Analysis of Dredged Material Management Alternatives for the Milwaukee Estuary Area of Concern Great Lakes Legacy Act Project(s)

This *Analysis of Dredged Material Management Alternatives* evaluates three alternatives for management of contaminated sediment from dredging projects in the Milwaukee Estuary Area of Concern (MKE AOC). These management alternatives are being contemplated by the stakeholders of the Wisconsin Department of Natural Resources (DNR), Milwaukee Metropolitan Sewerage District (MMSD), the City of Milwaukee and its divisions of the Redevelopment Authority of the City of Milwaukee and the Port Authority, Milwaukee County, We Energies, and the United States Environmental Protection Agency (EPA) as part of Great Lakes Legacy Act (GLLA) project(s). Management Alternatives include:

Alternative One (A1) – No Action
Alternative Two (A2) – Landfill Management
Alternative Three (A3) – Dredged Material Management Facility (DMMF)

This *Analysis of Dredged Material Management Alternatives* uses the evaluation criteria of **Natural Resources (NR) 722.07(4) Wisconsin (Wis.) Administration (Adm.) Code and the National Contingency Plan (40 CFR 300.430(e)(9))**, known as the nine criteria used in the Superfund process.

History

The MKE AOC has a long history of ecological degradation and pollution. Historical discharges resulted in sediment within the MKE AOC being contaminated with various pollutants, including metals, Polychlorinated Biphenyls (PCBs), and Polynuclear aromatic hydrocarbons (PAHs).

The DNR and EPA are committed to addressing eleven Beneficial Use Impairments (BUIs) in the MKE AOC as described in the Remedial Action Plan Update (DNR, 2017). Contaminated sediment is a principal source of impairments for seven of the BUIs due to impacts on water quality, healthy aquatic and fish habitats, fisheries, and safe consumption of fish and wildlife for humans. Meaningful progress on addressing the impacts of contaminated sediment in the AOC has been made, but the downstream areas of the Milwaukee, Menomonee, and Kinnickinnic Rivers still hold considerable quantities of legacy contamination. This contamination must be addressed to remove BUIs and ultimately delist the AOC.

The rivers in the MKE AOC were historically modified (straightened and dredged) to accommodate large vessel commercial shipping, making the estuary a settling basin for sediments. Over time, sections of the rivers that were previously maintained by dredging were no longer needed for deep draft navigation, but the sediments and their associated contaminants remain. The Milwaukee, Menomonee, Kinnickinnic Rivers, and inner and outer harbor contain between 1 to 2 million cubic yards (CY) contaminated sediment. Future investigations will refine these estimates.

The recently completed Focused Feasibility Study (FFS) for the Menomonee and Milwaukee (M&M) River project evaluated the use of a DMMF as a component of the remedy, as well as typical landfill disposal (Jacobs, 2019). For the M&M project, sediment volumes ranged from 100,000 to 400,000 CY. This *Analysis of Dredged Material Management Alternatives* expands the M&M FFS evaluation to a larger scale, with a proposed facility of 46 acres and a capacity of 1.7 million CY.

Background

A DMMF is a type of facility which is commonly known as a CDF, which is neither a conventional wastewater treatment facility nor a conventional solid waste facility. What makes it different is the physical and chemical (discussed later) properties of the dredged material. Wastewater treatment facilities are designed to receive water with low levels of solids while solid waste facilities are designed to receive mostly solids with very little water. Dredged sediments placed in nearshore DMMFs typically contain 10-50% solids (dry weight basis) and closer to 10% when placed by hydraulic dredging— which is discussed in later sections. An effective DMMF must therefore borrow features from both the wastewater treatment facility and the solid waste facility in a combination that is unlike either (USACE, 2015). The DMMF must be volumetrically large enough to meet both short-term storage capacity requirements, during filling operations, and long-term requirements for the anticipated life. The DMMF must have sufficient surface area and dike height with freeboard retention of fine-grained material to maintain effluent and nearshore water quality.

Alternatives Description

Alternative One (A1) – No Action

A no-action alternative is used for comparison only. Under A1, there would be no actions conducted to control contaminant exposure by dredging sediments and therefore no management is required. All contaminated sediments would be left in the waterbody and subject to ongoing erosional and depositional forces. BUIs and fish consumption advisories would remain. Natural degradation of contaminants would not occur in many lifetimes.

Alternative Two (A2) – Landfill Management

A2 utilizes existing local facilities for the management of dredged material (sediment and debris). For the purpose of this analysis, Waste Management's Orchard Ridge Landfill at W 124 B 9355 Boundary Rd, Menomonee Falls, WI 53051 is used because it is the closest facility. Dredged material would require dewatering and stabilization to meet transportation and landfill acceptance requirements for free liquids using the paint filter test. The paint filter test is the United States Environmental Protection Agency (EPA) approved test method (EPA 9095B) to determine the presence of free liquids in a representative sample of waste. In addition, cured material strength requirements[1] are more stringent than the paint filter test.

Once the material is accepted by the landfill and in their possession, the material would be managed consistent with the landfill's plan of operation. The landfill's plan of operation may need

[1] Landfills have been requesting moisture content of less than 90%, a threshold of 10% less than the liquid limit, a minimum of 1,600 pounds per square foot of unconfined compressive strength and a minimum short-term friction angle of 25 degrees or minimum cohesive strength of 800 pounds per square foot from the consolidated triaxial undrained shear strength test.

to be updated to address the acceptance and management of this relatively large volume of dredged material. Dredged material management at the landfill would typically include dumping loads within a designated monofill area, grading the material by a bulldozer or excavator and, in certain cases, may include use for daily cover within the landfill. The landfill may place additional dredged material or solid waste until the final grade is achieved. Intermediate soil cover would be applied after reaching final grade, until the landfill's final cover system would be installed, and vegetation would be established. In some cases, additional dewatering and stabilization may need to occur at the landfill during disposal and prior to placement of intermediate or final cover.

The landfill owner would operate and maintain the landfill and its contents into perpetuity. Operation would include leachate and landfill gas collection systems as well as groundwater and perimeter gas well monitoring. The landfill owner would be required to provide financial assurance for Closure and Long -Term Care for 40 years.

For reference, the Orchard Ridge Landfill is currently the largest landfill in Wisconsin, and it accepted 959,000 tons of wastes in 2017. This is equivalent to about 1.6 million cubic yards of wastes. If the 1.7 million cubic yards of dredged materials were placed in the landfill over a 2.5-year period, the quantity of materials disposed in the landfill would increase by 70 percent during this period. Placement of this quantity of dredged material in the landfill would also consume permitted capacity and speed up the need for a landfill expansion (or new landfill) in order to provide for continued solid waste needs of the region.

Alternative Three (A3) – DMMF

A3 would utilize a proposed near-shore DMMF directly adjacent and north of the existing Jones Island Confined Disposal Facility (JI-CDF) as shown on (Figure 1) –Proposed DMMF Area. The near-shore DMMF would be an engineered structure for the containment of dredged material. The proposed facility would take advantage of components of the existing JI-CDF for the southern containment structure and the existing shoreline bulkhead wall for the western containment structure. The proposed DMMF would require northern and eastern dikes to be constructed for containment on the remaining two sides.

The dikes are currently proposed[2] with a crest elevation (top of the berm) of about 7.5 ft above current Lake Michigan water levels, which currently at a historical high, and 6 ft lower than the existing CDF. The proposed height would be resilient to long-term changes in Lake levels, while leaving room for vertical expansion to levels similar to the existing CDF.

When the hydraulically dredged material is initially deposited in the DMMF by hydraulic dredging methods it would occupy several times its original volume. Polymers may be used to assist with inital flocculation[3] and settling, particularly as the available capacity in the DMMF is reduced. After initial settlement, consolidation will occur as a function of time and the overburden pressure generated by the fill. Excess porewater pressures in the dredged material will dissipate until it

[2] The crest elevation will be determined in design.

[3] Flocculation refers to the process by which fine particulates are caused to clump together, forming what is called a floc. The floc may then float to the top of the liquid (creaming), settle to the bottom of the liquid (sedimentation), or be readily filtered from the liquid.

reaches its appoximate original in-situ density that the material was at in the waterbody. The material placed above the internal DMMF high water elevation may need to be managed with active dewatering operations such as surface trenching. Adequate volume must be provided during the dredging operation to contain the total volume of sediment to be dredged, accounting for any volume changes during placement.

Placement operations would need to be performed in a manner that minimizes rehandling. Once the DMMF is filled and at final grade, a cap would be placed and vegetated. The space could then be used for shipping, Port Milwaukee operations, or public space. The DMMF is anticipated to be owned and operated by Port Milwaukee. Port Milwaukee would maintain the DMMF into perpetuity. The need for long term monitoring would be determined as part of permitting the DMMF.

Alternative Common Elements

Landfill and DMMF management have the following common elements:

Time and Production Rate Common Elements

Time is the critical common element to both alternatives (A2 and A3). The intent of the stakeholders is to implement all necessary management actions to address BUIs associated with contaminated sediments by 2024, while keeping with the proposed priority AOC designation in the Great Lakes Restoration Initiative (GLRI) Action Plan III (EPA, 2019). Other than volume, time is the single most important variable to manage in the MKE AOC. The timeline proposed in the June 2019 Legacy Application indicated that remediation would begin in the summer of 2022. This leaves 2.5 years, until the end of 2024, to complete remediation. For this analysis, 2.5 years is used for both the landfill and DMMF alternatives.

A 1.7 million CY project executed over a period of 2.5 years would require an average annual production rate of 680,000 CY per year and 2,125 CY per day[4] (this simplified assumption is used for the following document). Further refinement of this assumption will be performed in design to account for construction details (e.g. first pass and residual dredging).

Dredging Technology Common Elements

DNR anticipates that hydraulic dredging will be the main dredging technology used in the MKE AOC due to the limitations of the existing bridges that impede marine traffic. There are 21 movable bridges in the MKE AOC that cross the Menomonee, Kinnickinnic, and Milwaukee Rivers (Milwaukee's NPR, 2019). These movable bridges would require coordinated opening for material handling scows to support mechanical dredging. This would be impractical at scale, due to the need to open and close bridges several times a day over a period of 2.5 years. Hydraulic dredging will likely require a smaller supporting mechanical dredge for debris, but for simplicity in this analysis, the DNR assumes all material would be hydraulically dredged.

[4] Assuming 320 work days per year.

Location Common Elements

Contaminated sediments are expected to be hydraulically dredged and pumped via pipeline from the different rivers and reaches of the MKE AOC to the material processing location. A material processing location will be required for both alternatives (A2 and A3). The existing JI-CDF is the proposed processing location for A2. The new DMMF would be the location for material processing under A3. The difference in processing location between the proposed DMMF and the existing JI-CDF is insignificant because they are adjacent. Therefore, the hydraulic dredging pipeline length is about the same.

Water Treatment System Common Elements

Both A2 and A3 will require a temporary water treatment system[5] of enough capacity to support hydraulic dredging at the desired production rate of 2,125 CY per day. The facilities will also need the ability to direct discharge to Lake Michigan with a Wisconsin Pollutant Discharge Elimination System (WPDES) permit for a new outfall. A combination of a one 8-inch diameter and one 12-inch diameter hydraulic dredge would provide about 2,400 CY/day of production and require about 5,100 gallons per minute (GPM) of treatment capacity, without consideration of storage. The hydraulic dredge(s) would be the primary source of water that would require treatment. Water would also be generated from other components of material processing, including:

- Dewatering pad drainage from sediment
- Backwash from the treatment system
- Decontamination water
- Precipitation

For this analysis, based on discussions with water treatment contractors, the DNR has assumed that a water treatment system would include lamella clarifiers, bag filters, and granular activated carbon. Regular sampling of wastewater discharge would be conducted to verify that the requirements for discharge are met. After startup, Discharge Monitoring Reports (DMR) would be provided to the DNR on a weekly basis.

Post Placement Common Elements

For both A2 and A3, once dredged material is placed in the final facility (either A2 or A3), it would be contained within an engineered structure that would be designed, constructed, and managed for that purpose.

Contaminants found in sediments, generally[6], are relatively stable and persistent, hydrophobic, have low solubility, an affinity for organics, and bound with the finer solid particles (e.g. silts and clays). These properties are the reason that the legacy contaminants of metals, PCBs, and PAHs remain in the MKE AOC's sediment (sometimes even more than a century after being released instead of being diluted and dispersed).

[5] Utilizing MMSD's Jones Island Water Reclamation Facility is not an option because it produces Milorganite fertilizer and cannot accept any measurable amount of PCBs.

[6] This analysis is not meant for non-aqueous phase liquid (NAPL), which is a challenging material to manage and control. NAPL-containing dredged materials will likely be handled separately, with special provisions, such as a liner or stabilized monolith within the existing JI-CDF.

The contemplated MKE AOC projects are generally near the mouth of the estuary, where the Milwaukee, Menomonee, and Kinnickinnic Rivers merge and enter Lake Michigan. The estuarine conditions inherently create a depositional environment with higher silt content and organics[7].

Per- and Polyfluoroalkyl Substances (PFAS) Common Elements

Per- and Polyfluoroalkyl Substances (PFAS) are a class of man-made chemicals that are ubiquitous. They are present in a myriad of consumer products, industrial uses, and environmental media. PFAS are similar to typical sediment contaminants in that they are hydrophobic and persistent; however, PFAS are starkly different in that they are more soluble and much more mobile.

The DNR is unaware of any sediment samples tested for PFAS in the MKE AOC; however, its fish monitoring program has tested fish in Wisconsin's major rivers (Fox, Menominee, Milwaukee, Mississippi, Peshtigo, St. Louis, and Wisconsin as well as the Great Lakes), including those located in the MKE AOC. The Mississippi River data had the highest concentrations. DNR first issued fish consumption advice for Perfluorooctanesulfonic acid (PFOS) in 2007 (Williams & Schrank, 2016). Current fish consumption guidance for PFAS in Wisconsin is limited to PFOS and the Mississippi River. When fish tissue was last tested in the MKE AOC, concentrations of PFAS did not warrant issuance of a fish consumption advisory.

DNR plans to sample for PFAS in the MKE AOC to evaluate the presence of these chemicals in sediment and surface water and to account for it in remediation design. Detectable concentrations of PFAS in the MKE AOC are likely to be found. The science and knowledge of this class of compounds is rapidly changing and evolving. Granular activated carbon has been found to be an effective water treatment technology for many PFAS compounds. PFAS information would likely be necessary for both A2 and A3 scenarios. PFAS data may be needed to determine disposal for the water treatment system carbon units regardless of the alternative.

Alternative Differences

Landfills can only accept solid waste; hydraulically dredged sediments cannot be directly transported to a landfill as they contain too much water and will not meet strength criteria. The high-water content sediment must be dewatered before being suitable for landfill acceptance. Comparatively, a DMMF is itself designed to be part of the dewatering process and would not require upland space and processing for this purpose. The infrastructure and additional work needed to support A2 is common to remedial dredging and well understood. It is done in an environmental protective manner and in compliance with applicable laws. The main difference is in costs which are described in the following sections, which include differences in water treatment, bag field setup, bag field management, stabilization, trucking, material handling, and DMMF design and construction.

[7] The Milwaukee River Downstream Reach 4 investigation tested 40 samples for geotechnical parameters. Of these, 18 of the 40 (45%), classified as organic silt (OH) by the USCS classification system. The organic silts averaged 80% fines, a specific gravity of 2.5 and dry density of 50 pounds per cubic foot. The second most frequent classification was poorly graded sand (SP) for 5 of the 40 samples, which is 13%. The M&M Investigation duplicated the results of generally low sand content in sediments.

Water Treatment Differences

Because a DMMF itself is part of the dewatering process, the DNR expects that a smaller water treatment system could be used, compared to what would be needed for A2. A3 provides more space for settling, substantial storage, buffering capacity, and altogether more flexibility. However, the conservative cost estimate assumes that the same water treatment size and components (other than the geotextile tubes discussed in the following sections) would be used for water treatment and therefore no cost difference is provided.

Bag Field Setup Differences

The M&M FFS identified geotextile bag dewatering for A2. The need for a bag field is a key difference between A3 and A2. A bag field and perimeter haul roads are necessary infrastructure to support processing the sediment to be suitable for a landfill. This evaluation assumes that the existing JI-CDF[8], with about 20 acres of available upland space, would be utilized for dewatering and sediment stabilization with A2. This is expected to be the largest area in the MKE AOC that would be available for dewatering and stabilization. For consistency with the M&M FFS[9], this analysis assumes the same liner system and unit rates for a 12-inch base layer of 3-inch diameter base-rock, a 6-inch layer of ¾-inch gravel, a 6-inch sand bedding layer, a 16-ounce non-woven geotextile, and a 60-mil High-Density Polyethylene (HDPE) flexible membrane liner. Based on the unit rates in the M&M, with modifications provided by Jacobs for stacking the geotextile tubes three high, the DNR estimates the bag field setup would cost $7 million[10, 11] to support A2. This analysis excludes the cost for haul roads at the DMMF from this estimate for A2.

Bag Field Management Differences

After the bag field and water treatment system are installed, they must be managed throughout the dewatering process to support A2. Geotextile tube dewatering is a labor-intensive process compared to passive dewatering in the DMMF under A3. Tubes would need to be deployed with fill ports and control valves installed. Polymers and flocculants would be used for settling with continuous adjustment and quality control checks (note that polymers or flocculants will likely be used with A3 as well). Additional tube maintenance would include adjusting and moving fill ports and tubes, measuring tube fill level, vibrating and agitating the tube surface to promote dewatering, and deploying and stacking more tubes. The DNR estimates the costs for the geotextile tubes[12] and maintaining said tubes[13] to be $13 million of additional cost to support A2.

[8] The M&M FFS evaluated and identified about 12 acres of a series of adjacent properties owned by the city of Milwaukee and Department of Transportation located along the north shore of the Menomonee River adjacent to the I-94 overpass bridge (Figure 12). This is 40% less space available than the JI-CDF.

[9] The liner system for the bag field would be determined in design or by the contractor.

[10] $1.8, $1.3, and $1.5 per square foot, respectively for grading and compacting, geotextile, and a liner.

[11] $48, $32, and $31 per cubic yard, respectively, for 3-inch diameter baserock, 3/4-inch gravel, and a sand bedding layer

[12] $36/lineal foot and 243,000 lineal ft based on a 75-ft circumference and 7 CY per lineal foot

[13] $2.35 per cubic yard.

Stabilization Differences

For stabilization, several synergistic effects drive the need for and amount of stabilization agents in this analysis. Geotextile tubes need time for passive dewatering, on the scale of weeks to months. However, the large dredged material volume and lack of available bag field space for tubes to be stacked for the total size of the project means that material would need continuous haul out. Thus, the short construction time, large production volume (2,125 CY/day), high silt and organic content material requiring the use of polymers, and stringent landfill cured material strength requirements—as mentioned before—means that the DNR would expect that amendments and mixing would be necessary. The DNR has assumed 10% by weight of amendment to the dewatered dredged material based on the most recent experience at Wisconsin Public Services Former Green Bay Manufactured Gas Plant. The DNR estimates that stabilization would cost $15 million for the amendment itself and another $44 million for the mixing and loading to support landfill management over the project size of 1.7 million cubic yards. This totals to $59 million.

In addition to the cost, Portland Cement, a common stabilization agent, produces CO_2 during a necessary part of the manufacturing process. Approximately 0.9 tons of CO_2 are emitted for every ton of Portland Cement produced (National Ready Mixed Concrete Association, 2012). The 10% by weight dosage rate would generate 240,000 tons of Portland Cement and 210,000 tons of CO_2.

Trucking Differences

Trucking stabilized dredged material to the landfill and tipping fees are major differences between A2 and A3; trucking is not needed for A3 other than the construction of the facility, which is discussed later. Trucks would be required to have sealed gates, a retractable tarp, and need decontamination throughout the project. Over the life of the project, the DNR conservatively estimates that 130,900 truck trips[14] would be required, which would be a total of 5.9 million miles driven and 1.2 million gallons of diesel fuel and over 13,000 tons of related carbon dioxide emissions[15]. The DNR estimates that trucking and landfill fees would cost $130 million based on a unit rate of $48 per ton; the same unit rate as the M&M FFS.

Material Handling Summary Differences

This section summarizes the additional material handling differences between A2 and A3[16] :

1. Management of dredged material by dewatering in geotextile tubes includes manual agitation by vibration, tending fill ports, and leveling the tubes (as discussed in the bag field management section).
2. Opening geotextile tubes.
3. Adding and mixing amendments.
4. Testing aged and mixed materials to determine if materials pass paint filter and material strength criteria.
5. Loading dewatered and stabilized material into trucks.
6. Transporting trucks from the existing DMMF to the nearest landfill.
7. Trucks dumping the passing material at the landfill.

[14] Assumes trucks average 20 tons per trip and a final density of 1.5 tons/CY after amendment

[15] Assumes 22 pounds CO_2/gallon of diesel and 0.9 tons CO_2/ton Portland Cement Amendment

[16] Some of the handling below overlaps sections above, this is a summary.

8. The landfill operator grading dumped material at the landfill.

DMMF Design and Construction Differences

A major difference between DMMF and landfill alternatives is that A2 is permitted and existing, and the proposed A3 has not yet been constructed. If remedial projects were ready for construction in the MKE AOC, a landfill could be utilized sooner and allow a longer project duration. This would cut down on amendments dosage rate, water treatment plant size, and the overall production rate. However, remedial project(s) are not ready. No contaminated sediment project, as part of the Legacy Act application, has completed design. The closest project in the remedial phase is the M&M project, which identified Alterative 5: hydraulic dredging with DMMF disposal, as the preferred alternative.

The proposed DMMF would need to be designed, permitted, funded, and constructed. The design and construction process are expected to take, in total, two to four years. Preliminary cost estimates have ranged greatly, from $12 million for the most cost-effective option of a smaller-volume rubble mound dike-based structure to the most expensive of greater than $200 million for double sheet pile walls for the entire perimeter. At the time of this writing, currently at the 30% Design Stage, the DMMF design engineers (Foth) are estimating costs to range from $65 to $90 million depending on the type of structure and features.

Cost Summary Differences

This cost summary focuses on the differences in costs between A3 and A2; it does not include dredging.

Costs to support management at a landfill:

- Bag field setup: $7 million
- Geotextile Tubes and Tube Dewatering: $13 million
- Amendment at 10%: $15 million
- Mixing and Loading: $44 million
- Trucking and Landfill Fee: $130 million

Total $200 million or $120/CY

Cost range to support DMMF use:

Total $65 million to $90 million
$40/CY to $50/CY

Based on the assumptions in this analysis, A3 is expected to cost $110 to $135 million or 55 to 70% less than A2. On a unit rate basis, A3 costs $70 to $80/CY less than A2. This cost difference is largely due to the reduction in material handling and landfill fees.

These cost results are consistent with the Jacobs's findings in the M&M FFS, which identified hydraulic dredging and DMMF disposal (Alternative 5A) as the most cost-effective alternative for

$16 million[17]. Hydraulic dredging with DMMF costs were $33 million less (53% less) than for mechanical dredging with landfill disposal (Alternative 5C) (CH2M, 2019). In addition, the M&M FFS estimated that hydraulic dredging with DMMF (5A) costs were $140/CY less than mechanical dredging with landfill use (Alternative 5C).

Bird Use Differences

Both A2 and A3 will be used by birds, with the species and abundance changing as the facility, habitat, and food sources change. However, generally, there is less bird abundance and biodiversity at A2, as discussed in these next two paragraphs. At A2 and during filling, carrion birds, such as crows and gulls, are attracted to municipal solid waste (MSW) as a food source. Daily cover is used to limit available food sources and the abundance of birds. Carrion birds have the potential to be exposed to pollutants from the dredged material, if daily cover is not placed, but the dredged material itself is not a significant food source. The bird species change, at a certain area, most drastically at cell closure, when waste is no longer being accepted and the final cover system is placed and vegetated. Typical vegetation is grassland, that can be the habitat for pheasants, turkey, swallows, blackbirds, and numerous other native Wisconsin birds (DNR, 2008).

While filling, A3 would be used by more water-going birds and migratory birds as a stopover and resting point. The DMMF's dikes would create a sheltered water habitat in an otherwise uninhabitable area that is used for rest and forage by many migratory and resident anseriformes (ducks, geese, swans, magpie geese, screamers), passerines (swallows and martins), pelecaniformes (pelicans), seabirds, and shorebirds. The organic rich sediment and seed bed from the estuary quickly and prolifically vegetates to provide unique habitat. According to the Urban Ecology Center, the existing JI-CDF has become a "safe haven for several species of birds and possibly boasts the largest historical bird list of any single location in Wisconsin" (Urban Ecology Center, 2019). The JI-CDF is part of the 2019 Brew City Birding Festival by the Urban Ecology Center.

A DMMF's polluted sediment would contain heavy metals, PCBs, oil, grease, PAHs and pesticides. A Sentinel Duck Study was conducted at the JI-CDF in the summer of 1990 to determine if waterfowl were accumulating contaminants from the JI-CDF. Game farm mallards were released on the JI-CDF, collected 70 days later, and were analyzed for total PCBs, metals, pesticides and PAHs. The study concluded that ducks released into the JI-CDF did not accumulate significant concentrations of contaminants as compared to field and background levels (DNR, 1994). The DNR would expect similar bird usage with a new DMMF.

Per- and Polyfluoroalkyl Substances (PFAS) Differences

For a proposed DMMF, this contaminant class, if present, will be evaluated as a migration pathway through the dikes. Treatment, such as activated carbon amendments, may be added to the dike structure. Other measures could incorporated into the overall dike design to help address this contaminant class; which is expected to be evaluated during design.

[17] Note that M&M costs included all construction costs, including dredging. The M&M FFS did not evaluate hydraulic dredging with landfill disposal. However, it did evaluate mechanical dredging with both landfill and CDF use.

Groundwater Monitoring Differences

The DNR requires on-going groundwater monitoring at landfills. Groundwater monitoring is less likely, for various reasons, to be required at a DMMF. The need for groundwater monitoring would be determined through the design process and documented in a DNR grant of low-hazard waste exception. There are materials in the MKE AOC that would need to be addressed with special provisions, such as PAHs in the form of for non-aqueous phase liquid from former Manufactured Gas Plants. These are planned to be stabilized in a monolith at the existing CDF and are excluded from this analysis.

Analysis of Alternatives

This *Analysis of Dredged Material Management Alternatives* uses the evaluation criteria of Natural Resources (NR) 722.07(4) Wisconsin (Wis.) Administration (Adm.) Code and the National Contingency Plan (40 CFR3 00.430(e)(9)), known as the nine criteria used in the Superfund process. The criteria are grouped into the threshold, balancing and modifying criteria.

There is no flexibility in meeting the threshold criteria; they must be met. The threshold criteria are: compliance with applicable federal, state, and local regulations; and overall protection of human health and the environment.

Balancing criteria weighs the trade-offs between alternatives. A low rating on one balancing criterion can be compensated for by a high rating on another criterion. The five balancing criteria are: short and long-term effectiveness, reduction of toxicity, mobility or volume, implementability, and cost.

There are two modifying criteria: state and community acceptance. The degree of acceptance can alter the weighting of alternatives under the modifying criteria. Further, input from the community and the state can be used to adapt the Alternatives (A1, A2, and A3).

In addition to the nine criteria, before selecting an Alternative, sustainable actions will be evaluated with consideration of NR 722.09(2m). In summary, the nine criteria—which are divided up into three different sections—are:

Threshold Criteria
1. Compliance with applicable federal, state, and local regulations and standards
2. Overall protection of human health and the environment

Primary Balancing Criteria
3. Long-term effectiveness and permanence[18]
4. Reduction of toxicity, mobility, or volume[19]
5. Short-term effectiveness[20]
6. Implementability[21]
7. Cost[22]

Modifying Criteria
8. Community acceptance
9. State acceptance

A detailed comparison of alternatives using the nine criteria described above is included in Table 1.

Recommendation

The DNR recommends A3. A3 meets the threshold criteria of being compliant with applicable federal, state, and local regulations and standards as well as overall protection of human health and the environment. For the balancing criteria, the short- and long-term effectiveness, reduction of toxicity, mobility, or volume, and implementability of A2 and A3 are similar. The difference to the balancing criteria is cost. A3 costs approximately $135 million, or 70% less than A2. Additional costs for A2 are associated with bag field setup and management, water treatment, stabilization agents, material handling, landfill tipping fees, and trucking. The balancing criteria are intended to weigh the trade-offs between alternatives; and because the cost difference for A2 is substantial, it overwhelms the similarity of the other balancing criteria.

In addition to the nine criteria, the DNR also evaluated sustainability. A3 is more sustainable than A2; it saves approximately 1.2 million gallons of diesel fuel from reduced hauling and 240,000 tons of amendments. In total, this would reduce carbon emissions by 200,000 tons over the useful life of the facility.

Community acceptance, a modifying criterion, will be considered as part of the 45-day public comment period for this *Analysis of Dredged Material Management Alternatives* before issuing a decision document.

In summary, the DNR recommends A3 because it meets the threshold criteria, is similar to A2 for most balancing criteria but has significantly lower costs and is more sustainable.

Decision document

A decision document will be issued at the close of the 45-day public comment period with additional details on the selected alternative.

[18] NR 722.07(4)(a)(1) Wis. Adm. Code
[19] NR 722.07(4)(a)1.a.NR 722.07(4)(a)1.a. Wis. Adm. Code
[20] NR 722.07(4)(a)(2) Wis. Adm. Code
[21] NR 722.07(4)(a)(3) Wis. Adm. Code
[22] NR 722.07(4)(b) Wis. Adm. Code

References

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Attachments

- Table 1: Detailed Comparison of Alternatives
- Table 2: Proposed Milwaukee Estuary Dredged Material Management Facility Authority and Requirements
- DMMF Layout
- Figure 12: M&M FFS

Table 1: Detailed Comparison of Alternatives

Criterion	Alternative 1 (A1) No Action	Alternative 2 (A2) Landfill	Alternative 3 (A3) Dredged Material Management Facility (DMMF)
Threshold Criteria			
1. Compliance with applicable federal, state, and local regulations and standards	No action; therefore, not applicable.	Use existing licensed landfills. Disposal of stabilized dredged material is expected to comply with all applicable federal, state, and local requirements including the plan of operation, Department of Natural Resources' (DNR) approval letters, and facility requests for material strength.	A DMMF would be designed, constructed, and filled with mostly hydraulically dredged material and operated in compliance with all applicable federal, state, and local requirements; as well as, additional requirements at the request of the DNR. The DNR would provide approval through low-hazardous waste exemption, would be required to provide a 401-Water Quality Certification, and Wisconsin Pollutant Discharge Elimination System (WPDES) permit.
2. Overall protection of human health and the environment	No action would be conducted to control contaminant exposure. All contaminated sediments would be left in the waterbody. Beneficial Use Impairments (BUIs) and fish consumption advisories would remain. Natural degradation of contaminants would not occur in a reasonable time. This alternative does not provide overall protection of the human health and the environment.	Landfill disposal is a common dredging material management alternative that is protective of human health and the environment. Contaminated sediments are removed from a waterbody, conditioned for disposal, and placed in a facility that is designed, constructed, and managed to handle dredged materials with a high level of protection.	Although not as common as landfill disposal, 35% of the total volume of material dredged to maintain Federal projects in the United States is placed in CDFs (USACE, 2015). The current CDF material, as shown by the JI-CDF investigation, has elevated levels of contamination (We Energies, 2018). The proposed DMMFs would be designed, constructed, and managed specifically for contaminated dredged material and provide a high level of protection.
Balancing Criteria			
3. Long term effectiveness and permanence	No action; therefore, this alternative is not effective in the long-term.	Landfills are operated and maintained into perpetuity. Landfills are required to provide financial responsibility for the closure and long-term care of the landfill through NR 520 Wis. Adm. Code.	A new DMMF would be operated and maintained into perpetuity by Port Milwaukee. The use of the DMMF itself for Port activities would generate revenue past closure. This is unlike a landfill that receives its revenue at the time of acceptance through a tipping fee. Port Milwaukee's revenue from the DMMF itself would help the Port pay for any required maintenance.

Criterion	Alternative 1 (A1) No Action	Alternative 2 (A2) Landfill	Alternative 3 (A3) Dredged Material Management Facility (DMMF)
4. Reduction of toxicity, mobility, or volume	No action; therefore, this alternative provides no reduction in toxicity, mobility or volume.	Landfill disposal will effectively eliminate the mobility of contaminants of concern. Toxicity will be vastly reduced by eliminating the routes of exposure to humans and the environment. The volume of contamination will be reduced by dewatering and increased density of the dredge material. In this alternative, the contaminated sediment are removed from the waterbody, conditioned for disposal, and placed in a facility designed for the perpetual containment of waste. Landfills contain the contaminants through various methods so that they do not render: – Unclean air, land or waters of the state—making similar injurious to public health, harmful for commercial or recreation use – Deleterious to fish, bird, animal or plant life Landfills are efficient, nuisance-free, and environmentally acceptable solid waste management procedures.	A DMMF would effectively eliminate the mobility of contaminants of concern. Toxicity will be vastly reduced by eliminating the routes of exposure to humans and the environment. The volume of contamination will be reduced by dewatering and increased density of the dredge material. In this alternative, the contaminated sediment are removed from the waterbody and placed in a facility designed for the perpetual containment of waste. DMMFs, with various methods, contain the contaminants so that they do not render unclean air, land or waters of the state, or making the same injurious to public health, harmful for commercial or recreational use, or deleterious to fish, bird, animal or plant life. DMMFs are efficient, nuisance-free, and environmentally acceptable dredged material management facilities.
5. Short-term effectiveness	No action; therefore, this alternative is not effective in the short-term.	Since this comparison is performed over the same time scale as the DMMF alternative, there are no differences in scope. The main difference in short-term effectiveness is a much larger amount of truck traffic. Engineering and administrative controls would be implemented to mitigate short-term effects, risks, and impacts on local communities associated with Landfill disposal, including: – Traffic planning to minimize the potential for vehicle accidents – Proper construction quality assurance procedures such as covering materials in trucks, dust suppression, and limiting truck speed for on-site haul routes. The short-term has the potential to expose carrion birds to bioaccumulating compounds.	Since this comparison is performed over the same scale as the landfill, there are no differences in scope. The DMMF would result in significantly less truck traffic than landfill disposal. The effectives of a DMMF changes over time with the worst-case condition being when the DMMF initially starts filling. Seiche, long term lake levels, and wind driven waves will drive water movement through the perimeter dikes, as well as other features that are used to control contaminant migration. The dredging material itself, comprised as mostly the silts and organics, works to slow contaminant transport. Once full, there would be no wind driven transport for the DMMF area itself because it would be land. The short term has the potential to expose migratory birds to bioaccumulating compounds. DNR game farm mallard studies did not find significant accumulation of contaminants compared to field and background levels (DNR, 1994).

Criterion	Alternative 1 (A1) No Action	Alternative 2 (A2) Landfill	Alternative 3 (A3) Dredged Material Management Facility (DMMF)
6. Implementability	No action; therefore, not applicable.	This is a proven technology. Local landfills are existing and licensed. All services and necessary materials are readily available and have been successfully implemented on numerous similar projects. Dewatering and trucking contaminated sediment is a well understood process.	A DMMF would require design, permitting, and construction. Services and necessary materials are readily available to do this, but because this type of facility has not been permitted in Wisconsin for decades, there is less certainty about the process and requirements.
7. Cost	No action; therefore, not applicable.	$200 million, $120/cubic yard (CY)	$65 million - $90 million, $40 - $50 per cubic yard (CY)
Modifying Criteria			
8. Community Acceptance	No action; therefore, not applicable.	Existing licensed landfills, by statute, went through a public meeting to be able to accept dredged materials. Landfills are used as an acceptable environmental management tool.	Community acceptance for a new DMMF will be determined through outreach and a proposed plan. There has not been community opposition to the continued use of the existing CDF.
9. State Acceptance	No action; therefore, not applicable.	The DNR accepts landfills as an acceptable dredged material management alternative.	The DNR would accept a DMMF that meets the threshold criteria, our authority outlined in Table 2, and a design that provides robust and compelling protection over the long-term.
Sustainability	No action; therefore, not applicable.	Less sustainable than a DMMF in that more truck trips, diesel fuel, and amendments are needed. More sustainable than a DMMF in that existing landfills are already constructed and licensed. Although, with the volume of material projected, it is expect that new cells or expansions of existing landfill facilities would be needed.	Over the useful life of the DMMF, this alternative would save approximately 1.2 million gallons of diesel fuel due to reduced hauling and 240,000 tons of amendments. In total, this would reduce carbon emissions by 200,000 tons. This alternative uses 45 acres from Lake Michigan for construction of the facility. The City has been granted, by the Wisconsin State Legislature, the necessary lakebed of Lake Michigan required for the proposed DMMF.

Table 2: Proposed Milwaukee Estuary Dredged Material Management Facility Authority and Requirements

What	For	Agency or DNR Program or Bureau	Code or Statute
Lakebed Grant	An act that ceded submerged lands to the city of Milwaukee extending fifteen hundred feet into Lake Michigan between the harbor entrance and Russell Avenue (south of the existing CDF) for dock and wharf purpose and railway terminals.	Watershed Wetlands & Waterways	Chapter 358 of 1909
Lakebed Grant	Amends Chapter 358, granted and ceded submerged land to the City of Milwaukee, extending the area fifteen hundred feet into Lake Michigan between the harbor entrance and Russel Avenue (south of the existing CDF). The land is to be used by the city for public slips, basins, docks, wharves, structures, roads, highways, railroads, and railways, railway terminals, and lake and rail facilities and spurs for shipping.	Watershed Wetlands & Waterways	Chapter 285 of 1923
Lakebed Grant	Amends Chapter 358 of 1909 and Chapter 285 of 1923, ceded, granted and confirmed dry or submerged land under the waters of Lake Michigan to the city of Milwaukee for improving, filling, and utilizing the same for harbor purposes and in aid of navigation, in any manner the said city may deem expedient	Watershed Wetlands & Waterways	Chapter 381 of 1931
Environmental Analysis and Review Procedures	Review of an existing or proposed use of an existing lakebed grant is an integrated analysis action that does not require a separate environmental analysis process. The existing or proposed use must be consistent with the purpose and uses for which the grant was issued.	Watershed Wetlands & Waterways	NR 150.20(2) & NR 150.20(2)(a)19m
Exemption from Chapter 30	Exemption for submerged shorelands in Lake Michigan for the placing of structures from the Chapter because the title has been granted by the state to a municipality	Watershed Wetlands & Waterways	Chapter 30.05
Exempt from a request for public hearing under Chapter 30	The request for a public hearing under 30.208(3) is not applicable because Chapter 30 is exempt per Chap 30.05	Watershed Wetlands & Waterways	Chapter 30.208(3)
Water Quality Certification	The Clean Water Act Section 401 regulates actives that may result in a discharge of pollutants into the waters of the US.	Watershed Wetlands & Waterways	NR 299
Water Quality Certification Public Involvement	Public noticing for public comment or a public informational hearing is not a requirement. A public notice for a contested case hearing is a requirement per NR 299.05(4). The department shall provide notice of the decision to the applicant, the licensing or permitting agency, and known interested parties 310.14(2). Cause notice of its decision to be published by the applicant as a class I notice under Chapter 985, and shall identify the applicant and his or her address, describe the activity and its location, state the department's determination, and appraise the public of the opportunity to request a hearing under this chapter.	Watershed Wetlands & Waterways	NR 299.05(4)
Low-hazard Waste Exemption from Regulation	Dredge Material Management Facility	Waste and Materials Management	289.43(8)
PCB Disposal - Required Public Meeting	DNR cannot approve of the disposal of PCBs without a public meeting.	Waste and Materials Management	289.54(2)

Table 2: Proposed Milwaukee Estuary Dredged Material Management Facility Authority and Requirements

What	For	Agency or DNR Program or Bureau	Code or Statute
Permits for Water Pollutant Discharge Elimination System (WPDES)	Base authority for permitting.	Wastewater	283.31
Water Quality Standards	For use with the Clean Water Act	Wastewater	281.15
Water Quality Standards	For use with the Clean Water Act	Wastewater	NR 102
Surface water quality criteria for toxic substance	For use with the Clean Water Act	Wastewater	NR 105
Calculating Water Quality Based Effluent Limitations for Point Source Discharges to Surface Waters	For use with the Clean Water Act	Wastewater	NR 106
Individual Permit requirement	The General Permit excludes discharges of dredging wastewater from contaminated sediment to waters classified as public water supply in ch. NR 104, Wis. Adm. Code	Wastewater	WPDES General Permit No. WI-0046558-06
governs the submission of plans and specifications	Provides DNR a 90-day timeline to review plans and specifications.	Wastewater	NR 108
Two permits (1) for a new WWTP & (2) discharge through the perimeter structure	Sets forth the requirements for filing applications for the discharge permits required by s. 283.31, Stats.	Wastewater	NR 200
Public Participation for WPDES	NR 203.05 lists when a discretionary or mandatory hearing is required, the notice requirements in NR 203.06, the location (NR 203.07) requirements, who is entitled to a hearing NR 203.08 and other hearing information.	Wastewater	NR 203
General provisions for WPDES	Sets forth the definitions applicable to and abbreviations used in chs. NR 200 - 299 and general conditions for all WPDES permits.	Wastewater	NR 205
Section 10 Rivers and Harbors Act	Under Section 10, a Corps permit is required to do any work in, over or under a 'Navigable Water of the U.S.' Waterbodies have been designated as 'Navigable Waters of the U.S.' based on their past, present or potential use for transportation for interstate commerce.	United States Army Corps of Engineers (St. Paul District)	33 CFR 323
Section 404 Clean Water Act	Under Section 404, a Corps permit is required for the discharge of dredged or fill material into waters of the U.S.	United States Army Corps of Engineers (St. Paul District)	33 CFR 323

Table 2: Proposed Milwaukee Estuary Dredged Material Management Facility Authority and Requirements

What	For	Agency or DNR Program or Bureau	Code or Statute
Section 408	Any use or alteration that has the potential to impact the usefulness of a USACE Civil Works project is subject to the approval of USACE.	United States Army Corps of Engineers (Detroit District)	Section 14 of the Rivers and Harbors Act of 1899 / 33 USC 408
Section 106 National Historic Preservation Act	Lead federal agency will evaluate the effects of the federal action on properties listed in the Natonal Register of Historic Places or eligible for such listing. In processing a permit application, the Corps generally accepts lead federal compliance with requirements of NHPA.	potential Corps coordination with State Historic Preservation Officer	36 CFR 800 / 33 CFR 325 App C
Section 7 Endangered Species Act	Lead federal agency will evaluate the effects of the federal action on federally listed endangered and threatened species. In processing a permit application, the Corps generally accepts lead federal compliance with requirements of ESA.	potential Corps consultation with US Fish and Wildlife	16 U.S. Code 1536(3)
National Environmental Policy Act	NEPA requires federal agencies to assess the environmental and related social and economic effects of the federal action prior to making decisions.	US Army Corps of Engineers	40 CFR Parts 1500-1508/33 CFR 325 App B
Endangered Resource Review Program	An Endangered Resources Review is required for projects that are conducted, funded, or approved by the state that may result in impacts to endangered resource.	Wisconsin Bureau of Natural Heritage and Conservation	NR 29
Groundwater Quality	protection of groundwater quality	Remediation & Redevelopment	NR 140
Safe Drinking Water Act	Lake Michigan is a drinking water source for the City of Milwaukee. The Linnwood Water Treatment Plant draws water from an intake 6,565 feet from shore, five miles north of the Milwaukee Harbor, where Lake Michigan is 62 feet deep. Howard Avenue Water Treatment Plant draws water from an intake 11,767 feet from shore where lake water depth is 57 feet deep.	DNR	42 U.S.C. §300f et seq. (1974)

DRAFT DRAWINGS FOR MILWAUKEE ESTUARY DMMF

WEC BUSINESS SERVICES

MILWAUKEE COUNTY

Foth Infrastructure & Environment, LLC
2121 Innovation Court
Suite 100
De Pere, WI 54115
Phone: 920-497-2500 Fax: 920-497-8516

REVISIONS

NO.	BY	DATE	DESCRIPTION

RECORD DRAWING OF COMPLETED CONSTRUCTION BY:

RECORD DRAWINGS OF COMPLETED CONSTRUCTION CONFORMING TO CONTRACTOR AND/OR OWNERS RECORDS.

BY _____ DATE _____

DATE OF PREPARATION

	BY	DATE
SURVEYED		
DRAWN	JRS6	8/26/2019
DESIGNED		
CHECKED	TSW	8/26/2019

PROPOSED DMMF AREA

HORIZONTAL SCALE(FEET)
0 200 400

PROJECT ID: 19W012

WI

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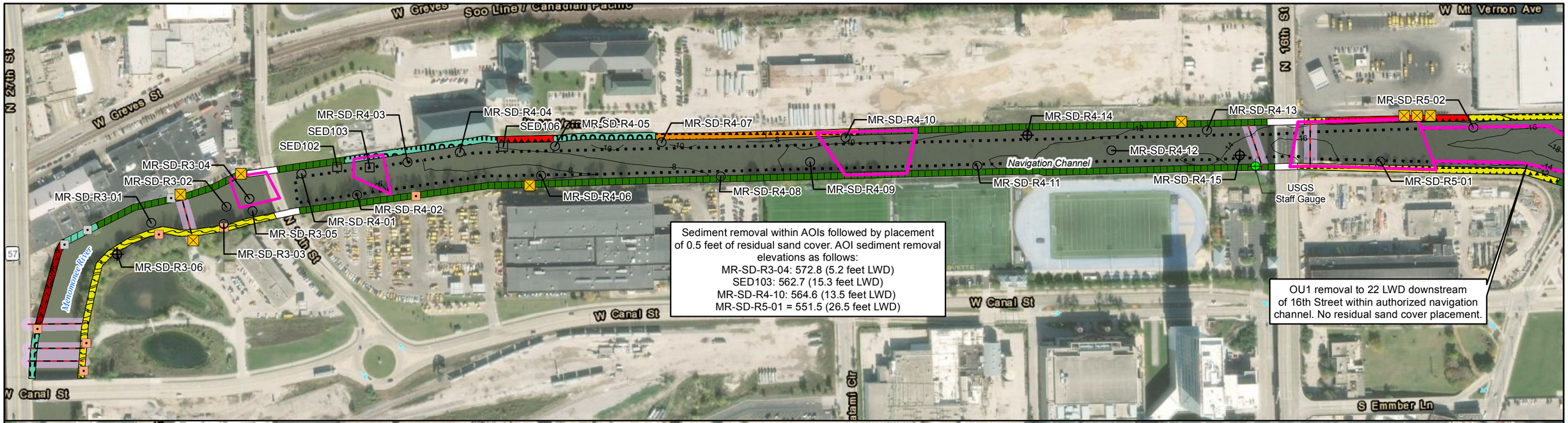

Figure 12
Alternative 4 Conceptual Plan
Menomonee and Milwaukee Rivers Focused Feasibility Study
Milwaukee, Wisconsin