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October 2023

Cover photo: Kenosha Dunes, Wisconsin, eroded shoreline. Photo by J. Miller, 2022.

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# Abstract

In 2020 the US Army Corps of Engineers (USACE) reassigned 14 federally maintained harbors in the Wisconsin waters of Lake Michigan to USACE–Chicago District. The administrative change presents opportunities for increased beneficial use of sediment at harbors that have not traditionally placed sediment beneficially. This paper summarizes a screening-level analysis of 12 harbors to determine which harbors are likely to have sediment appropriate for beneficial use in the future, either in water or upland. The harbors were qualitatively ranked according to the potential for future successful beneficial use of navigationally dredged sediment. Using this screening, data needs were defined and next steps to aid the development of a regional dredged-material management plan were identified.

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# Preface

This study was conducted for the US Army Engineering Research and Development Center University (ERDC-U) program, the Dredging Operations and Environmental Research (DOER) program, and the Dredging Operations Technical Support (DOTS) program under Civil Direct—Funding Account Code U4389228, AMSCO Code 089500. Dr. Todd Bridges was the DOER program manager, and Dr. Burton Suedel was the DOTS program manager. At the time of the report preparation, Dr. Miller was assigned to the US Army Corps of Engineers–Chicago District but was participating in the ERDC-U program.

The work was performed by the Environmental Risk Assessment Branch (EPR) of the Environmental Processes and Engineering Division (EPED), Environmental Laboratory (ERDC-EL), and the Coastal Engineering Branch (HNC) of the Navigation Division (HN), Coastal and Hydraulics Laboratory (ERDC-CHL). At the time of publication, Mr. James Lindsay was chief, EPR; Mr. Warren P. Lorentz was division chief, EPED; Ms. Lauren Dunkin was chief, HNC; Ms. Ashley Frey was chief, HN. The deputy director of ERDC-CHL was Mr. Keith Flowers, and the director of ERDC-CHL was Dr. Ty Wamsley. The deputy director of ERDC-EL was Dr. Brandon J. Lafferty, and the director of ERDC-EL was Dr. Edmond J. Russo Jr. Ms. Sheryl Carrubba was USACE–Headquarters acting navigation business line manager, and Mr. Charles E. Wiggins, ERDC-CHL, was the ERDC technical director for the civil works and navigation, research, development, and technology transfer portfolio.

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# 1 Introduction

## 1.1 Background

In 2020 a US Army Corps of Engineers (USACE) boundary change resulted in the reassignment of 14 federally maintained Lake Michigan harbors in Wisconsin to the USACE–Chicago District. This administrative change presents both challenges and opportunities. The challenges include a greatly expanded operation and maintenance mission, different (state) regulations, and unfamiliar harbor conditions and maintenance requirements. The opportunities include taking a fresh look at smaller harbors that require infrequent maintenance and developing a regional sediment-management plan that includes a large shoreline and multiple tributaries along the western shore of Lake Michigan.

## 1.2 Approach

Available data from previous sediment sampling, dredging events, surveys and similar existing information sources from the 14 harbors were reviewed and summarized. Most information was provided by USACE–Detroit District and represents many years of navigational maintenance.

The sediment chemical data presented are simple arithmetic averages of available data that may not represent current conditions. For mathematical purposes, the reporting limit was used as the concentration for nondetectable results; numbers that are reported as *less than* (<) were not detected in any sample at the limit stated. The summary data do not represent a statistical evaluation of the information. Rather, these data present a snapshot of the conditions at each harbor as a starting point for identifying harbors or portions of harbors with sediment that could be used beneficially. In all cases, additional data and coordination with regulatory agencies would be needed prior to any project implementation.

## 1.3 Objective

This study sought to perform a screening-level assessment of harbor conditions at 12 Lake Michigan federal project locations to determine which harbors most likely contain sediment suitable for beneficial use and to define data needs and next steps to develop a regional dredged-material-management plan (DMMP) that would allow USACE–Chicago District to more sustainably manage sediments dredged from these harbors.

# 2 Methods and Methodology

## 2.1 Beneficial Use of Sediment Research

The beneficial use of dredged sediment from federal navigation channels is frequently discussed in the Great Lakes but for various reasons has been implemented less than in other coastal regions of the United States. Reasons often given for the lack of beneficial use include the elevated (greater than 20%) fine content of the sediment (consisting of predominantly silts and clays) and the presence of legacy pollutants. Legacy pollutants are a serious issue, since compounds that bioaccumulate or may be toxic can harm the environment. However, the perception that sediment in the Great Lakes federal harbors is “toxic muck” that has no possible beneficial use is not consistent with the reality at many harbors. A large proportion of sediment dredged from federal navigation projects across the nation is suitable (that is, does not require special handling and is not contaminated) for beneficial use, yet for various reasons is not used.

The beneficial use of sediment with a high fine content, a key issue in the Great Lakes, has been studied in other coastal regions. Several authors report on USACE projects in Florida, where fine-grained sediments have been successfully placed nearshore or at beaches as part of beach-nourishment projects. A project at Egmont Key, Florida, used dredged sediment from an adjacent navigation channel with an average fine content (sediment passing a 0.063 mm sieve) of 20.7% for beach nourishment (Brutsché et al. 2019; Maglio et al. 2020). At this project, a conventional method of placing sediment in a trapezoidal arrangement parallel to the beach was used, and a newer method was used whereby sediment was placed in a cross-shore swash zone (CSSZ) configuration that extended perpendicularly from the beach. The project included postplacement monitoring to determine the fate of the sediment and an investigation of any impacts of the placement of fine material on the subaerial beach. Maglio et al. (2020) concluded that the beneficial-use placement event was a success in placing what had been determined to be “unsatisfactory material” (because of the fines content) onto a critically eroded shoreline (57). The CSSZ configuration was found to have meaningful benefits as an alternative to conventional beach-nourishment practices, since the placement into the swash zone was found to facilitate “washing” the fines from the beach (57). CSSZ allowed for the natural littoral processes to sort the sediments into an equilibrium profile according to grain size and required less equipment (thus lowering cost) (57–58). Brutsché et al. (2019) similarly concluded that the placement of the fine-grained sediment had no impact on the properties of the beach sediment, since the fine-grained materials were readily moved offshore by natural processes. Surficial samples of the dry beach taken after placement only contained approximately 1.9% fine material.

Wang et al. (2013) reported on the construction and monitoring of a nearshore berm at Fort Myers Beach, Florida, using sediment dredged from a USACE-maintained navigation channel. In this study, mixed sand and fine sediments were placed in the active littoral zone (within the zone of wave breaking) in a bar-shaped berm. The berm migrated landward during the two-year monitoring period, and the adjacent beach area was stable the entire monitoring period. The fine materials dispersed offshore after several months and did not affect the beach characteristics. Wang et al. concluded that nearshore berm construction is a good option for mixed sediments with high fine content (material that would not typically be considered beach quality) since the placement allows waves to move the sand fraction onshore while the fines are dispersed offshore.

Brutsché et al. (2014) also reported on the Fort Myers Beach, Florida, nearshore berm construction, concluding that applying this technique in practice produces a number of benefits. The benefits listed include fewer environmental disruptions to shoreline species (since the berm was constructed in water); maintenance of the materials in the littoral zone, with the onshore migration of the coarser materials; wave attenuation and reduced erosion of the shoreline; and the beneficial use of materials that otherwise would not be used beneficially because of their elevated fine content. Brutsché et al. (2014) do note that it is important to understand the dynamics of cross-shore and alongshore berm migration, along with the associated timescale. Site-specific information would be needed to determine the placement location required to achieve the desired results.

In summary, federal navigation channel sediment with a higher fine content (greater than 20%) has been used beneficially in the last 10 years, with the conclusion that the fine content does not degrade beach conditions but—to the contrary—provides many benefits. Key considerations include the placement location: CSSZ (bars perpendicular to the shore) or nearshore (submerged) berms both allow for the coarse material to migrate onshore and for the fines to disperse into deeper waters. These findings justify the consideration of a broader range of sediment for beneficial use in shoreline management and warrant the investigation of applying these practices along Great Lakes shorelines.

## 2.2 Wisconsin Sediment Regulations

The harbors of interest in this study are all located along Wisconsin's Lake Michigan shoreline. Wisconsin regulates sediment under several statutes and sections of the administrative code, depending in part on whether the sediment is considered contaminated. *Contaminated sediment* is defined by Wisconsin statute as "sediment that contains a hazardous substance."[1] The investigation and remediation of these materials is covered in the Wisconsin Administrative Code.[2] Along with the Wisconsin Administrative Code, the Wisconsin Department of Natural Resources has also issued guidance documents such as RR-088, *Consensus-Based Sediment Quality Guidelines Recommendations for Use & Application* (WDNR 2003).

Not all sediment falls under the category of *contaminated sediment*. Uncontaminated dredged sediments are also regulated under the Wisconsin Administrative Code.[3] In general, the numerical values of RR-088 are used for screening sediments to ensure they are not considered contaminated, and the requirements of NR 347 apply to all proposed dredging projects.

A specific, nonchemical concern for the placement of dredged materials is the grain size of the sediment. NR 347 specifically states the requirements for the fine-grained particles (less than 0.074 mm diameter):

> For projects in the Great Lakes involving beach nourishment disposal, grain–size analysis results of the

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1. Definitions. Wis. Stat. § 292.01(1s) (2023). https://docs.legis.wisconsin.gov/statutes/statutes/292.pdf.

2. Environmental Protection – Investigation and Remediation of Environmental Contamination. Wis. Admin. Code NR §§ 700–99 (2023). https://docs.legis.wisconsin.gov/code/admin_code/nr/700.

3. Sediment Sampling and Analysis, Monitoring Protocol and Disposal Criteria for Dredging Projects. Wis. Admin. Code NR § 347 (1989). https://docs.legis.wisconsin.gov/code/admin_code/nr/300/347.pdf.

> proposed dredged material and the beach shall be compared by the department.
>
> (a) The department may allow beach nourishment disposal if:
>
> 1. The average percentage of silt plus clay (material passing a #200 sieve or less than .074 mm dia.) in the dredged material does not exceed the average percentage of silt plus clay in the existing beach by more than 15% and the color of the dredged material does not differ significantly from the color of the beach material.
>
> Note: For example, if the silt plus clay content of the existing beach is 10%, suitable dredged material must have a silt plus clay content of less than 25%.[4]

This requirement potentially prevents the in-water use of fine-grained materials, which may have a very high (greater than 50%) fine content. Silty sediment is typically not desired for beach nourishment but may be placed below the ordinary high-water mark for shoreline nourishment or for habitat creation. Wisconsin does potentially allow for consideration of criteria outside the published requirements, when considering sediment placement options:

> If the bulk sediment analysis criteria in sub. (4) is exceeded, the applicant shall have the option of demonstrating to the department through use of bioassay, or other methods approved by the department, that the dredging and sediment disposal operations will have minimum effects on the environment.[5]

In general, the fine content of dredged sediment is often contentious, even when the sediment is found suitable for beneficial use and even in envi-

4. Wis. Admin. Code NR § 347.07(1)(4).
5. Wis. Admin. Code NR § 347.07(1)(6).

ronments such as Lake Michigan, which has a large volume of sandy materials. Sediments with a fine content greater than 10% are often considered to be unsuitable for in-water uses.

## 2.3 Harbor Selection

The 14 federally maintained harbors in the Wisconsin waters of Lake Michigan shoreline range from large commercial harbors (Milwaukee, Green Bay) to small recreational facilities (Washington Island, Oconto). The dredging frequency of these harbors varies widely, depending on shoaling, funding, and other factors (dredging frequency ranges from annual to less than once per decade). Sediment placement locations range from confined disposal facilities (CDFs) to in-water shoreline placement to upland unconfined placement. Because these harbors are recent additions to USACE–Chicago District's maintenance portfolio and the district does not have current DMMPs for most of these harbors, it is appropriate to consider which materials may be suitable for in-water or upland beneficial use as part of a regional approach to developing a DMMP.

Of the 14 harbors, 2 cannot reasonably be considered for new sediment beneficial uses. Milwaukee Harbor and the upstream estuary are known to be contaminated (EPA 2022). The existing CDF (now called a *dredged-material disposal facility*; DMDF) was expanded circa 2012 and has sufficient capacity for harbor maintenance for future years. The estuary is the focus of an Environmental Protection Agency Legacy Act project that will involve the creation of an additional DMDF for disposing of the contaminated riverine materials.

Green Bay Harbor is chemically clean and consists mostly of sands and silty sands. This material is placed at the Cat Island placement facility, which is a semiconfined island reconstruction project developed by USACE–Detroit District (USACE-LRE 2011). The Cat Island project is itself a beneficial-use project, with early results for habitat development being extremely promising. The Fox River outlets into Green Bay and is also a federally maintained channel. The lower Fox River is a Superfund site that was recently remediated. At this time there is no immediate dredging need; however, it is anticipated that near-term sediment accumulations may still contain legacy pollutants. Until testing of future shoaling determines that the Fox River sediment is suitable for beneficial use, that channel will not be considered further in this analysis.

The remaining 12 harbors are clean or partly clean, on the basis of past sampling and analysis. A few harbors have unknown sediment quality and are included in this screening assessment. It is anticipated that the outer harbor or approach, areas influenced by Lake Michigan rather than by tributaries to the harbors, are more likely to contain sediment chemically and physically suitable for beneficial use. Tributary materials may also be chemically suitable for beneficial use, although the materials are more likely to be fine grained. Historically, fine-grained sediment has been more difficult to use beneficially, especially in high-wave-energy environments.

The remaining 12 Lake Michigan federally maintained harbors along the Wisconsin coast shown in Figure 1 were screened to determine the potential for sediment beneficial use and to identify data gaps and next steps that would aid in the development of a regional DMMP. Using existing information, the harbors were screened for the potential for future beneficial use and particularly for in-water beneficial use. Screening criteria include the dredging history and sediment placement locations, grain size information, sediment chemical quality, and dredging frequency. The following sections summarize the current state of knowledge for each harbor. Following the harbor summaries, the harbors are ranked in terms of likelihood of short-term, beneficial-use project implementation. Strategic next steps and data needs are identified so that specific action can be planned and implemented using this information.

Figure 1. US Army Corps of Engineers (USACE)–Chicago District Lake Michigan Wisconsin Harbors under consideration for beneficial use of sediment.

# 3 Results

Each harbor is discussed individually below. The harbors are discussed starting in the south, in Kenosha, Wisconsin, and traveling north along the shore, and then into Green Bay, Wisconsin. The harbors are not listed in this section in any order of importance or ranking.

## 3.1 Kenosha Harbor

The historical sampling and dredging information is as follows:

- Last sampled—Harbor 2020; Channel 2006 (limited)
- Sampling method—Harbor ponar: grab samples; channel: cores
- Last dredged—2021 harbor only (planned for 2022 harbor only)
- Dredging and placement methods—Hydraulic dredging, rainbow placement
- Quantity dredged—18,000 $yd^3$ (13,700 $m^3$)[6]
- Most recent sediment-placement location—Kenosha Dunes shoreline (harbor only); prior to approximately 2000, sediment placed in a (now closed) CDF.
- Estimated dredged-sediment backlog—168,900 $yd^3$ (129,100 $m^3$)[7]

Kenosha Harbor (Figure 2) has an industrial past, and historically the sediment had been contaminated with a variety of metals and organic compounds (Table 1). Historically the inner harbor received industrial discharges, but those industries have been replaced with residential development. Pike Creek is channelized and outlets into the harbor through an underwater outfall (the creek is underground in Figure 2 and is not shown).

The Lake Michigan shoreline is considered impaired and is listed on the Wisconsin Clean Water Act 303d[8] list for mercury contaminated fish tissue, PCB-contaminated fish tissues, and bacterial contamination at

6. For a full list of the spelled-out forms of the units of measure used in this document and their conversions, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office, 2016), 248–52 and 345–47, https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf.

7. USACE-LRC (US Army Corps of Engineers–Chicago District), “Wisconsin Harbors Backlog Quantities 2021” (unpublished data set, 07 March 2022), Microsoft Excel file.

8. Federal Water Pollution Control Act Amendments of 1972 § 303(d), 33 U.S.C. § 1313(d)(1)(D). (2021). https://www.govinfo.gov/content/pkg/USCODE-2021-title33/pdf/USCODE-2021-title33-chap26.pdf.

beaches (WDNR 2022a, 1, 6–9, 12, 15–20, 23–25). Fish-tissue issues may be related to sediment quality, since the sediment can be a reservoir for mercury and PCBs, which can affect benthic organisms. The impairments along the Lake Michigan shoreline are common for the entire Lake Michigan shoreline of Wisconsin and do not indicate any specific issue at Kenosha. Pike Creek is impaired for fish and aquatic life because of high chloride (typically attributed to urban runoff and road salt.)

Like many harbors, a divide exists between the (inland) channel materials and the (lakeward) harbor materials (Figure 2). The harborside materials contain sands; this area shoals from the north with wind- and wave-driven sediment deposition. These materials have been consistently measured to be *clean* since at least 2013 (Table 1), and the sediment has been placed in several lakeside areas. Currently there appear to be two highly viable shoreline-placement areas for clean-sediment beneficial use, both located south of the harbor (Figure 3). Placement Area 1 is along Kenosha Dunes natural area; this location was used by USACE in 2021 and is planned for 2022 use (Figure 3). This area was the subject of an environmental assessment in 2020, and the use of this area for sediment placement was found to have many benefits and no significant negative impacts. Placement Area 2 is closer to the harbor and is an eroded area along city property; the city placed materials at Placement Area 2 in 2019. If Placement Area 2 or any other placement site would be used by USACE in the future, a National Environmental Policy Act[9] (NEPA) analysis would be required.

9. National Environmental Policy Act of 1970, 42 U.S.C. §§ 4321–47. (2021). https://www.govinfo.gov/content/pkg/USCODE-2021-title42/pdf/USCODE-2021-title42-chap55.pdf.

Figure 2. Kenosha Harbor, Kenosha, Wisconsin. Area highlighted in *light gray* marks the federal navigation channel portion of the harbor and related entrance channel.

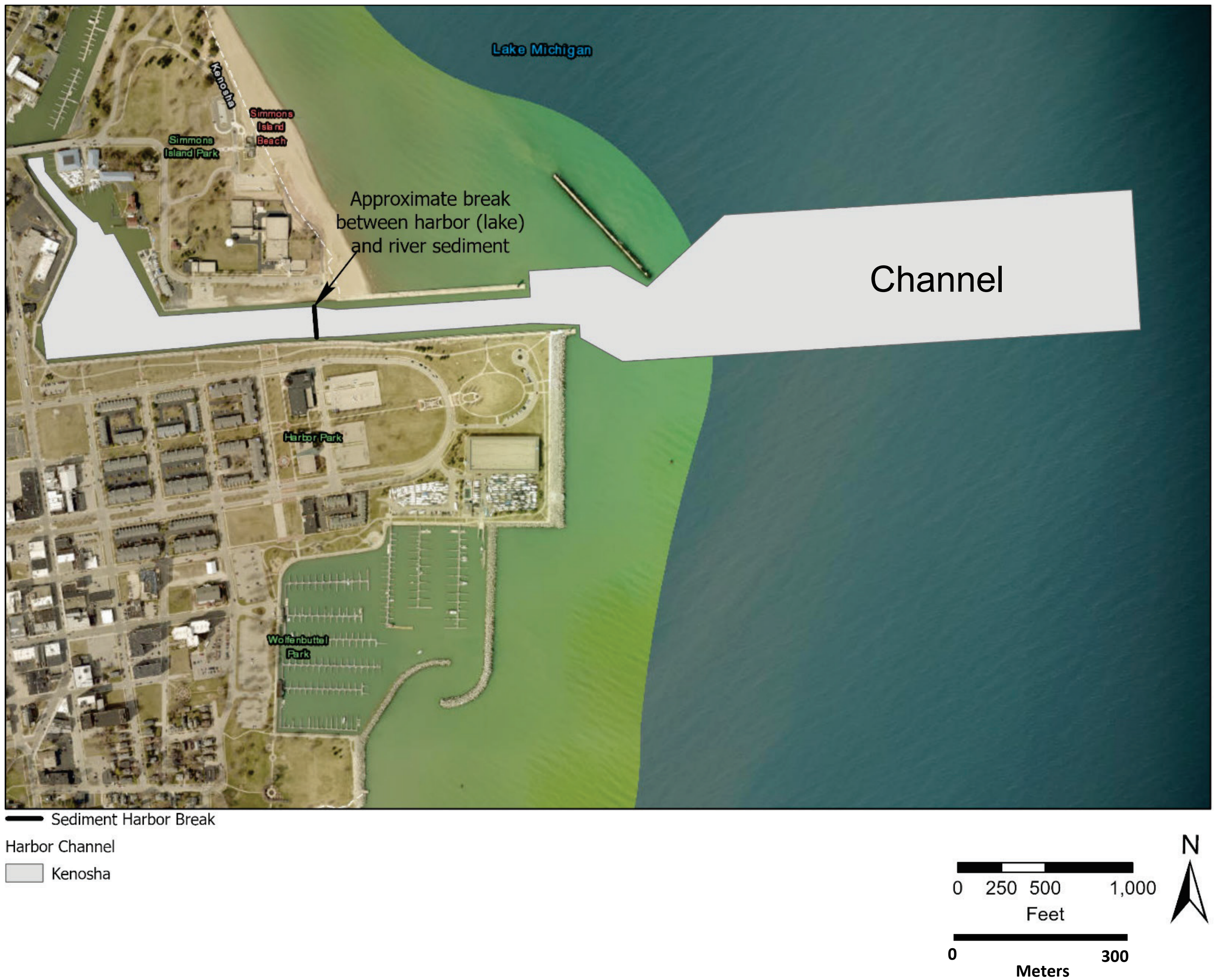

Figure 3. Kenosha Harbor, Kenosha, Wisconsin, historical nearshore sediment-placement sites (*yellow circles*).

Table 1. Kenosha Harbor sediment characteristics.

| **Kenosha** | **Harbor<br>2020<br>(USACE-LRC 2020)** | **Channel<br>2006<br>1985<br>(AES 2006; ERG 1986)** | **Wisconsin Requirements[a,b]** |
|---|---|---|---|
| Fines (P200 or <75 µm), percent | 7.1<br>(range1.6–20.2) | Not measured<br>36 | <15% above proposed placement site |
| Total organic carbon (mg/kg) | 14,300 | Not measured<br>Not measured | n/a[c] |
| Oil and grease, mg/kg | 123 | Not measured<br>2,500 | n/a |
| Ammonia (sediment), mg/kg | 1.57 | 7.5<br>52.3 | n/a |
| Total phosphorus (sediment), mg/kg | 177 | 208<br>Not measured | n/a |
| Cadmium, mg/kg | 0.212 | 0.21<br>4.5 | 0.99 (5.0) |
| Chromium, mg/kg | 6.5 | 11.2<br>30 | 43 (110) |
| Copper, mg/kg | 6.8 | 13<br>49 | 32 (150) |
| Lead, mg/kg | 9.6 | 64.4<br>77 | 36 (130) |
| Mercury, mg/kg | 0.0103 | <0.05<br><0.04 | 0.18 (1.1) |
| ΣPAHs,[d,e] µg/kg | 1060 | 5,700<br>Not measured | 1,610 (22,800) |
| Total PCBs,[e] µg/kg | 232 | Not measured<br><5.0 | 60 (676) |

[a] NR 347.07(4)(a)1.

[b] The values quoted here are the threshold effects concentration and (probable effects concentration). It is noted that acceptable sediment concentrations for a specific project may vary according to measured toxicity of the material using bioassay techniques. The values listed above are used for screening purposes only (WDNR 2003).

[c] These parameters do not have established specific requirements but are general indicators of sediment conditions.

[d] ΣPAHs—Numerical sum of acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, 2 methylnapthalene, phenanthrene, benz(a)anthracene, benzo(a)pyrene, benzo(e)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthese, indeno(1,2,3-cd)pyrene, pyrene. The sum of test results reported was not adjusted for percentage of total organic carbon.

[e] The reporting limit was used in summations for parameters with concentrations less than the reporting limit. That is, a reporting limit of <5 would be used as 5 for calculating the sum of the constituents.

## 3.2 Port Washington Harbor

The historical sampling and dredging information is as follows:

- Last sampled—1999
- Sampling method—Ponar (gravity core sampling was unsuccessful) in 1999; gravity core or ponar in 1987
- Last dredged—2003[10]
- Dredging and placement methods—Mechanical
- Quantity dredged—11,200 $yd^3$ (8,500 $m^3$)
- Most recent sediment-placement location—Milwaukee CDF
- Estimated dredged-sediment backlog—1,000 $yd^3$ (760 $m^3$) (functional); 158,500 $yd^3$ (121,200 $m^3$) (fully authorized)[11]

Although authorized as a deep-draft commercial harbor, Port Washington essentially functions as a recreational harbor because of the current lack of industry at the location (Figure 4). The harbor has not been dredged for several years. A functional channel (smaller than the fully authorized channel) is defined for the harbor and represents the area most likely to be maintained in the future.

Sauk Creek discharges into the western side of the harbor. Sauk Creek is listed as impaired for fish and aquatic life because of elevated phosphorus concentrations in the surface water (WDNR 2022a, 19). There are not considered to be any sediment-associated impairments. The Lake Michigan shoreline has the same fish-tissue impairments as the rest of the Wisconsin shoreline (mercury and PCB fish-tissue impairments).

Recent sediment-quality data are lacking. According to the most recent comprehensive sampling event (in 1987; Table 2), the sediment near the harbor entrance is sandier material. A more limited sampling event in 1999 focused on materials in the channel adjacent to the marina (Table 2). Both the older and newer data indicate the sediment is of chemical quality sufficient for beneficial use. The center of the harbor appears to be the divide between sandier and siltier materials (Figure 4); however, since the harbor has not been dredged in so long, the nature of the existing sediment is uncertain. The harbor appears to have unused areas that could potentially be used for habitat projects or other sediment-fill uses.

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10. USACE-LRC (US Army Corps of Engineers–Chicago District), “Contract Dredging Report, Detroit District, Operations Office” (unpublished data set, 09 October 2018–15 October 2018), PDF, 14.

11. USACE-LRC, “Wisconsin Harbors.”

Figure 4. Port Washington Harbor, Port Washington, Wisconsin.

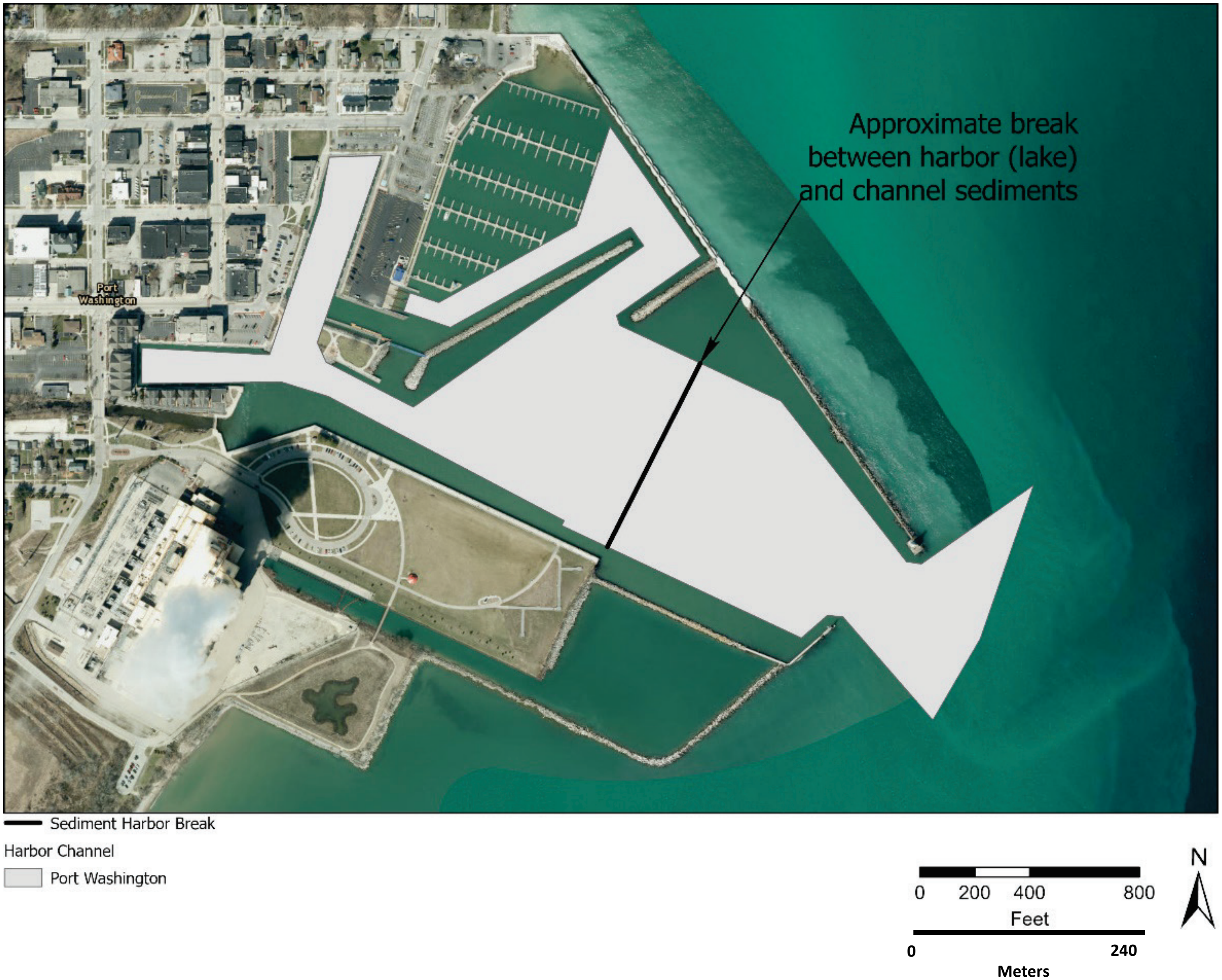

Table 2. Port Washington Harbor sediment characteristics.

| Port Washington | Harbor 1987 samples 11–14[a] (TMA and ERG 1988) | Channel 1999 (AES 1999) | Wisconsin Requirements[b,c] |
|---|---|---|---|
| Fines (P200 or <75 µm), percent | 0.2 | 75.1 | <15% above proposed placement site |
| Total organic carbon (mg/kg) | 11,000 | 18,000 | n/a[d] |
| Oil and grease, mg/kg | 230 | 690 | n/a |
| Ammonia (sediment), mg/kg | 48 | 30 | n/a |
| Total phosphorus (sediment), mg/kg | 270 | 99 | n/a |
| Cadmium, mg/kg | 3.0 | 0.41 | 0.99 (5.0) |
| Chromium, mg/kg | 25 | 11.6 | 43 (110) |
| Copper, mg/kg | 13 | 24 | 32 (150) |
| Lead, mg/kg | 6.4 | 18 | 36 (130) |
| Mercury, mg/kg | <0.05 | <0.10 | 0.18 (1.1) |
| ΣPAHs[e,f], µg/kg | Not measured | Not measured | 1,610 (22,800) |
| Total PCBs[f], µg/kg | <20 (nondetectable) | <300 (nondetectable) | 60 (676) |

[a] The 1987 sampling included samples in the harbor area and samples taken in the river channel. For this discussion, the harbor samples are discussed separately from the channel samples since there is a marked difference in characteristics.

[b] NR 347.07(4)(a)1.

[c] The values quoted here are the threshold effects concentration and (probable effects concentration). It is noted that acceptable sediment concentrations for a specific project may vary according to measured toxicity of the material using bioassay techniques. The values listed above are used for screening purposes only (WDNR 2003).

[d] These parameters do not have established specific requirements but are general indicators of sediment conditions.

[e] ΣPAHs—Numerical sum of acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, 2 methyln-apthalene, phenanthrene, benz(a)anthracene, benzo(a)pyrene, benzo(e)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthese, indeno(1,2,3-cd)pyrene, pyrene. The sum of test results reported was not adjusted for percentage of total organic carbon.

[f] The reporting limit was used in summations for parameters with concentrations less than the reporting limit. That is, a reporting limit of <5 would be used as 5 for calculating the sum of the constituents.

## 3.3 Sheboygan Harbor

The historical sampling and dredging information is as follows:

- Last sampled—2011
- Sampling method—Macrocore sampler
- Last dredged—1991: USACE;[12] 2012: Environmental Protection Agency (EPA) (EPA-GLNPO 2015, 12–14)
- Dredging and placement methods—Mechanical

12. USACE-LRC, "Contract Dredging," 15.

- Quantity dredged—46,500 $yd^3$ (35,550 $m^3$) (USACE harbor entrance dredging in 1991)
- Most recent sediment-placement location—Beach south of harbor, from centerline of Alabama Avenue extending south 700 ft (210 m) (CEC 1991); landfill (USEPA 2012)
- Estimated dredged-sediment backlog—46,200 $yd^3$ (35,300 $m^3$) (functional); 962,100 $yd^3$ (735,600 $m^3$) (fully authorized)[13]

The Sheboygan Harbor federal navigation channel (Figure 5) is part of the Sheboygan River Area of Concern (AOC), part of a joint US-Canada initiative to address historically contaminated harbors within the Great Lakes. The Sheboygan River AOC encompasses 14 miles (22.5 km) of the lower Sheboygan River downstream from the Sheboygan Falls Dam and includes the entire harbor and nearshore waters of Lake Michigan. These areas contained sediments with elevated concentrations of PCBs and PAHs. USACE has not dredged Sheboygan since 1991. EPA most recently dredged in 2012–2013 as part of the AOC restoration and Superfund work in the channel. Approximately 400,000 $yd^3$ (306,000 $m^3$) of contaminated sediment was removed across several projects and disposed in landfills.

The Sheboygan River, starting at the mouth at Lake Michigan and proceeding upstream beyond the limits of the federal channel, is considered impaired because of PCBs (WDNR 2022a, 19). Fish-tissue concentrations are high enough that river-species consumption is advised against. The river is also impaired because of high phosphorus levels, although the available biological data do not indicate impairment (no macroinvertebrate or fish index of biotic integrity scored in the *poor* category). The Lake Michigan shoreline has the same fish-tissue impairments as the rest of the Wisconsin shoreline (mercury and PCB fish-tissue impairments).

USACE last sampled in 2011 but only in the federal channel (Table 3). At that time, the river sediment was very fine grained and contained low levels of PCBs and metals. No recent (post–remedial action) data for the harbor or the channel exist, and so the current condition of the sediment is unknown. The harbor and channel are both shoaled. Although authorized as a commercial harbor, this waterway supports mainly recreational uses. The area around the harbor has been recently redeveloped for recreational users. The shoreline south of the harbor is armored and appears to be an erosion zone. Shoreline-restoration projects at this location would support the protection of adjacent developments.

13. USACE-LRC, "Wisconsin Harbors."

Figure 5. Sheboygan Harbor, Sheboygan, Wisconsin.

Table 3. Sheboygan Harbor sediment characteristics.

| Sheboygan | Channel 2011 (FNG 2012) | Wisconsin Requirements[a,b] |
|---|---|---|
| Fines (P200 or <75 µm), percent | 86.7 | <15% above proposed placement site |
| Total organic carbon (mg/kg) | 24,600 | n/a[c] |
| Oil and grease, mg/kg | <890 | n/a |
| Ammonia (sediment), mg/kg | 510 | n/a |
| Total phosphorus (sediment), mg/kg | 860 | n/a |
| Cadmium, mg/kg | 0.70 | 0.99 (5.0) |
| Chromium, mg/kg | 31 | 43 (110) |
| Copper, mg/kg | 31 | 32 (150) |
| Lead, mg/kg | 78 | 36 (130) |
| Mercury, mg/kg | 0.13 | 0.18 (1.1) |
| ΣPAHs[d,e], µg/kg | Not detected | 1,610 (22,800) |
| Total PCBs[e], µg/kg | 360 (Aroclor 1,242) | 60 (676) |

[a] NR 347.07(4)(a)1.

[b] The values quoted here are the threshold effects concentration and (probable effects concentration). It is noted that acceptable sediment concentrations for a specific project may vary according to measured toxicity of the material using bioassay techniques. The values listed above are used for screening purposes only (WDNR 2003).

[c] These parameters do not have established specific requirements but are general indicators of sediment conditions.

[d] ΣPAHs—Numerical sum of acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, 2 methylnapthalene, phenanthrene, benz(a)anthracene, benzo(a)pyrene, benzo(e)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthese, indeno(1,2,3-cd)pyrene, pyrene. The sum of test results reported was not adjusted for percentage of total organic carbon.

[e] The reporting limit was used in summations for parameters with concentrations less than the reporting limit. That is, a reporting limit of <5 would be used as 5 for calculating the sum of the constituents.

## 3.4 Manitowoc Harbor

The historical sampling and dredging information is as follows:

- Last sampled—2019
- Sampling method—Direct push
- Last dredged—2019
- Dredging and placement methods—Mechanical
- Quantity dredged—47,000 $yd^3$ (36,000 $m^3$)
- Most recent sediment-placement location—Manitowoc CDF

- Estimated dredged-sediment backlog—115,400 $yd^3$ (88,230 $m^3$) (functional); 484,300 $yd^3$ (370,300 $m^3$) (fully authorized)[14]

Manitowoc Harbor is a smaller commercial harbor that supports industrial and recreational vessels (Figure 6). The harbor area includes a CDF that is near capacity and a small boat harbor and marina. The channel includes a Superfund remediation site in the feasibility study phase as of 2023. There are no recent channel-sampling events, and it is assumed that the sediment is contaminated even upstream of the Superfund site. USACE does not plan to dredge the channel until the Superfund remediation action has occurred. The development of a DMMP for this harbor and Two Rivers Harbor began in 2022, and beneficial use will be considered for suitable sediment. That effort could lead the development of a regional DMMP and feed into the effort.

The main stem of the Manitowoc River is impaired for fish and aquatic life because of PAHs and PCBs (WDNR 2022a, 12), which are described as associated with contaminated sediments. The Lake Michigan shoreline has the same fish-tissue impairments as the rest of the Wisconsin shoreline (mercury and PCB fish-tissue impairments).

The harbor sediment is sandy but with a high fine content (Table 4). The material is chemically clean, and the harbor areas sampled in 2019 do not indicate PAH or PCB contamination, although it is possible that contaminated sediment is located within the channel. On the basis of the 2019 harbor samples, the harbor sediment could be used beneficially, perhaps for habitat development or upland. There are corners along the breakwater, both within and outside the breakwaters, which appear scoured and heavily armored on aerial photos. Some of these protected corners could be areas for beneficial placement of sediment and habitat development. Along the Manitowoc River, the areas closest to the harbor are developed and without much open space. Upstream of the federal channel there are open areas that may be upland placement sites; however, the river may be shallow and prevent barge transport of materials.

14. USACE-LRC, “Wisconsin Harbors.”

Figure 6. Manitowoc Harbor, Manitowoc, Wisconsin.

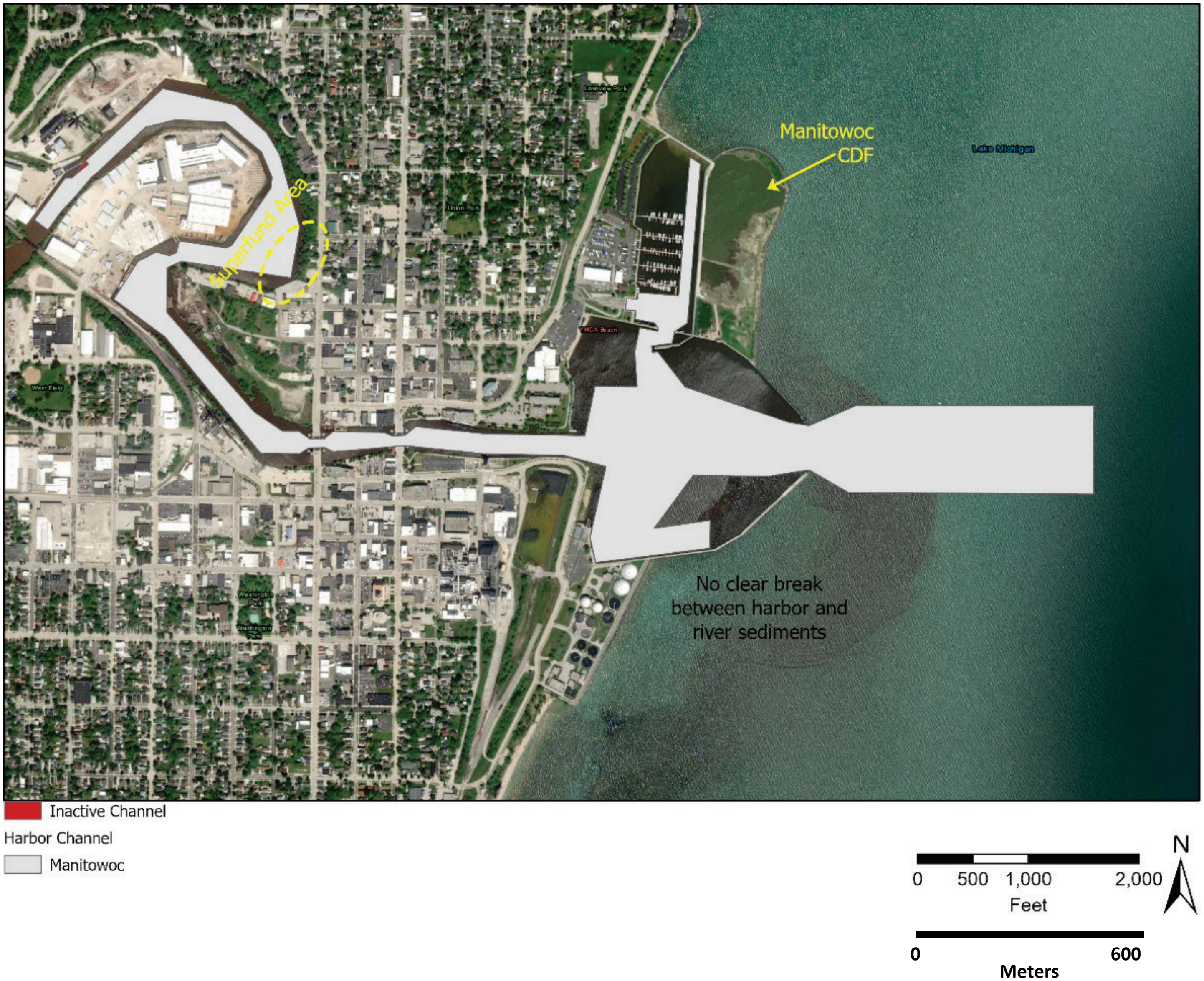

Table 4. Manitowoc Harbor sediment characteristics.

| Manitowoc | Harbor 2019 (AEM Group 2020) | Wisconsin Requirements[a,b] |
|---|---|---|
| Fines (P200 or <75 µm), percent | 68 (31–92.5) | <15% above proposed placement site |
| Total organic carbon (mg/kg) | 32,000 | n/a[c] |
| Oil and grease, mg/kg | 720 | n/a |
| Ammonia (sediment), mg/kg | 635 | n/a |
| Total phosphorus (sediment), mg/kg | 580 | n/a |
| Cadmium, mg/kg | 0.41 | 0.99 (5.0) |
| Chromium, mg/kg | 13 | 43 (110) |
| Copper, mg/kg | 12 | 32 (150) |
| Lead, mg/kg | 10 | 36 (130) |
| Mercury, mg/kg | 0.04 | 0.18 (1.1) |
| ΣPAHs[d,e], µg/kg | 1070 | 1,610 (22,800) |
| Total PCBs[e], µg/kg | <62 | 60 (676) |

[a] NR 347.07(4)(a)1.

[b] The values quoted here are the threshold effects concentration and (probable effects concentration). It is noted that acceptable sediment concentrations for a specific project may vary according to measured toxicity of the material using bioassay techniques. The values listed above are used for screening purposes only (WDNR 2003).

[c] These parameters do not have established specific requirements but are general indicators of sediment conditions.

[d] ΣPAHs—Numerical sum of acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, 2 methylnapthalene, phenanthrene, benz(a)anthracene, benzo(a)pyrene, benzo(e)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthese, indeno(1,2,3-cd)pyrene, pyrene. The sum of test results reported was not adjusted for percentage of total organic carbon.

[e] The reporting limit was used in summations for parameters with concentrations less than the reporting limit. That is, a reporting limit of <5 would be used as 5 for calculating the sum of the constituents.

## 3.5 Two Rivers Harbor

The historical sampling and dredging information is as follows:

- Last sampled—2018
- Sampling method—Direct push cores
- Last dredged—2020
- Dredging and placement methods—Hydraulic
- Quantity dredged—61,000 yd$^3$ (46,600 m$^3$)
- Most recent sediment-placement location—Beach nourishment north of channel

- Estimated dredged-sediment backlog—189,900 $yd^3$ (145,200 $m^3$)[15]

Two Rivers Harbor is a deep-draft commercial harbor located at the outlet of the Twin Rivers (Figure 7), although the harbor currently supports recreational uses. Sediment from the harbor is sandy and is placed along the beach. Sediment from the channel is silty but chemically clean. The sediment is authorized to be placed in the Manitowoc CDF but could be used beneficially since it is chemically suitable. A DMMP for this harbor, in combination with Manitowoc Harbor, started in 2022, and that process may help define possible sediment-placement sites. An evaluation of potential sediment-placement sites would inform the DMMP development. Two Rivers sediment was placed on an adjacent beach in 2020. For sandy sediment, several beach areas could be used for beneficial sediment placement. Silty materials would likely require separate placement sites.

Two Rivers Harbor is listed as impaired for fish and aquatic life because of unknown pollutants (WDNR 2022a, 22). Both branches of the Twin River are impaired for fish and aquatic life because of high phosphorus, and the West Twin River is also impaired because of elevated water temperatures (5, 24). Both branches of the Twin River are impaired for fish consumption because of PCB fish tissue concentrations, and the East Twin River is also impaired because of mercury fish-tissue concentrations. Fish-tissue impacts are often related to sediment quality, since persistent compounds such as PCBs can impact benthic organisms and be magnified through the food chain. The channel areas may have low concentrations of PCB that would prevent beneficial use of the sediment; however, according to the available data, the harbor material appears to be suitable (Table 5). The Lake Michigan shoreline has the same fish-tissue impairments as the rest of the Wisconsin shoreline (mercury and PCB fish-tissue impairments).

15. USACE-LRC, “Wisconsin Harbors.”

Figure 7. Two Rivers Harbor, Two Rivers, Wisconsin.

Table 5. Two Rivers Harbor sediment characteristics.

| Two Rivers | Harbor 2018 samples 5–15[a] (AEM Group 2019) | Channel 2018 samples 1–4 (AEM Group 2019) | Wisconsin Requirements[b,c] |
|---|---|---|---|
| Fines (P200 or <75 µm), percent | 2 | 20 | <15% above proposed placement site |
| Total organic carbon (mg/kg) | 7,100 | 38,000 | n/a[d] |
| Oil and grease, mg/kg | 75 | 295 | n/a |
| Ammonia (sediment), mg/kg | 48 | 1,050 | n/a |
| Total phosphorus (sediment), mg/kg | 170 | 1,060 | n/a |
| Cadmium, mg/kg | <0.21 | 0.54 | 0.99 (5.0) |
| Chromium, mg/kg | 3.5 | 20 | 43 (110) |
| Copper, mg/kg | 1.9 | 20 | 32 (150) |
| Lead, mg/kg | 1.2 | 18 | 36 (130) |
| Mercury, mg/kg | 0.013 | 0.074 | 0.18 (1.1) |
| ΣPAHs[e,f], µg/kg | 185 | 404 | 1,610 (22,800) |
| Total PCBs[f], µg/kg | <1.1 | 11 | 60 (676) |

[a] The 2018 sampling included samples in the harbor area (dredged in 2020) and samples taken inland from the dredge area. For this discussion, the harbor samples are discussed separately from the channel samples since there is a marked difference in characteristics.

[b] NR 347.07(4)(a)1.

[c] The values quoted here are the threshold effects concentration and (probable effects concentration). It is noted that acceptable sediment concentrations for a specific project may vary according to measured toxicity of the material using bioassay techniques. The values listed above are used for screening purposes only (WDNR 2003).

[d] These parameters do not have established specific requirements but are general indicators of sediment conditions.

[e] ΣPAHs—Numerical sum of acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, 2 methylnapthalene, phenanthrene, benz(a)anthracene, benzo(a)pyrene, benzo(e)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthese, indeno(1,2,3-cd)pyrene, pyrene. The sum of test results reported was not adjusted for percentage of total organic carbon.

[f] The reporting limit was used in summations for parameters with concentrations less than the reporting limit. That is, a reporting limit of <5 would be used as 5 for calculating the sum of the constituents.

## 3.6 Kewaunee Harbor

The historical sampling and dredging information is as follows:

- Last sampled—2014
- Sampling method—Vibracore
- Last dredged—2014[16]
- Dredging and placement methods—Mechanical

16. USACE-LRC, "Contract Dredging," 8.

- Quantity dredged—31,350 $yd^3$ (24,000 $m^3$)
- Most recent sediment-placement location—Kewaunee Harbor CDF
- Estimated dredged-sediment backlog—193,100 $yd^3$ (147,600 $m^3$) (functional); 407,000 $yd^3$ (311,000 $m^3$) (fully authorized)[17]

Kewaunee Harbor is located at the outlet of the Kewaunee River (Figure 8). This commercial harbor was previously considered contaminated, and sediment has historically been placed in the existing CDF at the harbor. Because the existing CDF is at capacity and the sediment is presumed to be of poor quality, the area has not been maintained recently.

The Kewaunee River has several identified water-quality impairments, related to historical commercial activities in the harbor. The river is considered impaired for fish and aquatic life because of total phosphorus and unspecified metals (WDNR 2022a, 9). The river is considered impaired for fish consumption because of PCB-contaminated fish tissues. The marsh area is considered impaired for public health and welfare because of arsenic-contaminated sediment; measured arsenic in sediment at the mouths of the sloughs exceed the sediment probable effect concentration, or PEC, of 33 mg/kg. Kewaunee Inner Harbor is listed as impaired for fish consumption because of PCB-contaminated fish tissues. The Inner Harbor is also listed as impaired for fish and aquatic life because of chronic aquatic toxicity attributed to unspecified metals. The Lake Michigan shoreline has the same fish-tissue impairments as the rest of the Wisconsin shoreline (mercury and PCB fish-tissue impairments).

On the basis of the most recent sampling, the sediment appears to be of decent quality from a chemical perspective (Table 6). The material has low metal and PAH concentrations and nondetectable pesticides and PCBs. The arsenic concentration in all samples within the federal harbor was less than 5.1 mg/kg (the threshold effect concentration, or TEC, is 9.8 mg/kg), and these results are not consistent with the listed impairment (which may apply to areas upstream and outside the federal channel). However, the Kewaunee sediment is very high in organic content and is quite fine grained. These characteristics may limit the suitability of the material for many in-water uses. A DMMP is planned for this harbor to start in 2023, and that process may help define possible sediment-placement sites. An evaluation of potential sediment-placement sites would inform the DMMP development.

17. USACE-LRC, "Wisconsin Harbors."

Figure 8. Kewaunee Harbor, Kewaunee, Wisconsin.

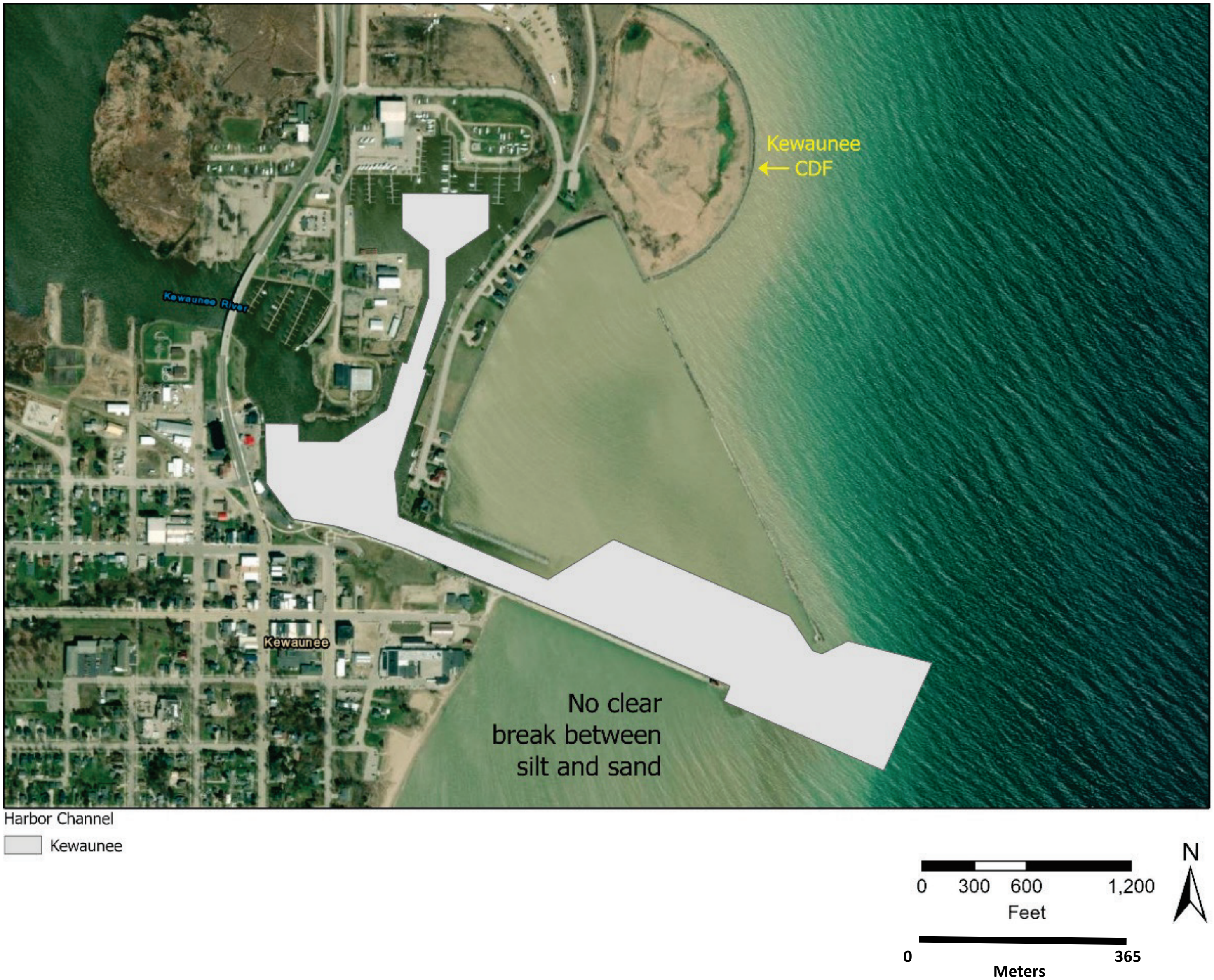

Table 6. Kewaunee Harbor sediment characteristics.

| Kewaunee | Channel 2014 (RTI Laboratories 2014) | Wisconsin Requirements[a,b] |
|---|---|---|
| Fines (P200 or <75 µm), percent | 77.7 | <15% above proposed placement site |
| Total organic carbon (mg/kg) | 51,400 | n/a[c] |
| Oil and grease, mg/kg | 3,480 | n/a |
| Ammonia (sediment), mg/kg | 390 | n/a |
| Total phosphorus (sediment), mg/kg | 890 | n/a |
| Cadmium, mg/kg | 0.46 | 0.99 (5.0) |
| Chromium, mg/kg | 12 | 43 (110) |
| Copper, mg/kg | 16 | 32 (150) |
| Lead, mg/kg | 7.4 | 36 (130) |
| Mercury, mg/kg | <0.46 | 0.18 (1.1) |
| ΣPAHs[d,e], µg/kg | 690 | 1,610 (22,800) |
| Total PCBs[e], µg/kg | <140 | 60 (676) |

[a] NR 347.07(4)(a)1.

[b] The values quoted here are the threshold effects concentration and (probable effects concentration). It is noted that acceptable sediment concentrations for a specific project may vary according to measured toxicity of the material using bioassay techniques. The values listed above are used for screening purposes only (WDNR 2003).

[c] These parameters do not have established specific requirements but are general indicators of sediment conditions.

[d] ΣPAHs—Numerical sum of acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, 2 methylnapthalene, phenanthrene, benz(a)anthracene, benzo(a)pyrene, benzo(e)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthese, indeno(1,2,3-cd)pyrene, pyrene. The sum of test results reported was not adjusted for percentage of total organic carbon.

[e] The reporting limit was used in summations for parameters with concentrations less than the reporting limit. That is, a reporting limit of <5 would be used as 5 for calculating the sum of the constituents.

## 3.7 Algoma Harbor

The historical sampling and dredging information is as follows:

- Last sampled—2000 (planned for 2022)
- Sampling method—Ponar (gravity core sampling was unsuccessful)
- Last dredged—1993[18]
- Dredging and placement methods—Mechanical
- Quantity dredged—17,100 $yd^3$ (13,100 $m^3$)

18. USACE-LRC, “Contract Dredging,” 1.

- Most recent sediment-placement location—Upland placement area 2.3 miles (3.7 km) south of harbor, adjacent to state highway WIS 42
- Estimated dredged-sediment backlog—81,700 $yd^3$ (62,500 $m^3$)[19]

Algoma Harbor is a recreational harbor at the mouth of the Ahnapee River (Figure 9). Although the breakwaters forming the harbor jut out into Lake Michigan, the limited data available suggest that the harbor is mostly shoaled with finer-grained riverine sediment and that the lake processes provide little sand. The most recent USACE dredging involved upland placement of the sediment; however, the material appears chemically clean and may be suitable for in-water habitat development. Sandy sediment could potentially be used for beach nourishment since there are beaches close to the harbor.

The Ahnapee River is considered impaired for fish and aquatic life (WDNR 2022a, 1). Previously phosphorus concentrations were very high and were the assumed cause of the impairment, but recent sampling shows lower phosphorus levels but still very poor aquatic and fishery conditions. The Ahnapee River is also impaired for fish consumption because of PCB levels in the fish tissue, although the sediment sampled previously in the federal channel does not appear to have elevated PCB concentrations (Table 7). The Lake Michigan shoreline has the same fish-tissue impairments as the rest of the Wisconsin shoreline (mercury and PCB fish-tissue impairments).

19. USACE-LRC, "Wisconsin Harbors."

Figure 9. Algoma Harbor, Algoma, Wisconsin.

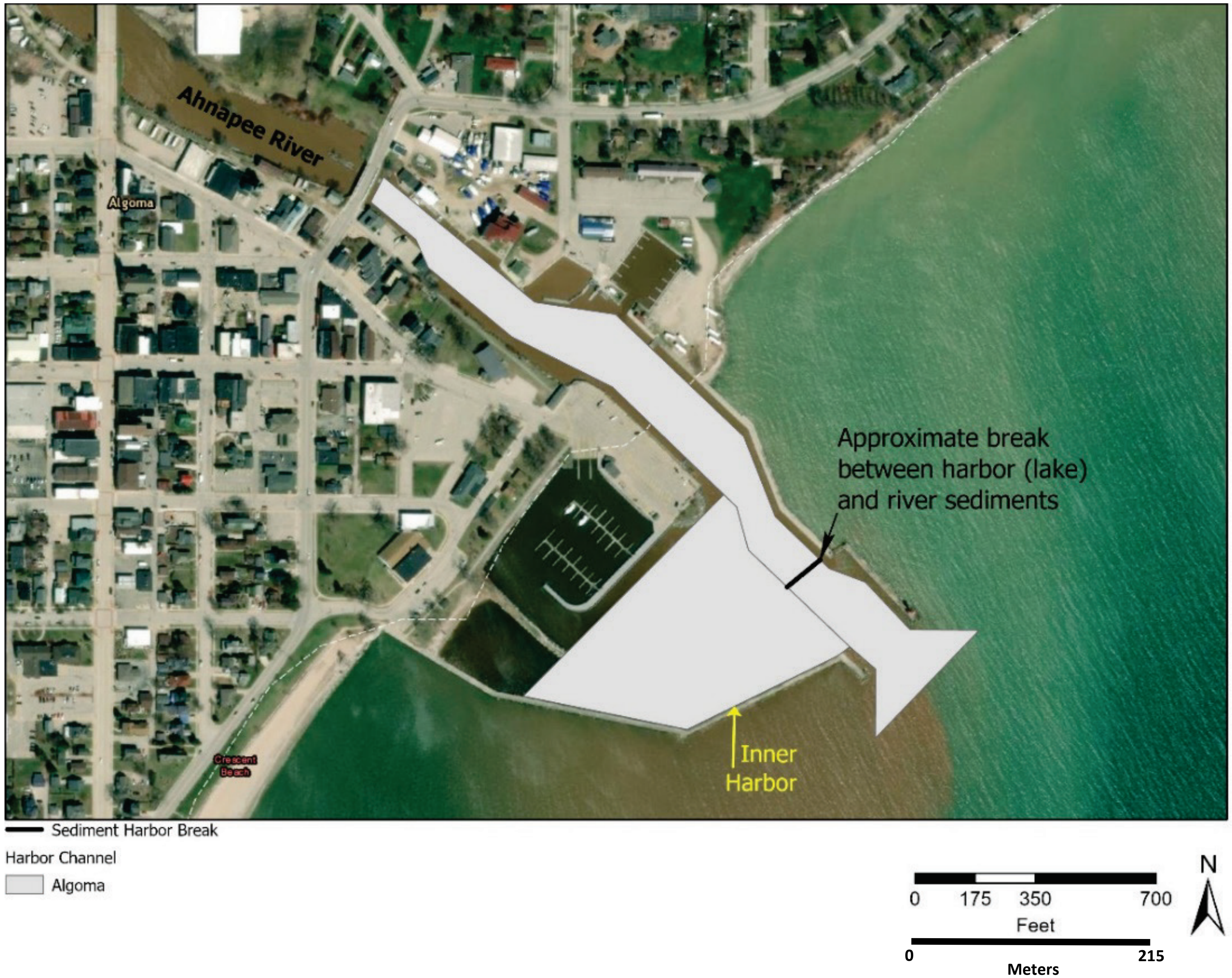

Table 7. Algoma Harbor sediment characteristics.

| Algoma | Harbor 2000 sample 5[a] (AES 2001) | Channel 2000 samples 1–4[a] (AES 2001) | Wisconsin Requirements[b,c] |
|---|---|---|---|
| Fines (P200 or <75 µm), percent | 16.1 | 50.6 | <15% above proposed placement site |
| Total organic carbon (mg/kg) | 7,500 | 113,500 | n/a[d] |
| Oil and grease, mg/kg | 500 | 3010 | n/a |
| Ammonia (sediment), mg/kg | <2.5 | 3.6 | n/a |
| Total phosphorus (sediment), mg/kg | 240 | 815 | n/a |
| Cadmium, mg/kg | 0.16 | 0.80 | 0.99 (5.0) |
| Chromium, mg/kg | 3.6 | 12 | 43 (110) |
| Copper, mg/kg | 3.2 | 24 | 32 (150) |
| Lead, mg/kg | 2.5 | 20 | 36 (130) |
| Mercury, mg/kg | <0.10 | 0.16 | 0.18 (1.1) |
| ΣPAHs[e,f], µg/kg | Not measured | Not measured | 1,610 (22,800) |
| Total PCBs[f], µg/kg | <120 | <120 | 60 (676) |

[a] The 2020 sampling included samples in the harbor area and samples taken in the river channel. For this discussion, the harbor samples are discussed separately from the channel samples since there is a marked difference in characteristics.

[b] NR 347.07(4)(a)1.

[c] The values quoted here are the threshold effects concentration and (probable effects concentration). It is noted that acceptable sediment concentrations for a specific project may vary according to measured toxicity of the material using bioassay techniques. The values listed above are used for screening purposes only (WDNR 2003).

[d] These parameters do not have established specific requirements but are general indicators of sediment conditions.

[e] ΣPAHs—Numerical sum of acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, 2 methylnapthalene, phenanthrene, benz(a)anthracene, benzo(a)pyrene, benzo(e)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthese, indeno(1,2,3-cd)pyrene, pyrene. The sum of test results reported was not adjusted for percentage of total organic carbon.

[f] The reporting limit was used in summations for parameters with concentrations less than the reporting limit. That is, a reporting limit of <5 would be used as 5 for calculating the sum of the constituents.

## 3.8 Sturgeon Bay Harbor and Lake Michigan Channel

The historical sampling and dredging information is as follows:

- Last sampled—2015 (included the eastern two-thirds of the channel)
- Sampling method—Gravity core and ponar
- Last dredged—2021
- Dredging and placement methods—Mechanical
- Quantity dredged—60,600 yd$^3$ (46,300 m$^3$)

- Most recent sediment-placement location—Sturgeon Bay Utility Placement Site (upland)
- Estimated dredged-sediment backlog—84,600 $yd^3$ (64,700 $m^3$) (functional channel); 511,700 $yd^3$ (391,200 $m^3$) (fully authorized)[20]

Sturgeon Bay Harbor and the Lake Michigan Ship Canal cut across the Door Peninsula with 8.5 miles (13.7 km) of maintained channel (Figure 10). The eastern end of the federal channel outlets into a small breakwater protected harbor area. The western end of the maintained channel stops in Sturgeon Bay, which is a large natural harbor. The waterway supports a shipyard in Sturgeon Bay as well as recreational uses. Sturgeon Bay is not considered impaired; the Lake Michigan shoreline (eastern end of the federal channel) has the same fish-tissue impairments as the rest of the Wisconsin shoreline (mercury and PCB fish-tissue impairments).

There is a clear grain-size distinction between the areas in Lake Michigan on the eastern end of the channel (within the breakwaters) and the channel proper, with the Lake Michigan materials being much sandier (Table 8). All materials are chemically clean and could be used beneficially, either upland or in water depending on the site. Because the western end of the channel in Sturgeon Bay has not been sampled recently, it is unknown whether that area is less chemically suitable for beneficial use because of the commercial influences in the bay.

Historically the Sturgeon Bay sediment has been placed upland at the Sturgeon Bay Utility Site, which is a sediment-placement site used by many harbors around the Door Peninsula. The Sturgeon Bay Utility Site could be a source for clean sand to be used beneficially, by mining sands from the facility. This sand reuse would leave additional upland capacity for materials less suitable for beneficial use.

20. USACE-LRC, "Wisconsin Harbors."

Figure 10. Sturgeon Bay Harbor and Lake Michigan Channel, Sturgeon Bay, Wisconsin.

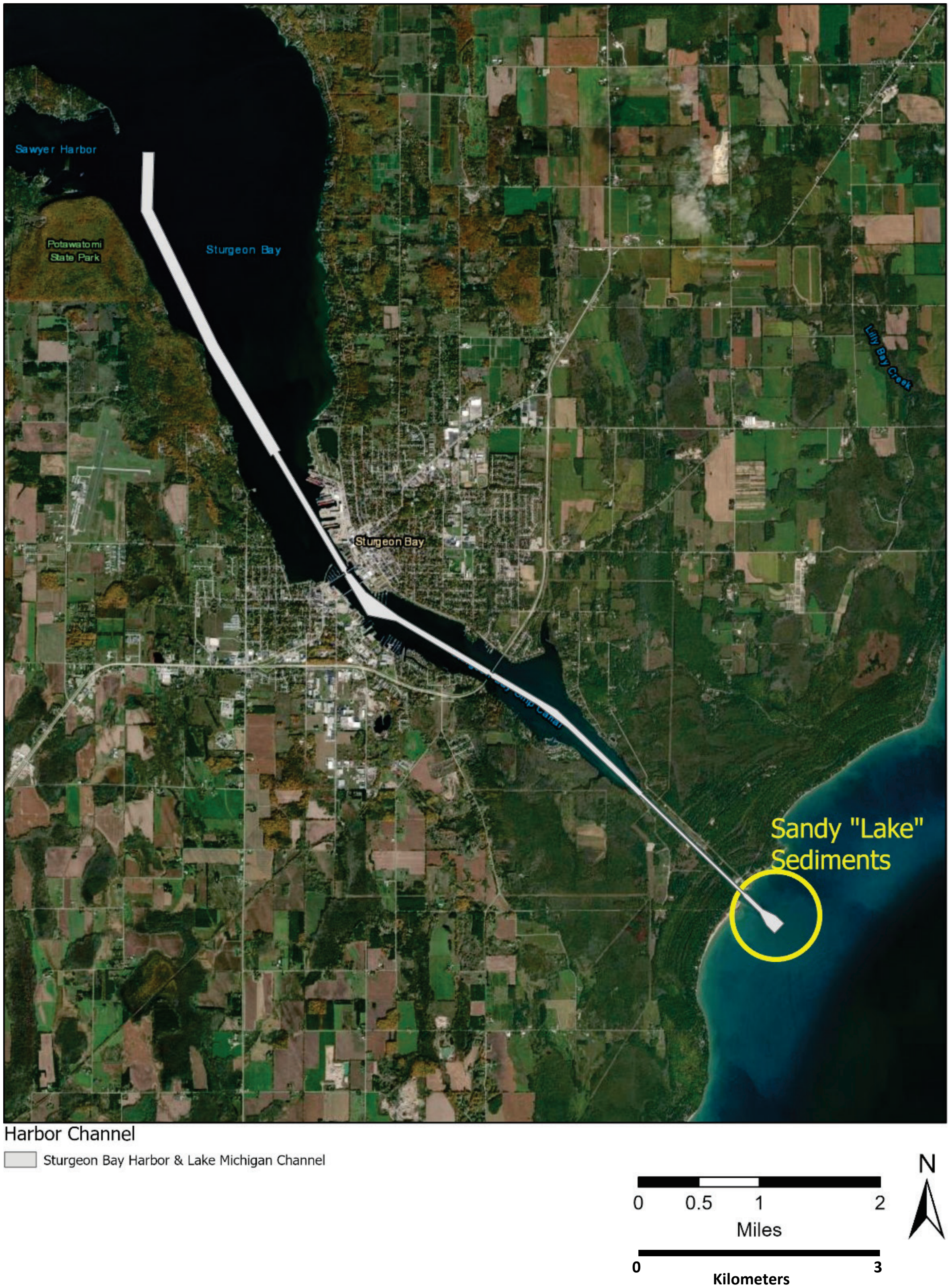

Table 8. Sturgeon Bay Harbor and Lake Michigan Channel sediment characteristics.

| Sturgeon Bay | Harbor 2015 samples 1–3[a] (USACE 2015) | Channel 2015 samples 4–12[a] (USACE 2015) | Wisconsin Requirements[b,c] |
|---|---|---|---|
| Fines (P200 or <75 µm), percent | 8.3 | 23.6 (range 7.9–38) | <15% above proposed placement site |
| Total organic carbon (mg/kg) | 27,700 | 39,000 | n/a[d] |
| Oil and grease, mg/kg | 110 | 270 | n/a |
| Ammonia (sediment), mg/kg | 140 | 390 | n/a |
| Total phosphorus (sediment), mg/kg | 140 | 265 | n/a |
| Cadmium, mg/kg | 0.1 | 0.35 | 0.99 (5.0) |
| Chromium, mg/kg | 4.5 | 8.5 | 43 (110) |
| Copper, mg/kg | 2.4 | 6.0 | 32 (150) |
| Lead, mg/kg | 3.2 | 7.0 | 36 (130) |
| Mercury, mg/kg | 0.012 | 0.066 | 0.18 (1.1) |
| ΣPAHs[e,f], µg/kg | 320 | 630 | 1,610 (22,800) |
| Total PCBs[f], µg/kg | <2.8 | <4.7 | 60 (676) |

[a] The 2015 sampling included samples in the harbor area and samples taken in the river channel. For this discussion, the harbor samples are discussed separately from the channel samples since there is a marked difference in characteristics.

[b] NR 347.07(4)(a)1.

[c] The values quoted here are the threshold effects concentration and (probable effects concentration). It is noted that acceptable sediment concentrations for a specific project may vary according to measured toxicity of the material using bioassay techniques. The values listed above are used for screening purposes only (WDNR 2003).

[d] These parameters do not have established specific requirements but are general indicators of sediment conditions.

[e] ΣPAHs—Numerical sum of acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, 2 methylnapthalene, phenanthrene, benz(a)anthracene, benzo(a)pyrene, benzo(e)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthese, indeno(1,2,3-cd)pyrene, pyrene. The sum of test results reported was not adjusted for percentage of total organic carbon.

[f] The reporting limit was used in summations for parameters with concentrations less than the reporting limit. That is, a reporting limit of <5 would be used as 5 for calculating the sum of the constituents.

## 3.9 Washington Island

The historical sampling and dredging information is as follows:

- Last sampled—Never
- Last dredged—1939[21]
- Dredging and placement method—Presumed mechanical
- Quantity dredged—84,100 $yd^3$ (64,300 $m^3$)
- Most recent sediment-placement location—Open water
- Estimated dredged-sediment backlog—4,300 $yd^3$ (3,300 $m^3$)[22]

Washington Island contains two harbors: Detroit Harbor (Figure 11) and Jackson Harbor (Figure 12). These harbors were constructed in 1939 to provide access to the subsistence community on Washington Island and to provide recreational access for fishing boats. Jackson Harbor is apparently little used, and the harbor is heavily shoaled. Neither Detroit Harbor nor Jackson Harbor is considered to be an impaired water.

Detroit Harbor has an authorized depth of −14 LWD (low water datum), which is approximately the current depth. Although shoals have developed in the turning basin, there is little impetus to dredge. The sediment quality is completely unknown; however, since this area has essentially no industry, the sediment is likely chemically suitable for beneficial use.

21. USACE-LRC, "Contract Dredging," 18.
22. USACE-LRC, "Wisconsin Harbors."

Figure 11. Detroit Harbor, Washington Island, Wisconsin.

Figure 12. Jackson Harbor, Washington Island, Wisconsin.

## 3.10 Oconto Harbor

The historical sampling and dredging information is as follows:

- Last sampled—2000
- Sampling method—Cores, split spoon
- Last dredged—1992[23]
- Dredging and placement methods—Mechanical
- Quantity dredged—51,200 $yd^3$ (39,100 $m^3$)
- Most recent sediment-placement location—Upland municipal dump site at Copper Culture Historic State Park
- Estimated dredged-sediment backlog—244,900 $yd^3$ (187,200 $m^3$)[24]

Oconto Harbor is a small, shallow-draft recreational harbor protected by breakwaters that jut into Lake Michigan at the outlet of the Oconto River into Green Bay (Figure 13). The inland channel extends more than 0.5 miles (0.8 km) upriver. The Oconto River is considered impaired for mercury-contaminated fish tissue (WDNR 2022a, 15). The Lake Michigan shoreline has the same fish-tissue impairments as the rest of the Wisconsin shoreline (mercury and PCB fish-tissue impairments).

During the most recent sampling event, Oconto Harbor was divided into an inner and outer harbor, with the dividing line at the end of the 1,460 ft (445 m) cross-section portion of the channel. This section's data summary uses this division, which may not accurately reflect the change from Lake Michigan–influenced to tributary-influenced sediment: all the samples were taken upstream from the shoreline and so likely represent riverine rather than Lake Michiganian influences. Regardless, the sediment had a fairly low fine content (10%–11% fines) (Table 9).

The most recent sediment-placement site for Oconto sediment was upland, at a site in Copper Culture Mounds State Park where the WDNR used the material as part of a cap for an unlicensed municipal dump. The dredged material was apparently used as clean fill prior to achieving the desired elevation and the placement of a closure cap. The park is next to the Oconto River upstream of the federal channel. The Oconto River's green space and natural areas along the channel may provide placement locations. A large amount of undeveloped shoreline south of the harbor may also afford habitat-development and restoration opportunities.

23. USACE-LRC, "Contract Dredging," 12.
24. USACE-LRC, "Wisconsin Harbors."

Figure 13. Oconto Harbor, Oconto, Wisconsin.

Table 9. Oconto Harbor sediment characteristics.

| Oconto | Harbor 2000[25] | Channel 2000[26] | Wisconsin Requirements[a,b] |
|---|---|---|---|
| Fines (P200 or <75 µm), percent | 10.6 | 11 | <15% above proposed placement site |
| Total organic carbon (mg/kg) | 11,500 | 7,100 | n/a[c] |
| Oil and grease, mg/kg | 310 | 500 | n/a |
| Ammonia (sediment), mg/kg | 600 | 101 | n/a |
| Total phosphorus (sediment), mg/kg | 233 | 147 | n/a |
| Cadmium, mg/kg | 0.22 | 0.057 | 0.99 (5.0) |
| Chromium, mg/kg | 6.8 | 7.9 | 43 (110) |
| Copper, mg/kg | 4.7 | 43.8 | 32 (150) |
| Lead, mg/kg | 0.4 | 4.0 | 36 (130) |
| Mercury, mg/kg | <0.1 | <0.1 | 0.18 (1.1) |
| ΣPAHs[d,e], µg/kg | Not measured | Not measured | 1,610 (22,800) |
| Total PCBs[e], µg/kg | <130 | <130 | 60 (676) |

[a] NR 347.07(4)(a)1.

[b] The values quoted here are the threshold effects concentration and (probable effects concentration). It is noted that acceptable sediment concentrations for a specific project may vary according to measured toxicity of the material using bioassay techniques. The values listed above are used for screening purposes only (WDNR 2003).

[c] These parameters do not have established specific requirements but are general indicators of sediment conditions.

[d] ΣPAHs—Numerical sum of acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, 2 methylnapthalene, phenanthrene, benz(a)anthracene, benzo(a)pyrene, benzo(e)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthese, indeno(1,2,3-cd)pyrene, pyrene. The sum of test results reported was not adjusted for percentage of total organic carbon.

[e] The reporting limit was used in summations for parameters with concentrations less than the reporting limit. That is, a reporting limit of <5 would be used as 5 for calculating the sum of the constituents.

## 3.11 Pensaukee Harbor

The historical sampling and dredging information is as follows:

- Last sampled—1991
- Sampling method—Drill rig and split spoon
- Last dredged—1993[27]
- Dredging and placement methods—Hydraulic

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25. AES (Altech Environmental Services), "Draft Report: Sediment Sampling and Analysis Oconto Harbor, Wisconsin; July 26, 27, 2000," Delivery Order No. 0022, (Southfield, MI: Altech Environmental Services, [2001?]).

26. AES, "Draft Report."

27. USACE-LRC, "Contract Dredging," 13.

- Quantity dredged—66,800 $yd^3$ (51,000 $m^3$)
- Most recent sediment-placement location—In water, 100 ft (30 m) leeward (south) of an existing island and extending 1,000 ft (305 m) southwestwardly in 2 ft (0.6 m) water depth
- Estimated dredged-sediment backlog—67,400 $yd^3$ (51,500 $m^3$)[28]

Pensaukee Harbor is a shallow-draft recreational harbor at the mouth of the Pensaukee River (Figure 14). The channel stretches into Lake Michigan. The Pensaukee River is listed as impaired because of high phosphorus concentrations, although the biological data do not support a listing for fish and aquatic life (no macroinvertebrate or fish index of biotic integrity scored in the *poor* category; WDNR 2022a, 16). The Lake Michigan shoreline has the same fish-tissue impairments as the rest of the Wisconsin shoreline.

The 1991 sediment sampling (Table 10) event did not include a map or coordinates of the five samples. It appears that sampling was conducted starting in Lake Michigan and moving up channel. The drilling logs for the core samples clearly note sandy material for Cores 1 and 2 and silty materials for Cores 3, 4, and 5. All cores had sandy materials at depth (greater than 9 ft [2.7 m], which is assumed to be below the authorized depth of 8 ft [2.4 m]; a vertical reference was not clearly established, so there is some uncertainty in the relationship between the cores and the authorized dredge prism). On the basis of the material differences, Cores 1 and 2 were used to describe the *harbor* sediment, while the remaining cores were used to describe the *channel* sediment.

The 1993 dredging event included in-water (open-water) placement of the materials. It appears that only the sandy sediment from the harbor (Lake Michigan) was dredged. The placement location was south of the channel, just south of an existing island (Figure 14). Sediment was placed beneficially in the existing shallows in a sandbar-type feature.

28. USACE-LRC, "Wisconsin Harbors."

Figure 14. Pensaukee Harbor, Pensaukee, Wisconsin.

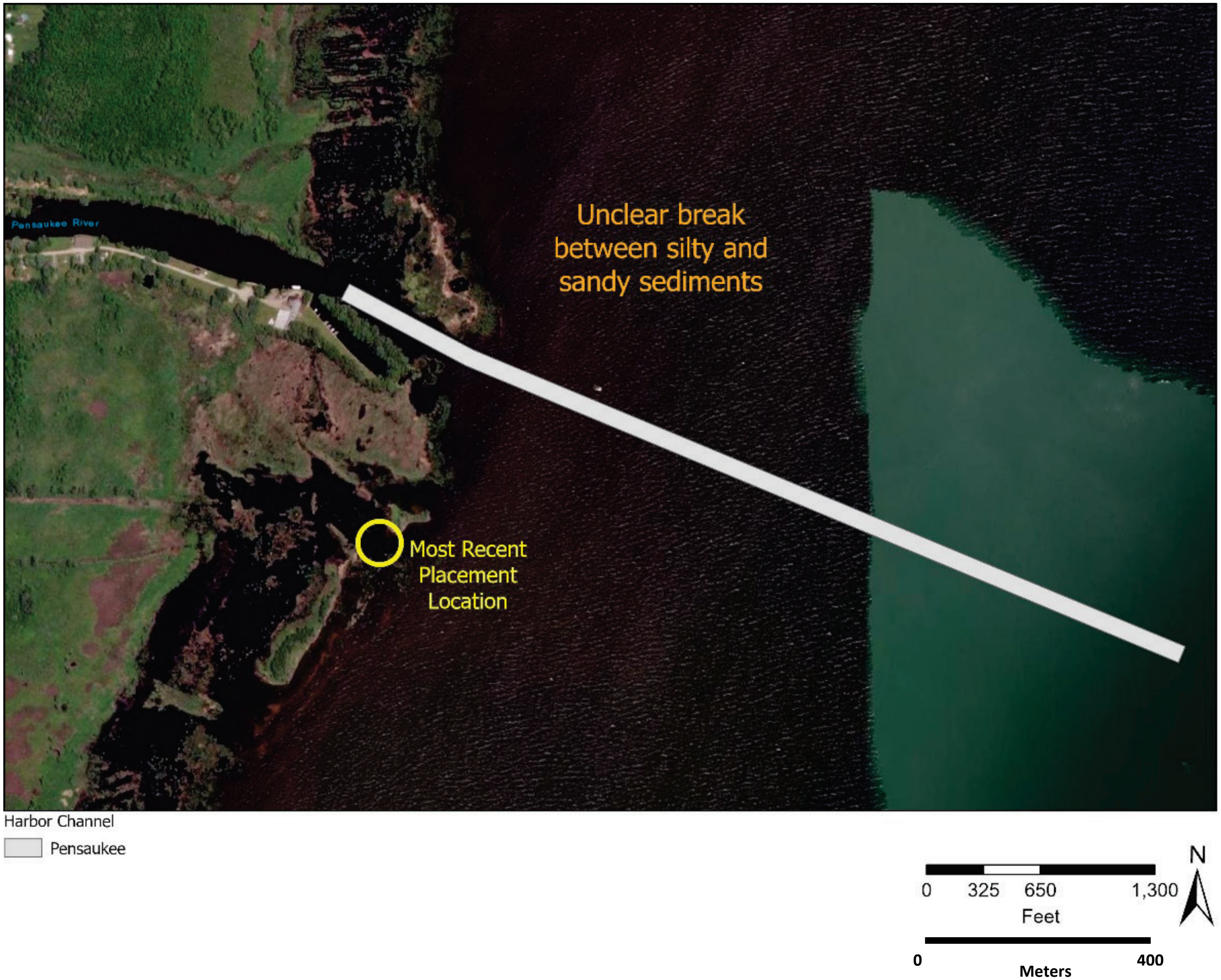


Table 10. Pensaukee Harbor sediment characteristics.

| Pensaukee | Harbor 1991 (Aquatec 1992) | Channel 1991 (Aquatec 1992) | Wisconsin Requirements[a,b] |
|---|---|---|---|
| Fines (P200 or <75 µm), percent | Fine to medium sand | Organic silt | <15% above proposed placement site |
| Total organic carbon (mg/kg) | 3,000 | 51,000 | n/a[c] |
| Oil and grease, mg/kg | 46 | 670 | n/a |
| Ammonia (sediment), mg/kg | 31 | 630 | n/a |
| Total phosphorus (sediment), mg/kg | 111 | 500 | n/a |
| Cadmium, mg/kg | 0.04 | 0.2 | 0.99 (5.0) |
| Chromium, mg/kg | 3.2 | 12.7 | 43 (110) |
| Copper, mg/kg | 1.41 | 8.6 | 32 (150) |
| Lead, mg/kg | 1.40 | 10 | 36 (130) |
| Mercury, mg/kg | <0.06 | <0.12 | 0.18 (1.1) |
| ΣPAHs[d,e], µg/kg | Not measured | Not measured | 1,610 (22,800) |
| Total PCBs[e], µg/kg | Not measured | Not measured | 60 (676) |

[a] NR 347.07(4)(a)1.

[b] The values quoted here are the threshold effects concentration and (probable effects concentration). It is noted that acceptable sediment concentrations for a specific project may vary according to measured toxicity of the material using bioassay techniques. The values listed above are used for screening purposes only (WDNR 2003).

[c] These parameters do not have established specific requirements but are general indicators of sediment conditions.

[d] ΣPAHs—Numerical sum of acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, 2 methylnapthalene, phenanthrene, benz(a)anthracene, benzo(a)pyrene, benzo(e)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthese, indeno(1,2,3-cd)pyrene, pyrene. The sum of test results reported was not adjusted for percentage of total organic carbon.

[e] The reporting limit was used in summations for parameters with concentrations less than the reporting limit. That is, a reporting limit of <5 would be used as 5 for calculating the sum of the constituents.

## 3.12 Big Suamico Harbor

The historical sampling and dredging information is as follows:

- Last sampled—2001 (sampled in 2022, results not available as of this report)
- Sampling method—2001: bucket auger, three subsamples in a transect across the channel composited for each analytical sample; 1993: petite ponar for the harbor-approach samples (which is in Lake Michigan)
- Last dredged—2002[29]

29. USACE-LRC, "Contract Dredging," 2.

- Dredging and placement methods—Mechanical
- Quantity dredged—17,000 $yd^3$ (13,000 $m^3$)
- Most recent sediment-placement location—Upland
- Estimated dredged-sediment backlog—25,000 $yd^3$ (19,000 $m^3$)[30]

Big Suamico is a shallow-draft recreational harbor that extends approximately 0.5 miles (0.8 km) up the Big Suamico River (Figure 15). The most recent sampling event was conducted in the river channel. The Suamico River is not an impaired water; the Lake Michigan shoreline has the same fish-tissue impairments as the rest of the Wisconsin shoreline.

A portion of the maintained channel is in Lake Michigan, and according to the 1993 sampling results, this material appears to be sandy and chemically clean (Table 11). The break between sandier lake materials and finer-grained, riverine materials appears to be near the river mouth. A more recent sampling event in 2001 was focused on the channel. This material is very fine grained and, according to the sampling documentation, appears to be typical topsoily material found in many rivers; the channel materials appear to be chemically clean.

The fine-grained materials were chemically clean and were placed upland, at a location along Longview Lane in Suamico (south of the intersection with Riverside Drive, west side of the road). The placement location was a former farm field; the existing soils were graded into berms to contain the dredged materials. It appears that several homes have been constructed on the property sometime around 2015. Away from the immediate shore of the channel, there appear to be open areas (farmed lands) which could be used for upland placement. The sediment may also be used for habitat development, since several projects are proposed within the larger Green Bay area (Figure 16).

30. USACE-LRC, "Wisconsin Harbors."

Figure 15. Big Suamico Harbor, Suamico, Wisconsin.

Table 11. Big Suamico sediment characteristics.

| Big Suamico | Harbor 1993 samples 4–8[a] (ESE 1993) | Channel 2001 (AES 2001) | Wisconsin Requirements[b,c] |
|---|---|---|---|
| Fines (P200 or <75 µm), percent | 4.8 | 69 | <15% above proposed placement site |
| Total organic carbon (mg/kg) | 9,700 | 18,000 | n/a[d] |
| Oil and grease, mg/kg | 179 | <50 | n/a |
| Ammonia (sediment), mg/kg | 33.5 | 18.3 | n/a |
| Total phosphorus (sediment), mg/kg | 172 | 421 | n/a |
| Cadmium, mg/kg | <0.65 | 0.10 | 0.99 (5.0) |
| Chromium, mg/kg | 2.52 | 12.5 | 43 (110) |
| Copper, mg/kg | 1.3 | 14 | 32 (150) |
| Lead, mg/kg | <12.9 | 7.4 | 36 (130) |
| Mercury, mg/kg | <2.5 (nondetectable) | <0.1 | 0.18 (1.1) |
| ΣPAHs[e,f], µg/kg | Nondetectable | Not measured | 1,610 (22,800) |
| Total PCBs[f], µg/kg | <65 | <100 | 60 (676) |

[a] The 1993 sampling included samples in the harbor area as well as samples taken in the river channel. For this discussion, the harbor samples are discussed separately from the channel samples since there is a marked difference in characteristics.

[b] NR 347.07(4)(a)1.

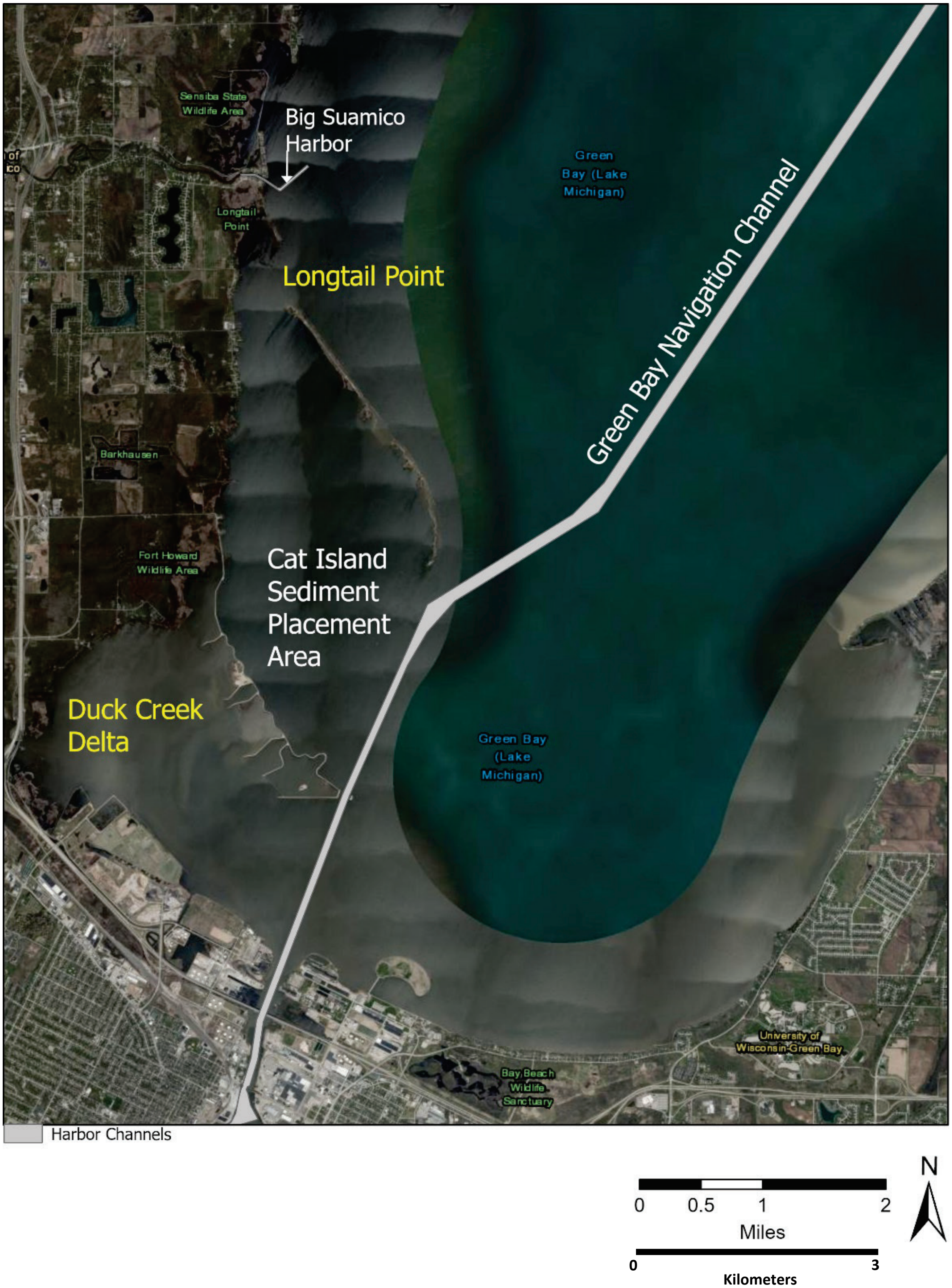
[c] The values quoted here are the threshold effects concentration and (probable effects concentration). It is noted that acceptable sediment concentrations for a specific project may vary according to measured toxicity of the material using bioassay techniques. The values listed above are used for screening purposes only (WDNR 2003).

[d] These parameters do not have established specific requirements but are general indicators of sediment conditions.

[e] ΣPAHs—Numerical sum of acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, 2 methylnapthalene, phenanthrene, benz(a)anthracene, benzo(a)pyrene, benzo(e)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthese, indeno(1,2,3-cd)pyrene, pyrene. The sum of test results reported was not adjusted for percentage of total organic carbon.

[f] The reporting limit was used in summations for parameters with concentrations less than the reporting limit. That is, a reporting limit of <5 would be used as 5 for calculating the sum of the constituents.

Figure 16. Proximity of Big Suamico Harbor to proposed Green Bay habitat projects.



# 4 Summary

## 4.1 Beneficial-Use Documentation Process

USACE generally prefers to place sediment below the ordinary high-water mark or just above it and at locations in close proximity to the federal navigation project as a general approach to reduce sediment-transportation requirements and costs. At the same time, it is important to ensure that any placement site will not result in the migration of sediment back into the federal channel or to other areas where it would have a negative effect. Evaluations of the coastal conditions and wave environment would aid in determining viable placement sites for the 12 harbors included in this screening assessment.

For any federal channel sediment to be used beneficially, additional information is needed before sediment beneficial-use alternatives can be meaningfully considered. Specifically, prior to awarding a dredging contract, the following documentation would need to be compiled and coordinated with the State of Wisconsin and other agencies:

- Recent (less than five years old typically) sediment sampling results that represent the entire proposed dredging prism and including elutriate or other data (biological testing, leaching data) as needed for the proposed placement location and method.
- Determination of a suitable placement site. Ideal sites are located close to the dredging area, include beneficial use of the sediment and are often in water to minimize handling and transportation requirements, have stakeholder acceptance, and do not cause impacts to existing environmental resources including historical and cultural resources.
- A *federal standard determination* for the harbor or area, which is a USACE evaluation that the proposed alternative represents the lowest cost, sound engineering, and environmentally acceptable alternative. This documentation provides justification for future budget planning for the harbor maintenance.
- Coordination with the state water-quality program, with receipt of permits and certifications as needed.
- Coordination with the state coastal-zone program, to ensure that the proposed action is consistent with the coastal-management objectives.
- Coordination with the agencies overseeing endangered species management.

- Coordination with the historical, archaeological, and cultural protection agencies.
- Documentation that the proposed project is consistent with NEPA; that is, an environmental assessment for the dredging and for the sediment-placement alternative or a categorical exclusion determination for the work.
- Design documentation as needed; required documentation may be more extensive for habitat-construction projects than for shoreline (beach) nourishment.

## 4.2 Ranked Harbor Beneficial Use Potential

Using the available information, the harbors were ranked qualitatively regarding the potential for beneficial use and particularly for in-water beneficial use. Ranking criteria include the history of sediment placement; grain size information and specifically whether at least a portion of the federal channel appears to have sediment with less than 20% fines; past chemical quality; and whether the harbor is likely to be dredged in the near future. The rankings are listed with the harbors most likely to have successful beneficial use ranked higher (in this ranking, 1 is the highest rank). The order of the ranking is based on most likely to achieve beneficial use to least likely to achieve beneficial use.

Information on the 12 harbors is summarized in Table 12. Using the available information, at least eight of the harbors appear to have potential for sediment beneficial use. Two harbors have low volumes or are low priorities for dredging (Port Washington and Washington Island) such that they are not likely to be project candidates in the near future. For completeness, these harbors could be included in a regional beneficial-use plan. Two harbors have unknown sediment conditions, Sheboygan and Kewaunee. The channel portion of Manitowoc is in an unevaluated similar state. These two harbors and channel have historical or current sediment issues that may preclude beneficial use of any materials. All 12 harbors are discussed further in this section.

Table 12. Summary of harbor conditions.

| Project Area | Last Dredged | Placement Location | Last Sampled | Backlog Quantity | Sandy? (<20% Fines) | Chemically Clean? | Past Beneficial Use? | Rank |
|---|---|---|---|---|---|---|---|---|
| Kenosha | 2021 (harbor) | Nearshore nourishment | 2020 | 168,900 | Yes | Yes | Yes | 1 |
| Two Rivers | 2019 | Beach | 2018 | 189,900 | Yes | Yes | Yes | 2 |
| Oconto | 1992 | Upland | 2000 | 244,900 | Yes | Yes | Yes | 3 |
| Pensaukee | 1993 | Nearshore | 1991 | 67,400 | Yes | Yes | Yes | 3 |
| Big Suamico | 2002 | Upland | 2001 | 25,000 | Yes | Yes | Yes | 3 |
| Sturgeon Bay | 2021 | Upland disposal site | 2015 | 84,600 (functional) | Yes | Yes | No | 6 |
| Algoma | 1993 | Upland | 2000 | 84,700 | Yes | Yes | Yes | 7 |
| Manitowoc | 2019 | CDF | 2019 | 115,400 (functional) | No | Yes | No | 8 |
| Port Washington | 2003 | CDF | 1999 | 1,000 (functional) | Yes | Yes | No | 9 |
| Washington Island | 1939 | Open water | Never | 4,300 | Unknown | Unknown | No | 10 |
| Kewaunee | 2014 | CDF | 2014 | 193,100 (functional) | No | Yes (harbor) | No | 11 |
| Sheboygan | 1991 (USACE) 2012 (EPA) | Beach (USACE) | 2011 | 46,200 (functional) | No | Historical—No; Current—Unknown | Yes | 12 |

*Note: Functional* refers to the actively maintained portion of the federal channel. A larger authorized channel exists but is not dredged.

The most viable harbors for beneficial use appear to be Kenosha, Two Rivers, Big Suamico, Pensaukee, and Oconto. Kenosha and Two Rivers harbor sediment has been used beneficially, for beach nourishment or shoreline placement, within the last five years and it is assumed that, as a minimum, those placement practices would continue. Big Suamico, Pensaukee, and Ocontol harbor materials have been used beneficially either upland or in water, although several years have passed since dredging has been conducted. On the basis of the sediment characteristics and past dredged-material placement, beneficial-use projects are very likely to be successful. Further investigation of in-water, beneficial-use alternatives is clearly warranted for these five harbors; past placement sites may not represent the most beneficial placement alternative.

Additional harbors with potential for beneficial use include Sturgeon Bay and Lake Michigan Channel, Algoma Harbor, and Manitowoc Harbor, all of which have similarly silty, but chemically suitable, materials. (It is recognized that the channel portion at Manitowoc and some other harbors may not be suitable for beneficial use.) Since these harbors have clean materials, consideration of beneficial-use options is appropriate. Without a previously identified beneficial-use placement site, defining new placement sites represents an additional process.

The four remaining harbors appear to have less potential for beneficial use in the immediate future. Port Washington appears to have clean sediment, including sandy materials near the harbor entrance. However, this small, deep-draft commercial harbor is essentially used only for recreational vessels at this time. USACE has defined a smaller functional channel to maintain, and there is currently little shoaling within the functional channel, making funding for dredging in the near future less likely. This harbor could be included in any beneficial-use plan, however, since the historical placement location (Milwaukee DMDF) is inappropriate for clean materials.

Similarly, Washington Island sediment is likely chemically suitable for beneficial use, but this small harbor has only been dredged one time in its history. There are no sediment data, but given the surrounding land uses and harbor history, the sediment is likely to be of good chemical quality. Washington Island has little shoaling and is a very low maintenance priority, so it is unlikely to be dredged in the near future. It could be included in any beneficial-use plans, but the likelihood of short-term project implementation is low.

Sheboygan and Kewaunee Harbors have unknown current sediment conditions, and at least portions of the channels have or had legacy pollution issues. According to the limited data available, portions of these harbors may be suitable for beneficial use; however, comprehensive sediment sampling is needed to characterize the backlog sediment characteristics. These two harbors have sufficient uncertainty and therefore are probably not appropriate for inclusion in a regional beneficial-use plan at this time. In addition, some other channel areas may also be identified that would not be included in such a plan (for example, Manitowoc Channel).

## 4.3 Data Needs and Next Steps

Sediment data are needed at all harbors to define current chemical and physical properties. Sediment sampling was conducted for Big Suamico and Algoma Harbors in 2022, although as of this report the results are not published. Additional harbors will be sampled as funding allows; it is generally recognized that comprehensive sampling is needed at all Wisconsin federal harbors. Such sampling may result in the addition or removal of some areas from any list of potential beneficial-use materials.

Assuming that sediment sampling confirms the suitable chemical quality of the materials in (at least separable portions of) the federal channels, the next step would be to systematically identify possible in-water and upland beneficial-use sites according to coastal characteristics, wave climate, sediment physical properties, and local considerations. Once potential placement sites are identified, coordination with WDNR and other agencies and stakeholders should begin; coordination can be integrated into the NEPA process. It is critical to identify the regulatory requirements or other potential limitations for beneficial use early in the process to prevent project delays.

# Bibliography

AEM Group. 2019. *FY18 Two Rivers Harbor Sediment Sampling and Analysis: Two Rivers, Wisconsin; Final Report*. Project No. F18725. Contract Nos. W911XK-16-D-0014 and W911XK18F0060 [sic]. Prepared for U.S. Army Corps of Engineers, Detroit District, 14 June 2019. Plymouth, MI: AEM Group.

AEM Group (Advanced Environmental Management Group). 2020. *FY19 Manitowoc Harbor Sediment Sampling and Analysis: Manitowoc, Wisconsin; Final Report*. Project No. F19735. Contract Nos. W911XK-16-D-0014 and W911XK19F0041 [sic]. Prepared for U.S. Army Corps of Engineers, Detroit District. Plymouth, MI: Advanced Environmental Management Group.

AES (Altech Environmental Services). 1999. *Final Report: Sediment Sampling and Analysis Port Washington Harbor, Wisconsin; September 27-28, 1999*. Project No. 9210, Delivery Order No. 0012. Contract No. DACW35-98-D-0007. Prepared for United States Army Corps of Engineers, Detroit District. Southfield, MI: Altech Environmental Services.

AES (Altech Environmental Services). 2001. *Sediment Sampling at Big Suamico Harbor, Wisconsin*. Delivery Order No. 0027. Prepared for US Army Corps of Engineers, Detroit District, March 2001. Southfield, MI: Altech Environmental Services.

AES (Altech Environmental Services). 2006. *Limited Soil Investigation Report: Kenosha Retaining Wall, Kenosha, Wisconsin*. Project No. 9201-041. Contract No. DACW35-01-D-0006. Prepared for US Army Corps of Engineers, Detroit District, July 2006. Southfield, MI: Altech Environmental Services.

AES (Altech Environmental Services). 2001. *Sediment Sampling and Analysis: Algoma Harbor, Wisconsin; June 7, 2000*. Project No. 9218, Delivery Order No. 0018. Contract No. DACW35-98-D-0007. Prepared for United States Army Corps of Engineers, Detroit District. Southfield, MI: Altech Environmental Services.

Aquatec. 1992. *Pensaukee Harbor Analytical Results: FY 1992*. Contract No. DACW35-91-D-[0008?]. Prepared for U.S. Army Engineer District, Detroit, 16 January 1992. Colchester, VT: Aquatec.

Brutsché, Katherine E., Zachary J. Tyler, Coraggio K. Maglio, Jase D. Ousley, and Ping Wang. 2019. *Beneficial Use of Dredged Material with Increased Fine Sediment Content: A Case Study at Egmont Key, Florida*. ERDC/CHL TR-19-11. Vicksburg, MS: US Army Engineer Research and Development Center–Coastal and Hydraulics Laboratory. https://dx.doi.org/10.21079/11681/33363.

Brutsché, Katherine E., Ping Wang, Tanya M. Beck, Julie D. Rosati, and Kelly R. Legault. 2014. "Morphological Evolution of a Submerged Artificial Nearshore Berm along a Low-Wave Microtidal Coast, Fort Myers Beach, West-Central Florida, USA." *Coastal Engineering* 91 (September): 29–44. https://doi.org/10.1016/j.coastaleng.2014.04.010.

CEC (Coleman Engineering Company). 1991. *Field Boring Logs, Daily Field Reports and Transmittal Letters for Pensaukee Harbor Subsurface Investigation*. CEC Project #G-91189. Contract No. DACW35-91-D-0008. Prepared for U. S. Army Corps of Engineers, 30 October 1991. Iron Mountain, MI: Coleman Engineering Company.

Definitions. 2023. Wis. Stat. § 292.01(1s) (2023). https://docs.legis.wisconsin.gov/statutes/statutes/292.pdf.

Environmental Protection – Investigation and Remediation of Environmental Contamination. 2023. Wis. Admin. Code NR §§ 700–99 (2023). https://docs.legis.wisconsin.gov/code/admin_code/nr/700.

EPA (Environmental Protection Agency). 2023. "Milwaukee Estuary AOC." https://www.epa.gov/great-lakes-aocs/milwaukee-estuary-aoc.

EPA-GLNPO (Environmental Protection Agency–Great Lakes National Program Office). 2015. *Restrictions on Dredging Activities BUI at the Sheboygan River AOC*. Chicago, IL: Environmental Protection Agency–Great Lakes National Program Office. Published online February 2021. https://www.epa.gov/sites/default/files/2021-02/documents/dredging_bui_removal_package_sheboygan.pdf.

ERG (Environmental Research Group). 1986. *Kenosha Harbor, WI: Sediment Data Report 1985*. Report 309, Project A3778. Prepared for Limno Tech, 24 February 1986. Ann Arbor, MI: Environmental Research Group.

ESE (Environmental Science and Engineering). 1993. *Sediment Sampling and Analysis: Big Suamico Harbor*. Report No. c-ec-s2/bigsu, ESE No. 393-0870-0G-0100, Project No. 7934052G. Prepared for USACE Detroit District, 27 August 1993. St. Louis, MO: Environmental Science and Engineering.

Federal Water Pollution Control Act Amendments of 1972 § 303(d). 2021. 33 U.S.C. § 1313(d)(1)(D). https://www.govinfo.gov/content/pkg/USCODE-2021-title33/pdf/USCODE-2021-title33-chap26.pdf.

FNG (FutureNet Group). 2012. *Sediment and Soil Sampling and Analysis Report: Sheboygan Harbor, Wisconsin*. Project No. 11652-0036, Task Order No. 0036. Contract No. W911XK-09-D-0014. Prepared for U.S. Army Corps of Engineers, Detroit District, January 2012. Detroit, MI: FutureNet Group.

Maglio, C. K., J. D. Ousley, A. G. Hershorin, K. E. Brutsché, M. B. Taylor, Z. J. Taylor [Tyler], and P. Wang. 2020. "2014 Egmont Key Beneficial Use of High Fines Material Using Traditional Versus Cross Shore Swash Zone Placement." *Western Dredging Association* 18, no. 1 (October): 36–59. https://www.westerndredging.org/phocadownload/WEDA%20Journal%20Vol%2018%20No%201.pdf.

National Environmental Policy Act of 1970. 2021. 42 U.S.C. §§ 4321–47. https://www.govinfo.gov/content/pkg/USCODE-2021-title42/pdf/USCODE-2021-title42-chap55.pdf.

RTI Laboratories. 2014. *Kewaunee Harbor Sediment Sampling and Analysis Report: Kewaunee, Wisconsin*. Delivery Order No. 0028. Contract No. W911XK-11-D-0005. Prepared for U.S. Army Corps of Engineers, Detroit District, December 2014. Livonia, MI: RTI Laboratories.

RTI Laboratories. 2015. *Sturgeon Bay Federal Navigation Channel Sediment Sampling and Analysis Report: Door County, Wisconsin*. Delivery Order No. DC08. Contract No. W912P4-12-D-0002. Prepared for U.S. Army Corps of Engineers, Detroit District, November 2015. Livonia, MI: RTI Laboratories.

Sediment Sampling and Analysis, Monitoring Protocol and Disposal Criteria for Dredging Projects. 1989. Wis. Admin. Code NR § 347 (1989). https://docs.legis.wisconsin.gov/code/admin_code/nr/300/347.pdf.

TMA (Thermo Analytical) and ERG [Environmental Research Group?]. *Detroit Corp of Engineer: Port Washington Harbor October 28, 1987*. 1988. Report 523, Project A7585. Contract No. DACW35-87-M-0665. Prepared for U. S. Army Engineer District –Detroit [sic], 08 February 1988. Ann Arbor, MI: Thermo Analytical and ERG [Environmental Research Group?].

USACE-LRC (US Army Corps of Engineers–Chicago District). 2020. *Clean Water Act Section 404(B)(1) Contaminant Determination: Maintenance Dredging and Beneficial Use Kenosha Harbor, Kenosha, Wisconsin*. July 2020. Chicago: US Army Corps of Engineers–Chicago District.

USACE-LRE (US Army Corps of Engineers–Detroit District). 2011. *Amended Finding of No Significant Impact: Dredged Material Management Plan, Green Bay Harbor, Wisconsin*. Environment Assessment. 11 October 2011. Detroit, MI: US Army Corps of Engineers–Detroit District.

Wang, Ping, Katherine E. Brutsche [Brutsché], James W. LaGrone, Tanya M. Beck, and Julie D. Rosati. 2013. *Performance Monitoring of a Nearshore Berm at Ft. Myers Beach, Florida: Final Report*. ERDC/CHL TR-13-11. Vicksburg, MS: US Army Engineer Research and Development Center–Coastal and Hydraulics Laboratory. https://hdl.handle.net/11681/7338.

WDNR (Wisconsin Department of Natural Resources). 2003. *Consensus-Based Sediment Quality Guidelines: Recommendations for Use & Application*. RR-088. Interim Guidance. December 2003. Madison, WI: Wisconsin Department of Natural Resources. https://widnr.widen.net/content/1vtc2fbdqj/pdf/RR088.pdf.

WDNR (Wisconsin Department of Natural Resources). 2022a. *Appendix A: 2022 Impaired Waters List*. 1 April 2022. Madison, WI: Wisconsin Department of Natural Resources. https://dnr.wisconsin.gov/topic/SurfaceWater/ConditionLists.html.

WDNR (Wisconsin Department of Natural Resources). 2022b. *2022 Water Condition Lists*. 1 April 2022. Madison, WI: Wisconsin Department of Natural Resources. https://dnr.wisconsin.gov/topic/SurfaceWater/ConditionLists.html.

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**14. ABSTRACT**
In 2020 the US Army Corps of Engineers (USACE) reassigned 14 federally maintained harbors in the Wisconsin waters of Lake Michigan to USACE–Chicago District. The administrative change presents opportunities for increased beneficial use of sediment at harbors that have not traditionally placed sediment beneficially. This paper summarizes a screening-level analysis of 12 harbors to determine which harbors are likely to have sediment appropriate for beneficial use in the future, either in water or upland. The harbors were qualitatively ranked according to the potential for future successful beneficial use of navigationally dredged sediment. Using this screening, data needs were defined and next steps to aid the development of a regional dredged-material management plan were identified.

**15. SUBJECT TERMS**
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