable option as a sediment barrier in the study area.

- ***Structural Barriers*** – Some examples of structural barriers are sheet piling and cofferdams. Structural barriers are typically used in areas of high current velocities or areas that are contaminant hotspots. The sediment areas within the structural barriers are typically pumped dry and sediment is removed by dry dredging (i.e. backhoe). Because structural barriers are engineered systems they can be costly. It is most likely that this method will not be necessary because the river current is relatively slow at base flow conditions and there are not any locations identified that would need to be isolated by a structural barrier from the rest of the study area.

5.4 Sediment and Water Transport

After removal, sediment is transported to an area for treatment or disposal. If sediment requires treatment before disposal, rehandling of the sediments is often required. Therefore, additional transportation/handling equipment is required for on-site treatment, followed by transportation off-site for final disposal.

Dredged material can be transported to the treatment/disposal area by barge, pipeline, conveyor, truck/trailer, and/or any combination of these methods. The transportation method selected is dependant upon the solids content of the dredged material as well as the dredging method used. Pipelines require the dredged material to be in slurry form (low solids content) and are typically associated with hydraulic dredging. Barges are typically used in conjunction with mechanical dredging to transport dredged material to shore. Trucks and trailers may then be used to transport the dredged material to the treatment/disposal area. Barge transport is the most common method for transporting dredged sediments on this stretch of the Kinnickinnic River. Barge transport of dredged sediments will be the method used for transporting sediment to the Jones Island CDF for disposal or to the staging, dewatering, and stabilization area if landfill disposal is required. If landfill disposal is required, rehandling of the material and transportation of the dewatered/stabilized sediment to the landfill for disposal will also be needed.

5.5 Dewatering of Dredged Sediment

If CDF disposal for the dredged material were not available, then the sediments would require landfill disposal. Landfill disposal would require low sediment water content and dewatering would be necessary. Dewatering can occur by air-drying, mechanical filtration, and/or stabilization/ solidification. Stabilization/solidification does not necessarily dewater sediments; it increases the solid content of the sediment and traps free liquids. Stabilization/solidification can be used in conjunction with air-drying and mechanical dewatering methods. One of the primary issues with sediment dewatering is odor from decaying organic. This is an issue that should be evaluated when determining staging area locations.

5.5.1 Air Drying

Air-drying is based on evaporation and gravity flow of water from sediments. Sediments are typically placed in an impoundment basin and allowed to dry. Sediments can be agitated by a backhoe or underdrains can be installed in the basin to collect water gravity drainage as measures to decrease drying time. This method is typically less equipment intensive than mechanical methods, but may take additional time to dewater as compared to mechanical methods. Large land areas are required for air-drying as compared to mechanical methods. If the desired solids content is not reached, stabilization/solidification material can be added to the sediments by mixing in with a backhoe or by a pug mill.

5.5.2 Mechanical Dewatering

Mechanical dewatering physically forces water out of sediment. The two primary types of mechanical dewatering systems operate on the basis of filtration and centrifugation.

5.5.2.1 Filtration

Belt presses are the most common mechanical filtration method and utilizes porous belts to compress sediments and drive off water. Low solid content sediments often require gravity settling or polymer stabilization prior to belt pressing. The overall dewatering process typically involves gravity draining free water, followed by low-pressure compression, and finally high-pressure compression. This method is similar to sludge management methods used in wastewater treatment facilities. Filtration typically yields substantial quantities of decanted water, which generally requires additional treatment prior to discharge.

5.5.2.2 Centrifuge

Centrifugation uses centrifugal force to separate liquids from solids based on density differences. Centrifugation takes up little space, but is generally not as effective as filtration or air-drying.

5.5.3 Stabilization/Solidification

Stabilization/solidification involves the use of an additive to increase the percentage of total solids and binds free liquid in dredged material. For the purpose of this report, only ex-situ treatment methods will be discussed.

Methods for stabilization/solidification of sediments includes: cement-based, pozzolonic, thermoplastic, organic polymerization, and organophilic clay-based. Cement-based and pozzolonic stabilization/solidification methods are the most frequently used stabilization methods. The other methods mentioned above have been used only on a limited basis, because they are not proven methods, will not be included in this evaluation.

Sediment would be staged in a concrete impoundment basin (i.e. same as air drying containment) with underdrains to collect water that has gravity drained from the sediments. Mechanical equipment such as a backhoe or pug mill would be used to add stabilization/solidification amendments to the dredged sediments.

5.5.3.1 Cement-Based Stabilization/Solidification

This stabilization method consists of adding Portland Cement to dredged sediments. A treatability study would be necessary to determine the quantity of cement and additives required to stabilize the dredged sediment to an acceptable state for landfill disposal. The consistency of the stabilized material will range from soil-like to a cohesive solid. The Medusa cement company is located near the study area and could be a local source of Portland Cement.

5.5.3.2 Pozzolanic Stabilization/Solidification

This stabilization method consists of using additives such as fly ash, lime, kiln dust, and blast furnace slag; combined with lime and/or cement. This method generally takes longer than cement-based stabilization/solidification. Kiln dust, lime, and cement are readily available at the nearby Medusa cement company. A treatability study would be necessary to determine the quantity of cement kiln dust and additives required to stabilize the dredged sediment to an acceptable state for landfill disposal.

5.6 Sediment Staging Areas

It is assumed that sediment would be staged and treated in the vicinity of the project area if landfill disposal were required. If the Jones Island facility were not available for staging, an area near the river would be recommended to limit handling costs.

5.7 Disposal

There are two alternatives available for disposal of dredged sediments: 1) disposal at the Jones Island CDF or 2) dewatering/stabilization/solidification of sediments and disposal at an off-site landfill. Disposal at the Jones Island CDF would be a less expensive disposal option, because sediment could be off-loaded directly to the disposal area, thereby eliminating the additional treatment steps required for off-site disposal. The limitations of using the Jones Island CDF are explained in Section 5.7.1.1 below. However, if off-site disposal were required it is assumed that sediment would be staged and treated in the vicinity of the project area prior to landfill disposal. Off-site disposal would require additional treatment and handling procedures that would increase disposal costs. The additional costs would be associated with: 1) treatability studies for dewatering of dredged sediments; 2) construction of a dewatering/stabilization/solidification facility; 3) transport of the material to the staging area; 4) dewatering/stabilization/solidification of dredged material; 5) additional permitting, testing, and treatment of pore water from dredged sediments; 6) rehandling of material for transport to an off-site landfill; 7) transport of material to an off-site landfill; and 8) off-site landfill disposal costs.

5.7.1 Dredged Material

The following subsections describe the requirements for disposal at the Jones Island CDF and general requirements for disposal at an off-site landfill. The closest landfill that will accept dredged sediments is located approximately 10 miles from the study area at the Metro Landfill in Franklin, Wisconsin.

5.7.1.1 Jones Island CDF

Only navigational related material may be disposed of at the Jones Island CDF. The USACE has reviewed the PCB and PAH data obtained during the Altech Environmental Services Investigation

(Altech, 2003). The contaminant concentrations present in the sediments fall within the range found to be acceptable for disposal at the Jones Island CDF. Jones Island CDF does not accept material that exceeds TSCA levels (i.e. PCBs > 50 mg/kg). None of the sediment samples collected during the Altech investigation exceeded TSCA levels. The sediment samples from Section 3, located near the 1st Street Bridge exhibited higher PCB concentrations as compared to the rest of the study area. These levels will be evaluated by the USACE to determine if specific dredged material management measures are necessary to eliminate any contaminant pathways of exposure to the environment. It is assumed that the Jones Island CDF has the capacity to receive dredged material from the study area. As part of the regulatory process, the WDNR must request use of the Jones Island CDF in order to be considered for sediment disposal at the Jones Island CDF. It is anticipated that the USACE would process such a request within 60 days of receipt.

A project sponsor needs to apply for the permission to the USACE to use the CDF. If permission to use the CDF is granted by the USACE, guidelines for acceptance, management, and placement of the dredged material would be established by the USACE before material is accepted. It should be noted that the USACE routinely accepts navigation related dredged sediment for disposal following review of the request, including sediment quality and capacity needs.

5.7.1.2 Off-Site Landfill Disposal

Landfill disposal would require low sediment water content and dewatering would be necessary. Because this material is not considered hazardous it could be disposed of at a Subtitle D industrial landfill. The typical minimum acceptance criterion for disposal is that the waste not a hazardous waste (defined by ignitability, corrosivity, toxicity, etc.) and that it is a solid (defined by paint filter test).

5.7.2 Decanted Water

The Jones Island CDF is regulated by the State of Wisconsin, but is not required to have an NPDES permit. Direct discharge of decant water is not permitted. As a result, materials received at the CDF are limited to those generated by mechanical dredging.

Dewatering of sediments would be required prior to landfill disposal. Dewatering activities conducted within the study area that discharged treated water into the Kinnickinnic River would be required to obtain an NPDES permit. A general discharge permit issued by the Wisconsin DNR would not be applicable to the dewatering of sediment and discharge to the Kinnickinnic River.

Therefore, a site-specific discharge permit would be necessary for discharge to the Kinnickinnic River. Another discharge option is to discharge treated water at the Jones Island POTW; the applicability and acceptability of discharging treated water at the Jones Island POTW is evaluated on a case-by-case basis. This is primarily dependant on the time of year and operating capacity of the Jones Island wastewater treatment plant.

5.8 Capping

An alternative for isolating exposed sediments that exceeded background PCB concentrations (1 mg/kg PCBs) would be to install an engineered cap over these areas. The cap would consist of clean sand material deposited in areas to a depth of approximately three feet. Prior to construction, capping would require an engineering evaluation of the proposed capping areas to determine the final design. An inspection and maintenance plan would be necessary to maintain the cap integrity. For a detailed description of engineered cap design please refer to *Guidance for Subaqueous Dredged Material Capping* (Palermo, 1998) and *Subaqueous Cap Design: Selection of Bioturbation Profiles, Depths and Process Rates* (USACE, 2001).

5.9 Regulatory/Permitting Requirements

All dredging and related activities including: dredging, staging, capping, discharge of pore water, and disposal may require the acquisition of permissions, approvals and/or regulatory permit acquisition

- USACE Section 10 dredging permit
- USACE Section 404 of the Federal Clean Water Act
- 40 CFR Part 70 – Air Pollution Control
- WPDE Permit
- Chapter 30 of the Wisconsin Statutes
- Discharge Permit to the KK River or the Jones Island POTW
- Landfill approval for acceptance of dredged material
- Local Soil/Sediment Erosion Control Plan Permits

5.10 Plan Formulation

5.10.1 Plan Formulation Meeting

A plan formulation meeting was held on May 9, 2003 at The Port of Milwaukee office to discuss project issues and to select remediation alternatives for the Concept Design Documentation Report that would meet remediation goals and local recreational navigational needs.

5.10.2 Public Informational Meeting

A meeting with interested local businesses and stakeholders was also held on May 9, 2003 at The Port of Milwaukee office (following the Plan Formulation Meeting). The purpose of the meeting was to provide updates about the ongoing sediment investigation within the study area and to discuss the potential remediation/dredging options.

5.10.3 Resolution of Key Issues

Discussion of project issues has continued among stakeholders since the meetings in Milwaukee on May 9, 2003. These discussions have resulted in the following:

Sediment Quality Objectives

- PCB data will be used to make decisions regarding dredging alternatives. PAH data will not be considered. The reason is that after the contaminated sediment is removed based on the PCB profiles, the majority of PAH contaminated sediment will also be removed.

- Alternatives will be developed using a sediment quality objective of either background PCB concentrations or a comparison to existing PCB concentrations in the upper level of sediments (i.e. PCB concentrations in sediment left after dredging cannot be greater than existing concentrations).

Minimum Navigation Depth

- The dredging reference point for all alternatives will be the Chart Datum for Lake Michigan (elevation of 577.5 feet as referenced to the International Great Lakes Datum 1985 (IGLD85)). Water depth for all alternatives will use this reference point as 0.

- Alternatives will provide a minimum of 10 feet of water below the reference point to accommodate locally-determined requirements for commercial and recreational navigation.

One alternative will be developed that considers the historic low water level as the reference point to determine depth.

Dredging Width

- During the Scoping Meeting, the consensus of the group was that only dredging of the entire width of the river (bank-to-bank) would be studied in the Concept Design.

- The sediment volume calculations should consider that native (undisturbed) sediments will likely not be contaminated. Based on observations during the 2002 sediment investigation (Altech, 2003 and Coleman, 2002), there was some indication of a visual division between soft sediment (contaminated) and native sediment (non-contaminated). The historic dredging depth of the project area (18 to 21 feet below chart datum) is the depth that native material would most likely be observed.

- An additional dredging scenario, based on an 80-foot wide channel that slopes up to the seawalls and provides a minimum navigation depth, will be studied in the Concept Design.

Capping After Dredging

The capping options discussed included 1) an engineered cap (one example would be 2 feet of sand; 1 foot of armoring stone) to be placed following dredging (to be used when dredging operations leave significant PCB contamination exposed); and 2) natural deposition over areas where dredging operations leave behind exposed sediments with near-background PCB concentrations. Other capping options, including: 1) a thin-layer cap (1 to 3 inches of clean sand); and 2) a 12-inch thick gravel cap, were discussed. In addition, it is recommended that a river velocity profile for the project area be determined to aid in dredging and cap design.

Further discussion considered the following:

- The Fox River FS (prepared for WDNR) discarded the thin-layer cap option as inappropriate for PCB contamination. The FS cites that the thin-layer capping option is more appropriate for "contaminants that naturally attenuate over time".

- USACE's Guidance for Subaqueous Dredge Material Capping states that cap design should consider bioturbation, erosion, and chemical isolation. A thin-layer cap would not address any of these issues; the 12-inch thick gravel cap might address erosion issues, but would not meet bioturbation and chemical isolation criteria.

- Anchoring by recreational vessels would likely penetrate 1 to 2 feet of the sediment layer. A thin layer or 12-inch gravel layer does not consider this issue.

- The sizing of the armoring stone used to protect the integrity of the cap layer is affected by boat draft, propeller size, engine power, etc. If the capping alternative is selected, sizing of the armoring stone would occur in the design phase.

Based on this information, it was concluded that the capping options considered for this project should:

- Consider only the engineered cap (2 feet of sand; 1 foot of armoring stone) in the capping option. Final specification of cap would be completed in the design phase.

- Drop the 12-inch gravel cap options from further consideration.

- Consider natural deposition and/or a thin-layer cap for exposed sediments with PCB concentrations at or slightly above background.

5.10.4 Summary of Alternatives

A more detailed description of the dredging alternatives is provided in Section 6, this includes dredged sediment volumes, seawall replacement estimates, and cost estimates for disposal of dredged sediments at the Jones Island CDF and an off-site landfill. Listed below is a brief description of the dredging alternatives evaluated for this concept design report.

Alternative 1: No Action

- This alternative is provided as a baseline to compare the five dredging alternatives described below.

Alternative 2: Dredge Bank to Bank

- ***Alternative 2A***: Dredge the entire channel width (bank to bank) to historic navigation depths, 20.5 to 24.5 feet below the Lake Michigan Chart Datum IGLD85 (557 to 553 ft msl). The anticipated post dredging PCB concentration in surficial sediments would be $\leq$1.0 mg/kg.

- ***Alternative 2B***: Dredge the entire channel width and cap contaminated sediments to an elevation that accommodates navigation, 11 ft below the Lake Michigan Chart Datum

IGLD85 (566.5 ft msl). Sediments would be dredged to 563.5 ft msl and then a 3-foot cap would be installed to 566.5 ft msl to isolate contaminants. The anticipated post dredging PCB concentration in surficial sediments would range from <1.0 mg/kg to 36 mg/kg. However, after cap installation it is anticipated that surficial sediment PCB concentrations would be ≤1.0 mg/kg.

- ***Alternative 2C***: Dredge the entire channel width and cap contaminated sediments to an elevation that accommodates navigation needs based on historic low water levels, 12.5 ft below the Lake Michigan Chart Datum IGLD85 (565 ft msl). Sediments would be dredged to 562 ft msl and then a 3-foot cap would be installed to 565 ft msl to isolate contaminants. The anticipated post dredging PCB concentration in surficial sediments would range from <1.0 mg/kg to 21 mg/kg. However, after cap installation it is anticipated that surficial sediment PCB concentrations would be ≤1.0 mg/kg.

Alternative 3: Dredge an 80-foot Wide Navigation Channel

- ***Alternative 3A***: Dredge an 80-foot navigation channel to the historic navigation depths, 20.5 to 24.5 feet below the Lake Michigan Chart Datum IGLD85 (557 to 553 ft msl) and slope the remainder of the channel width to the seawall to an elevation that accommodates navigation (566.5 ft msl). PCB concentrations of the surficial sediment in the 80-foot navigation channel would be ≤1.0 mg/kg. PCB concentrations of surficial sediments on the slope would vary significantly and could exceed 3 mg/kg at some locations.

- ***Alternative 3B***: Dredge an 80-foot navigation channel to 16.5 to 20.5 ft below the Lake Michigan Chart Datum IGLD85, this will remove a significant portion of contaminants from the navigation channel, but will still leave some contaminants in place. The remainder of the channel width would be sloped up to the seawall to an elevation that accommodates navigation (566.5 ft msl). PCB concentration of the surficial sediment in the 80-foot navigation channel would range from 1 to 3 mg/kg and PCB concentrations of surficial sediments on the slope would vary significantly and could exceed 3 mg/kg at some locations.

Cost, volume, and seawall replacement estimates for CDF Disposal and Offsite Landfill Disposal are provided in Section 6 for the alternatives described above.

5.11 Methodology for Dredging Alternatives

Six alternatives developed during the plan formulation were considered in detail and are described in Section 6. All of the dredging alternatives evaluated in Section 6 use similar dredging techniques that are described below rather than in each alternative subsection.

Mechanical dredging is the most commonly used technique for navigational dredging in the Milwaukee Harbor. Since mechanical dredges are readily available and provide near in-situ sediment solid concentrations this is the preferred method for dredging sediments in the study area and will be the dredging method used for all the alternatives. Dredged sediments would be loaded onto a barge for transport to a nearby staging/disposal area. During dredging activities a mobile silt curtain would be placed downstream of the dredging activities to minimize the loss of suspended sediments. Two proven disposal options were considered in detail for the alternatives and include: 1) disposal of sediments at the Jones Island CDF; and 2) disposal of sediments at an off-site landfill.

5.12 Methodology for Estimating Seawall Replacement/Installation Quantities

Section 6 of this report evaluates conceptual design costs for six dredging alternatives. These alternatives are described briefly in Section 5.10.4 to provide a reference point for how the seawall replacement/installation lengths were determined for the dredging alternatives analysis and cost estimates in Section 6. This subsection of the report describes the methodology used for estimating the length of seawall that would be replaced for each dredging alternative.

Two general dredging scenarios exist for determining seawall replacement/installation lengths: 1) to dredge the entire width of the river (Alternatives 2A through 2C) and 2) dredge an 80-ft navigation channel that slopes up to the riverbank (Alternatives 3A and 3B). Alternative 1 is the no action alternative and does not include seawall replacement/installation and therefore, is not evaluated here.

The dredging scenario depths for Alternatives 2 and 3 were compared to the seawall stability evaluation performed in the *Seawall Evaluation Report* (Appendix B) to determine the approximate length of seawall that would most likely need to be replaced or installed in the project area.

5.12.1 Alternative 2: Seawall Replacement/Installation Estimate

Alternatives 2A through 2C would most likely not provide sufficient sediment depth next to the seawalls or unprotected river bank to provide sufficient seawall or river bank stability. Based on the conceptual design seawall stability evaluation (Appendix B) and general engineering judgment it is estimated that the entire project area would require seawall replacement or installation if the project area were dredged bank to bank. This would equate to approximately 3,983 ft of seawall that would need to be replaced or installed.

5.12.2 Alternative 3: Seawall Replacement/Installation Estimate

Alternatives 3A and 3B would most likely provide sufficient sediment depth next to the seawalls or unprotected river bank at some locations. Based on the conceptual design seawall stability evaluation (Appendix B) and general engineering judgment it is estimated that only a portion of the project area would require seawall replacement or installation. The seawall replacement/installation length was determined assuming that:

1) The Wakefield timber walls are generally in poor condition and would likely not withstand dredging activities and would require replacement.

2) The concrete walls are in good condition, but the depths of the walls are unknown and therefore, were assumed to be too shallow to withstand dredging activities and would require replacement.

3) Stretches of the river that do not have seawall and would have sufficient distance from the 80-ft channel to maintain bank stability would be left alone and would not require seawall.

4) Unprotected river bank that would most likely not remain stable after dredging would require seawall installation. This includes two areas: 1) the outside river bend in Section 2 (Parcels 427 and 428, Appendix B) because it has a building near the dredging limits and would most likely require a seawall to maintain bank stability and 2) the south river bank of Section 3, which is close to the dredging limits creating a steep slope that would most likely result in slope failure of the unprotected area.

Based on these assumptions approximately 2,669 feet of seawall would need to be replaced or installed for Alternatives 3A and 3B if dredging were to occur within 10 feet of the existing seawall or unprotected river bank.

5.12.3 Additional Seawall Evaluation

Additional information or seawall evaluation may be required after the limits of the channel dredging are finalized in the design phase of this project. The additional information required once the dredging depth and width are determined include: 1) the soil type in the vicinity of the seawalls and structures; 2) design information for walls and structures not available during the preparation of the *Seawall Evaluation Report* (Appendix B); and 3) a complete and detailed structural analysis of the structures and seawalls in question. For additional seawall information refer to Appendix B for the complete *Seawall Evaluation Report*.

6.0 Detailed Analysis of Alternatives

6.1 Detailed Description of Alternatives

6.1.1 Alternative 1 – No Action

Included to provide a baseline for comparison with other alternatives

- **Sediment removed:** None
- **Water depth:** 0 to 10 feet below Lake Michigan Chart Datum IGLD85
- **Top of sediment elevation:** 577.5 to 567.5 feet msl
- **Anticipated post-project surficial sediment PCB concentration:** No change (Range: ≤ 1.0 mg/kg to 6 mg/kg)
- **Estimated mass of PCBs removed**: None
- **Project-related river bank work**: None
- **Estimated Project Cost:** $0

Recreational and commercial navigation use of the area would continue to resuspend contaminated sediments. The transport of contaminated sediments in the water column would continue to impair beneficial uses in the areas, including the harbor and Lake Michigan. The exposed sediment portions of the river do not have analytical samples associated with them and the concentrations of PCBs and PAHs are unknown. If no action were to occur, it is recommended that sediment samples be collected from the exposed sediment areas and analyzed for contaminants. If contaminant concentrations of the exposed sediments are considered harmful to human health it is recommended that immediate remedial action is taken to address the exposed sediment portions of the project area.

6.1.2 Alternative 2: Deepen Bank to Bank

6.1.2.1 Alternative 2a – Deepen bank to bank (dredge to historic navigation depth)

- **Sediment removed:** approximately 192,000 cubic yards (CY), calculations are provided in Appendix E.

- **Post-project water depth:** 20.5 to 24.5 feet below Lake Michigan Chart Datum IGLD85.

- **Dredging elevations:** Section 1: 557 ft msl: Section 2: 557 to 553 ft msl; and Section 3: 553 ft msl.

- **Anticipated post-project surficial sediment PCB concentration:** ≤ 1 mg/kg

- **Estimated mass of PCBs removed:** 1,300 lbs, calculations are provided in Appendix F.

- **Project-related river bank work:** Install seawalls along entire project area river bank (3,983 ft)

- **Estimated Project Cost:** $15 Million to $36 Million, detailed cost estimates are provided in Tables 1 and 2.

The anticipated project schedule is provided in Figure 9.

6.2.1.2 Alternative 2b – Deepen bank to bank (dredge to minimum navigation depth)/isolate contaminated sediments

- **Sediment removed:** Approximately 92,000 CY, calculations are provided in Appendix E.

- **Post-project water depth**: 11 feet below Lake Michigan Chart Datum IGLD85. Sediments would be dredged to 14 feet below the Lake Michigan Chart Datum IGLD85 and then a 3-foot cap would be installed to 11 feet below the Lake Michigan Chart Datum IGLD85 to isolate contaminants.

- **Dredging elevations:** Section 1: 563.5 ft msl: Section 2: 563.5 ft msl; and Section 3: 563.5 ft msl.

- **Top of cap elevations:** Section 1: 566.5 ft msl: Section 2: 566.5 ft msl; and Section 3: 566.5 ft msl.

- **Volume of material for cap:** Assuming a 3 foot engineered cap is required, approximately 35,000 CY of material would be needed.

- **Contaminated sediment isolation**: Install a 3-foot thick, engineered cap over the project area. Ultimately, the engineered cap will require annual maintenance to confirm the integrity of the cap and to patch areas that have scoured.

- **Anticipated post-capping surficial sediment PCB concentration**: ≤1 mg/kg (Note: Post dredging PCB concentrations would range from <1 to 36 mg/kg prior to cap installation)

- **Estimated mass of PCBs removed:** 600 lbs, calculations are provided in Appendix F.

- **Project-related river bank work:** Install seawalls along entire project area river bank (3,983 ft)

- **Estimated Project Cost:** $13 Million to $23 Million, detailed cost estimates are provided in Tables 3 and 4.

The anticipated project schedule is provided in Figure 10.

6.2.1.3 Alternative 2c – Deepen bank to bank (dredge to minimum navigation depth based on historic low water level)/isolate contaminated sediments

- **Sediment removed:** Approximately 110,000 CY, calculations are provided in Appendix E.

- **Post-project water depth:** 12.5 feet below the Lake Michigan Chart Datum IGLD85. Sediments would be dredged to 15.5 feet below the Lake Michigan Chart Datum IGLD85 and then a 3-foot cap would be installed to 12.5 feet below the Lake Michigan Chart Datum IGLD85 to isolate contaminants.

- **Dredging elevations:** Section 1: 562 ft msl: Section 2: 562 ft msl; and Section 3: 562 ft msl.

- **Top of cap elevations:** Section 1: 565 ft msl: Section 2: 565 ft msl; and Section 3: 565 ft msl.

- **Volume of material for cap:** Assuming a 3 foot engineered cap is required, approximately 35,000 CY of material would be needed.

- **Contaminated sediment isolation:** Install a 3-foot thick, engineered cap over the project area. Ultimately the engineered cap will require annual maintenance to confirm the integrity of the cap and to patch areas that have scoured.

- **Anticipated post-capping surficial sediment PCB concentration:** ≤1 mg/kg (Note: Post dredging PCB concentrations would range from <1 to 21 mg/kg prior to cap installation.)

- **Estimated mass of PCBs removed:** 700 lbs, calculations are provided in Appendix F.

- **Project-related river bank work:** Install seawalls along entire project area river bank (3,983 ft)

- **Estimated Project Cost:** $14 Million to $26 Million, detailed cost estimates are provided in Tables 5 and 6.

The anticipated project schedule is provided in Figure 11.

6.1.3 Alternative 3 – 80-foot wide navigation channel

6.1.3.1 Alternative 3a – 80-foot wide navigation channel (dredge to historic navigation depth)

- **Sediment removed:** Approximately 170,000 CY, calculations are provided in Appendix E.

- **Post-project water depth:** 20.5 to 24.5 feet below Lake Michigan Chart Datum IGLD85 for 80-foot wide channel with side slope transitioning to 11 feet below the Lake Michigan Chart Datum IGLD85 near the river bank.

- **Dredging elevations:** Section 1: 557 ft msl in 80-ft channel to 566.5 ft msl at river bank: Section 2: 557 to 553 ft msl in 80-ft channel to 566.5 ft msl at river bank; and Section 3; 553 ft msl in 80-ft channel to 566.5 ft msl at river bank.

- **Anticipated post-project surficial sediment PCB concentration**:

  - **Channel**: ≤ 1 mg/kg

  - **Side slope**: Variable over a large range and could exceed 5 mg/kg at some locations

- **Estimated mass of PCBs removed**: 1,200 lbs, calculations are provided in Appendix F.

- **Project-related river bank work:** No alteration of existing steel sheet piling of known depth; replace concrete and Wakefield timber seawalls; install seawall along unprotected south river bank of Section 3 and along the outside river bend in Section 2 (Parcels 427 and 428, Appendix B).

- **Estimated Project Cost:** $12 Million to $31 Million, detailed cost estimates are provided in Tables 7 and 8.

The anticipated project schedule is provided in Figure 12.

6.1.3.2 Alternative 3b – 80-foot wide navigation channel (dredge to a range between the historic navigation depth and the minimum navigation depth)

- **Sediment removed**: Approximately 134,000 CY, calculations are provided in Appendix E.

- **Post-project water depth**: 16.5 to 20.5 feet below Lake Michigan Chart Datum IGLD85 for 80-foot wide channel with side slope transitioning to 11 feet 5 feet below Lake Michigan Chart Datum IGLD85 near the river bank

- **Dredging elevations:** Section 1: 561 ft msl in 80-ft channel to 566.5 ft msl at river bank: Section 2: 561 to 557 ft msl in 80-ft channel to 566.5 ft msl at river bank; and Section 3; 557 ft msl in 80-ft channel to 566.5 ft msl at river bank.

- **Anticipated post-project surficial sediment PCB concentration**:

    - **Channel:** ≤1 to 3 mg/kg
    - **Side slope:** Variable over large range and could exceed 5 mg/kg at some locations

- **Estimated mass of PCBs removed:** 1,000 lbs, calculations are provided in Appendix F.
- **Project-related river bank work:** No alteration of existing steel sheet piling of known depth; replace concrete and Wakefield timber seawalls; install seawall along unprotected south river bank of Section 3 and along the outside river bend in Section 2 (Parcels 427 and 428, Appendix B).
- **Estimated Project Cost:** $11 Million to $25 million, detailed cost estimates are provided in Tables 9 and 10.

The anticipated project schedule is provided in Figure 13.

6.1.7 Costs

In order to evaluate relative costs for each alternative, conceptual engineering cost estimates are provided in Tables 1 through 10. Cost estimates for each alternative is subdivided into capital costs, engineering and administration costs, and operation and maintenance costs. To calculate operation and maintenance costs as present value costs an interest rate of 7% was applied over a period of 30 years. Estimated unit costs were based on information obtained by speaking with local dredging contractors, the Metro Landfill, reviewing cost estimates for dredging projects in Michigan and Wisconsin, and using good engineering judgment. To account for the uncertainty inherent with conceptual cost estimates a 25% contingency was added to the total cost. These costs are not to be construed as design and construction costs, but as conceptual design costs to be used for cost comparison. The costs and benefits of each alternative needs to be considered when selecting the remedy and should be weighted on recreational, commercial, and environmental restoration goals.

6.2 Detailed Analysis of Alternatives

No action and five other alternatives being considered were analyzed and compared to each other for the following criteria:

- Engineering Implementation, Reliability and Constructability

- Technical Feasibility
- Adverse Impacts During Implementation
- Risks Remaining After Implementation
- Costs

6.2.1 Engineering Implementation, Reliability, and Constructability

This section describes the relative feasibility of the dredging alternatives in regards to engineering implementation, reliability, and constructability. The criteria used to evaluate these aspects are described below.

Engineering Implementation

- Ability to monitor migration and exposure pathways
- Ability to conduct additional remediation, if necessary
- Time for beneficial results to be observed after implementation of remedial efforts

Reliability

- Operation and maintenance requirements
- Demonstrated and expected reliability

Constructability

- Ability to execute the selected technologies
- Availability of services and materials
- Necessity of permits and agreements
- Are treatment or disposal facilities available

Because all the alternatives are proven technologies, implementation, reliability, and constructability are relatively well understood. Alternatives that involve disposal of dredged sediments at an off-site landfill will have additional logistics associated with them as compared to CDF disposal and include:

additional permitting for porewater discharge; locating a site suitable for dewatering sediments; constructing a facility for dewatering/stabilizing sediments; testing and optimization of sediment dewatering/stabilization; odor and permit issues associated with dewatering/stabilizing sediments; and transport and disposal at an off-site landfill.

Alternatives that involve an engineered cap (Alternatives 2B and 2C) would require additional design and testing to determine the appropriate installation of material in the study area; armoring and/or sufficiently sloping the cap to limit scouring; and an operation and maintenance plan would also be necessary to monitor and maintain cap integrity. The capping alternatives would also hinder and add to the cost of future remediation that would remove all contaminants from the sediments in the study area, because the volume of sediments would include the three-foot cap material in addition to the contaminated sediments that are beneath the cap.

All alternatives will require additional seawall evaluation for the selected dredging scenario to better estimate seawalls that would require repair, replacement, or areas without seawalls that would require seawall installation. This will be a significant portion of the dredging efforts proposed in the study area.

6.2.2 Technical Feasibility

This section describes the relative feasibility of the dredging alternatives in regards to technical feasibility. The criteria used to evaluate this are described below.

- Effectiveness in terms of intended function
- Expected reductions in toxicity, mobility, and volume
- Sustainability of intended remedy
- Mass of contaminants remaining

Because all the alternatives are proven technologies, the technical feasibility of the alternatives is relatively well understood. There will be immediately observed benefits for all of the dredging alternatives (Alternatives 2 and 3), which include: removal of sediments that are above the water line, which would eliminate direct contact exposure; provide sufficient depths for navigation; decrease PCB and PAH contaminant mass in the sediments; and provide better habitat for aquatic life.

Alternative 2A is the most protective of the environment, because sediments are dredged down to the background PCB concentration of ≤1.0 mg/kg. Alternative 3A may prove to be the next dredging alternative that is protective of the environment. However, there is some uncertainty for Alternative 3A as to whether are not all of the PCBs will be removed from the area outside of the dredged 80-ft navigation channel, because there was limited data collected in this area and the surficial sediment PCB concentrations remaining on the side slope is uncertain and may exceed 5 mg/kg. Prior to sometime between 1936 and 1944 a navigation channel was maintained in the study area down to 18 to 21 feet (560 to 557 ft msl); see Appendix C for historic navigation charts and elevation table. It is also known that the channel was not dredged entirely to the seawall and that from the seawall to the former navigation channel this area would have been sloped. Therefore, it is assumed that "native" sediment that was in place below the historic navigational dredging elevation, ≤560 to 557 ft msl, would not contain significant concentrations of contaminants, because freshly deposited contaminated sediment would have been removed by historic maintenance dredging.

Long-term benefits will be observed with deposition of cleaner upstream sediments (PCBs ≤1.0 mg/kg) into the study area, providing a "clean" cap over any surficial sediment. Alternatives 3A and 3B either partially or entirely rely on natural deposition to cover surficial sediments that exceed background PCB concentrations. Therefore, for these alternatives, there is some limited exposure to sediments that are above background PCB concentrations.

6.2.3 Adverse Impacts during Implementation

This section describes the relative feasibility of the dredging alternatives in regards to adverse impacts during implementation. The criteria used to evaluate this are described below.

- Risk to community/environment during remedial implementation
- Worker exposure to contaminants during remedial implementation
- Seawall and miscellaneous structure stability during dredging activities

For all dredging alternatives some sediments will be disturbed and suspended within the water column. A silt containment barrier will be used to limit transport downstream, but there is a chance that some contaminated sediment will not be contained by the barrier and would be transported downstream. Risk to the community will be low for all dredging scenarios since there will be very little direct or indirect contact with the sediments and the community. There are some slight risks posed to the workers inherent to any dredging activity (i.e. water, large equipment operation, etc.).

Risks inherent to this study area would include utilities or structures located in or near the study area (i.e. overhead or underground utilities, draw bridges, seawalls, etc.). Contaminants are above background concentrations, but are below hazardous waste (TSCA) levels. Therefore, a health and safety plan should address any site specific risks.

Alternatives that involve disposal of dredged sediments at an off-site landfill will have some nuisance odor issues at the dewatering and staging facilities that may need to be addressed by an air permit and monitoring. As well as increased traffic created by trucks hauling dewatered sediment to an off-site landfill. Depending on the dredging alternative selected there would be approximately 5,000 to 10,000 trips by trucks (assuming a 20 CY trailer) to the landfill to dispose of dredged sediments.

Alternatives 2A through 2C, which involve dredging the entire width of the channel, will most likely require installation of new seawalls and/or strengthening of existing seawalls for the entire project area. Alternatives 3A and 3B, which involve only dredging an 80-foot wide channel, would most likely require installation of new seawalls and or strengthening of existing seawalls for only a portion of the project area. All the dredging alternatives will most likely require replacement or strengthening of miscellaneous structures in the project area (i.e. boat slips, boat lifts, bridge abutments, and railroad bridge protective timber pile fence).

6.2.4 Risks Remaining After Implementation

This section describes the relative feasibility of the dredging alternatives in regards to risks remaining after implementation. The criteria used to evaluate this are described below.

- Magnitude of risk remaining after implementation of remedial action
- Potential for future exposure to contaminants
- Maintenance
- Reliability of remedial action to limit contaminant exposure

Each dredging alternative poses the following risks: 1) potential re-suspension of contaminated sediment during dredging operations; 2) re-deposition of contaminated sediment either within the study area or downstream of the study area; and 3) due to the limited characterization of sediment within the study, post-dredging surficial sediment PCB concentrations that exceed target levels (i.e., hot spots not identified by previous sampling efforts). Alternative 2A is the most protective of the environment, because sediments are dredged down to background PCB concentrations of ≤1.0 mg/kg. Long-term benefits will be observed with deposition of cleaner upstream sediments into the study area, providing a "clean" cap over any surficial sediment. Alternatives 3A and 3B either partially or entirely rely on natural deposition to cover surficial sediments with average concentrations that exceed background PCB concentrations. Therefore, for these alternatives there is some exposure to sediments that are above background PCB concentrations. Alternatives that involve an engineered cap (2B and 2C) would require annual operation and maintenance to monitor and maintain cap integrity. Compared to the no action alternative, Alternative 3B would leave the greatest mass of contaminants in place.

6.2.5 Costs

This section describes the relative feasibility of the dredging alternatives in regards to cost. The criteria used to evaluate this are described below.

- Cost/benefit of remedial value

The conceptual cost analysis is provided in Tables 1 through 10 and a summary of alternative descriptions and costs is provided in Tables 11 and 12. Costs range from $11 million for Alternative 3B (CDF disposal), which removes a significant quantity of PCBs (~1,000 lbs), but has some uncertainty to the mass of PCBs remaining on the side slopes; to $36 million for Alternative 2A (off-site landfill disposal), which dredges the entire width of the river to background and removes the largest quantity of PCBs (1,300 lbs). In general, off-site landfill disposal of sediments is the most expensive, with costs being approximately twice the cost of disposal at the CDF. The cost range for the alternatives that dispose of sediments at the CDF, range from $11 million for Alternative 3B, which removes a significant quantity of PCBs (~1,000 lbs), but has some uncertainty to the mass of PCBs remaining on the side slopes; to $15 million for Alternative 2A, which dredges the entire width of the river to background PCB concentrations. The cost range for the alternatives that dispose of sediments at an off-site landfill range from $23 million for Alternative 2B, which restores the minimum navigation depth and isolates contaminants with a 3-foot cap; to $36 million for Alternative 2A, which dredges the entire width of the river to background.

6.3 Public Meeting

A public meeting was held on February 11, 2004 at The Port of Milwaukee office to discuss the findings of this report. The information sheet for this meeting is provided in Appendix G.

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