

# REMEDIAL ACTION PLAN UPDATE

for the

## LOWER GREEN BAY AND FOX RIVER AREA OF CONCERN



February 2019



Wisconsin Department of Natural Resources  
Office of Great Waters

**Remedial Action Plan Update  
for the  
Lower Green Bay and Fox River Area of Concern  
December 2018**

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**Cover Photo:** Photo taken by Andrew Ransom and pictures Angela Grimm, Chris Houghton, and Stefan Tucker from UW-Green Bay Aquatic Ecology and Fisheries Lab.

Disclaimer

The Great Lakes Water Quality Agreement is a non-regulatory agreement between the U.S. and Canada, and criteria developed under its auspices are non-regulatory. The actions identified in this document as needed to meet beneficial use impairment (BUI) delisting targets are not subject to enforcement or regulatory actions.

The actions identified in this Remedial Action Plan Update do not constitute a list of preapproved projects, nor is it a list of projects simply related to BUIs or generally to improve the environment. Actions identified in this document are directly related to removing a BUI and are needed to delist the Area of Concern

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## **PURPOSE STATEMENT**

This Remedial Action Plan (RAP), which updates the 2017 RAP, documents and communicates progress made in the AOC in the last year and shares the path forward with our partners and stakeholders. The RAP includes a concise summary of beneficial use impairment status and tracks progress on specific actions that are important for reaching the delisting targets. These “actions” may include on-the-ground restoration projects, monitoring and assessment projects, and stakeholder engagement processes. As the primary agency with the responsibility to develop and implement the RAP, the Wisconsin Department of Natural Resources and the Office of Great Waters is committed to making progress in remediating and restoring Wisconsin’s Areas of Concern. In order to be lasting and effective, the RAP must be a program of continuous improvement, evaluating its course as new information and technology become available. Subsequent RAP updates will be produced as needed to incorporate new information.

Remedial Action Plans are required by Annex 1 of the Great Lakes Water Quality Protocol of 2012 (which replaced the 1987 Protocol amending the Revised Great Lakes Water Quality Agreement of 1978). The 2012 Protocol indicates that Remedial Action Plans must include the following elements:

1. Identification of beneficial use impairments (BUIs) and causes;
2. Criteria for the restoration of beneficial uses that take into account local conditions and established in consultation with the local community;
3. Remedial measures to be taken, including identification of entities responsible for implementing these measures;
4. A summary of the implementation of remedial measures taken and the status of the beneficial use; and
5. A description of surveillance and monitoring processes to track the effectiveness of remedial measures and confirm restoration of beneficial uses.

## 2018 Progress Summary

The Wisconsin Department of Natural Resources (WDNR) and its many partners continue to work diligently to remove the significant limitations impeding recovery in the Lower Green Bay and Fox River Area of Concern (AOC; Figure 1). In 2018, substantial progress was made on remediating contaminated sediments, assessing beneficial use impairments (BUI) to inform BUI status and assist in the development of BUI restoration criteria, and the development of management action lists for key BUIs. More information regarding the status, current remedial actions, and next steps for individual BUIs can be found in the next section of this document. Project-specific details are included in Appendices as relevant.

In 2018, 575,424 cubic yards of material were dredged as part of the in-river remedial action work for the Lower Fox River polychlorinated biphenyl (PCB) cleanup project. In total, 49 acres were sand-covered and 3.4 acres stone-capped. In addition, dredging was completed at the South Focus Area of the Green Bay Manufactured Gas Plant (MGP) site, located at the East River confluence, with approximately 7,600 cubic yards of material dredged. PCB cleanup on the Fox River has been adjusted and is expected to be completed in 2019. Cleanup of sediment polluted with PAHs and heavy metals at the WPS Green Bay former MGP site is expected to be completed by the end of 2020. Both cleanup projects are key to addressing several BUIs, including **Fish Tumors, Bird and Animal Deformities, Fish and Wildlife Consumption Advisories, Restrictions on Dredging Activities, Degradation of Benthos, Degradation of Phytoplankton and Zooplankton Populations, Degradation of Fish and Wildlife Populations, and Restrictions on Drinking Water Consumption.**

The **Fish Tumors or Other Deformities** BUI is listed as suspected due to the presence of persistent, bioaccumulating toxic substances such as PCBs and PAHs. In 2015, a draft target for this BUI was developed based on those of other Wisconsin AOCs. Stakeholders indicated that they preferred an approach where contaminated sediments would be addressed before assessing the status of this BUI. WDNR, with assistance from West Virginia University and USGS, will conduct this fish tumor assessment on white suckers (*Catostomus commersonii*) beginning in spring 2021, pending completion of the in-river remedial work for the Lower Fox River PCB Cleanup and WPS Green Bay former MGP site.

WDNR began compiling historic benthic data collected within the AOC and convened a small working group of benthic invertebrate community and habitat experts in late 2018 to help inform our path forward for this BUI. The working group has determined that more information is needed to evaluate the health of the benthic community, and in response, a proposal for a benthic community and habitat suitability assessment was drafted in late 2018 for submittal to USEPA Great Lakes National Program Office (GLNPO). The proposed assessment will extend a grant awarded in 2018 by UW Sea Grant to UW-Green Bay researchers to evaluate the benthic community throughout the Bay of Green Bay and will expand the area of interest to include more sites within the AOC. The results of this proposed assessment will allow WDNR to determine the status and next steps for this BUI and provide supplemental information to assist with management action development for the **Loss of Fish and Wildlife Habitat** and **Degradation of Fish and Wildlife Populations** BUIs.

Following the completion of the AOC fish and wildlife inventory and assessment led by the University of Wisconsin-Green Bay (UWGB) in collaboration with The Nature Conservancy (TNC) in 2017, a final project report was completed in 2018. WDNR continues its partnership with UWGB to assist in the development of a list of management actions that are expected to move the current cumulative condition scores for the fish and wildlife habitat and populations BUIs to the recommended BUI removal target scores. In order to assist with this process, WDNR convened a Fish and Wildlife Habitat and Populations Steering Committee and Technical Advisory Committee in early 2018 which is utilizing a consensus-based approach to identify potential restoration activities to implement for a set of nine AOC Restoration Priority Areas. An initial list of activities for each

Restoration Priority Area will be presented for stakeholder input prior to being submitted to USEPA GLNPO in mid-2019, and a management action list will be completed and presented for stakeholder input prior to being submitted to USEPA GLNPO in April 2020.

With regard to **the Eutrophication and Undesirable Algae BUI**, WDNR continued to explore ways in which the AOC program can address this impairment while acknowledging the scope of the program, which focuses on defined geographic areas and legacy pollutants. Given the scope and complexity of the eutrophication issue, the AOC program aims to complement and support efforts that are underway through other programs and initiatives. In 2018, WDNR built upon previous years' work by convening a group of technical advisors to discuss implementation opportunities for selected "AOC-like" conservation practices. The group began developing rough estimates of phosphorus reductions that could be accomplished by implementing these practices within the Lower Fox Basin. In 2019, WDNR will continue working with technical advisors to further develop estimates for the "AOC-like practices" and present the methods for obtaining these estimates and results to stakeholders and USEPA GLNPO. These estimates will provide the basis for discussion on how and where to install management actions within the Lower Fox Basin. The management action list will define the AOC contribution toward reducing nutrient loading to the Lower Fox River and Lower Green Bay, which will impact the **Degradation of Phytoplankton and Zooplankton, Loss of Fish and Wildlife Habitat, Degradation of Fish and Wildlife Populations Restrictions on Drinking Water Consumption, Beach Closings, and Degradation of Aesthetics** BUIs. WDNR anticipates having a management action list presented for stakeholder input prior to being submitted to USEPA GLNPO by the end of calendar year 2019.

WDNR partnered with NEW Water, University of Wisconsin – Milwaukee and University of Wisconsin - Green Bay to complete the third year of monitoring to assess cyanobacteria harmful algal blooms in the AOC. A primary goal of the study is to understand the nature and extent of algae blooms in the lower bay and to develop tools for managing recreational risk. This assessment leverages NEW Water's existing water quality monitoring network with additional sampling locations at Bay Beach and Joliet Park. Buoys near Bay Beach and Long Tail Point collected continuous water quality and meteorological data from 2017-2018. Cyanobacterial cell counts indicate that the current target is not being met; however, USEPA's proposed recreational criteria for cyanobacteria focuses on toxin concentration rather than a combination of cell counts and toxins. Proposed criteria establish lower concentrations for microcystin than the current BUI target. The existing target will need to be revised considering health information in the USEPA recreational criteria proposal and achievability in context with the entire Lower Fox River system. Two additional years of data are planned which will be used to propose a target revision and develop predictive models to assess toxin production. The current data set will be used to inform the status of the Restrictions on Drinking Water Consumption BUI.

The final year of aesthetics monitoring was completed in 2018 in collaboration with the Fox-Wolf Watershed Alliance (FWWA), a local nonprofit organization that has implemented this volunteer program for three consecutive years. The purpose of this program is to assess the status of the **Degradation of Aesthetics** BUI, and to determine what, if any, management actions will be necessary to remove this BUI. Results from the 2015 to 2018 aesthetics monitoring survey years indicate very limited interference by objectionable substances on public use in the waters or shorelines at each survey station, and a generally positive overall aesthetic impression score at all survey stations in the AOC. The results of the surveys will be shared with stakeholders in early 2019, after which we will determine next steps for this BUI.

Having reviewed with stakeholders the historical and recent information that can help inform the status of **Tainting of Fish Flavor** this BUI, WDNR has concluded that there is sufficient evidence available to remove this suspected BUI. In response, WDNR drafted a BUI removal recommendation in 2018 that will be available for stakeholder review in early 2019, followed by submitted to USEPA GLNPO for concurrence.



**Figure 1.** The boundaries of the Lower Green Bay and Fox River Area of Concern.

For additional information about the history of the AOC and a narrative description of the AOC boundary, please refer to previous RAP documents which are available online: <http://dnr.wi.gov> Search “Lower Green Bay and Fox River AOC”; RAP documents are stored on the “AOC Plans” tab. A listing of previous RAPs, RAP Updates, and important historical documents is included in the References section.

**Table 1.** Current Status of Beneficial Use Impairments in the Lower Green Bay and Fox River AOC (Refer to Appendix C for more detail).

<b>Beneficial Use Impairment</b>	<b>Beneficial Use Remains Impaired</b>	<b>Summary Status</b>
Fish tumors or other deformities	Suspected	Assessment of this BUI will begin in 2021 after the contaminated sediment projects are completed: PCB site will be finished in 2019 and former Manufactured Gas Plant (MGP) site completed in 2020.
Bird or animal deformities or reproductive problems	Yes	Complete the contaminated sediment projects (PCB and former MGP site), which are known to cause deformities and reproductive problems, by 2020. A repeat assessment of wildlife (tree swallows) will then be conducted with assistance from USGS from 2021 to 2022.
Restrictions on fish and wildlife consumption	Yes	Complete the removal of sediments containing PCBs in 2019. Waterfowl and fish consumption assessments will begin in 2020, until targets are met. A combination of responsible party and WDNR program data will be used to assess consumption advisories following the PCB cleanup.
Restrictions on dredging activities	Yes	Cleanup of sediment polluted with PAHs and heavy metals at the WPS Green Bay former MGP site and cleanup of riverbed sediments containing PCBs in the Lower Fox River is expected to be completed by the end of 2020. A BUI removal document may be drafted in 2022.
Degradation of benthos	Yes	More information is needed to determine the health of the benthic community. To assist with this, WDNR is working with a small group of experts to determine a strategy for assessing this BUI. We anticipate conducting a benthic community and habitat suitability assessment beginning in the Bay of Green Bay in 2019 and in the Fox River after completion of the contaminated sediment remediation projects (PCB and MGP site) in 2020.
Degradation of phytoplankton and zooplankton populations	Yes	Assessment data on soft algae from the Harmful Algal Blooms (HABs) project, which runs through 2018, will help inform this BUI. A status check will be done in 2019 to evaluate data and determine next steps.
Loss of fish and wildlife habitat	Yes	UW-Green Bay has completed mapping different habitat types within the AOC and developed tools for quantitatively assessing the status of this impairment. The technical advisory committee anticipates having a list of management actions completed by April 2020. Timeline of implementation will be determined once the projects are selected.
Degradation of fish and wildlife populations	Yes	UW-Green Bay has completed an assessment of fish and wildlife populations within the AOC and developed tools for quantitatively assessing the status of this impairment. The technical advisory committee anticipates having a list of management actions completed by April 2020. Timeline of implementation will be determined once projects are selected.
Restrictions on drinking water consumption, or taste and odor problems	Yes	A study is underway of cyanobacteria and cyanotoxins caused by blue-green algae blooms to determine if waters in the lower Bay are meeting standards for drinking water. The study will be completed in 2021, but data collected through 2019 will be adequate to inform next steps for this BUI.
Beach closings	Yes	The assessment of harmful algal blooms will be completed in 2021 and will inform any necessary target revisions for this BUI. Additional management actions may be identified depending on the status determination.

Eutrophication or undesirable algae	Yes	Technical groups and stakeholders are continuing to work on finalizing the delisting target and identifying the necessary management actions to address eutrophication in the AOC. A list of management actions is expected to be prepared by December 2019.
Degradation of aesthetics	Yes	The final year of aesthetics monitoring volunteer surveys was completed in 2018. All the data will be evaluated in 2019 with stakeholders to determine next steps.
Tainting of fish and wildlife flavor	Suspected	Information from angler surveys, wastewater permits, and historical documents was compiled, and a BUI removal document was prepared in 2018 which will be shared with stakeholders in early 2019. WDNR anticipates recommending removal of this BUI in 2019.

**BENEFICIAL USE IMPAIRMENT UPDATES**

For each BUI section, the following symbols indicate the status of the management actions listed:

- = Not started
- ➡ = Underway
- ✓ = Complete

**FISH TUMORS OR OTHER DEFORMITIES**

Target	Status
Removal may occur if: <ul style="list-style-type: none"> <li>• All known major sources of PAHs and chlorinated organic compounds within the AOC and tributary watershed have been controlled or eliminated</li> <li>• A fish health survey of resident benthic fish species, such as white suckers, finds incidences of tumors or other deformities at a statistically similar incidence rate of minimally impacted references sites.</li> </ul>	Action needed
OR, in cases where tumors have been reported: <ul style="list-style-type: none"> <li>• A comparison study or resident benthic fish such as white suckers of comparable age and maturity, or of fish species found with tumors in previous fish health surveys in the AOC, with fish at minimally impacted reference sites indicate that there is no statistically significant difference (with 95% confidence) in the incidence of liver tumors or deformities.</li> </ul>	TBD

**Status**

In 2018, the Lower Fox River PCB cleanup project continued downriver, with the active portion of the Fox River PCB cleanup anticipated to be complete in 2019. Dredging began in 2018 at the South Focus Area of the former MGP site located at the East River confluence. Remedial action work at the north Focus Area of the former MGP site is targeted to begin by mid-summer 2020. See the “Restrictions on Dredging” section for more details.

WDNR’s policy on this BUI is that assessment should ensue after remediation of contaminated sediments has occurred. Because of the altered timeline associated with the completion of the PCB and former MGP site cleanup, WDNR will not begin assessing this impairment until 2021. WDNR will work with West Virginian University, USGS, and USFWS to develop methodology for assessing this BUI in 2019 and 2020. Study design, which will include collection of white suckers (*Catostomus commersonii*), pathological analysis of tumor rate, and stable isotope analysis to determine residence, will be finalized and funding for the study to be secured in fall 2020. We anticipate that the assessment will be conducted from 2021-2022.

*A status check is currently scheduled for this BUI in 2023.*

**Management actions**

- ➔ Complete the contaminated sediment projects (PCB and former MGP site)

**Additional actions**

- Complete an AOC fish tumors assessment once the PCB remedial work has been completed

BIRD OR ANIMAL DEFORMITIES OR REPRODUCTION PROBLEMS

Target	Status
<p>PCB remedial actions have been implemented and the AOC is in recovery</p>	<p>In progress</p>
<p>Studies indicating the incidence rates of deformities (e.g., crossbill syndrome) or reproductive problems (e.g., eggshell thinning) in sentinel wildlife species (avian, amphibian, mammalian, predatory fish, and reptilian) do not exceed background levels of reference populations from unimpacted sites of comparable physical and chemical characteristics.</p> <p>A stepwise approach will be used to conduct <u>both</u> of the following evaluations in the AOC to determine when the BUI can be delisted:</p> <ol style="list-style-type: none"> <li>1. If fish tissue or other food sources (e.g., insects and amphibians) concentrations of contaminants of concern identified in the AOC are:             <ol style="list-style-type: none"> <li>a. at or lower than the Lowest Observable Effect Level (LOEL) known to cause reproductive or developmental problems in fish, fish-eating birds, and mammals, the BUI can be delisted, or</li> <li>b. not statistically different than Lake Michigan (at 95% confidence interval), then the BUI can be delisted.</li> </ol> <p>Fish and other food sources (e.g., insects and amphibians) should be of a size and species considered prey for the species under consideration;</p> </li> <li>2. Field studies including observational data and direct measures of birds and other wildlife (including predatory fish) exhibit deformities or reproductive problems are verified through an:             <ul style="list-style-type: none"> <li>– Evaluation of observational data of bird and other animal deformities for a minimum of two successive monitoring cycles in indicator species identified in the initial studies as exhibiting deformities or reproductive problems. If deformity or reproductive problem rates are not statistically different than those at minimally impacted reference sites (at a 95% confidence interval), or no reproductive or deformity problems are identified during the two successive monitoring cycles, then the BUI can be delisted. If the rates are statistically different than the reference site it may indicate a source from either within or outside the AOC. Therefore, if the rates are statistically different or the data are insufficient for analysis, then:</li> </ul> <p>Evaluation of tissue contaminant levels in egg, young and/or adult wildlife. If contaminant levels are lower than the Lowest Observable Effect Level (LOEL) for that species for a particular contaminant that are not statistically different than those at minimally impacted reference sites (at a 95% confidence interval), then the BUI can be delisted.</p> </li> </ol>	<p>Assessment in progress</p>

## Status

In 2018, the Lower Fox River PCB cleanup project continued downriver, with the active portion of the Fox River PCB cleanup anticipated to be complete in 2019. Dredging began in 2018 at the South Focus Area of the former MGP site located at the East River confluence. Remedial action work at the north Focus Area of the former MGP site is targeted to begin by mid-summer 2020. See the “Restrictions on Dredging” section for more details.

Extensive datasets examining the effects of contaminants on tree swallows and bald eagles currently exist for the AOC. From 2016-2018, USGS researchers published several articles detailing the results of contaminant levels in tree swallows in several AOCs throughout the Great Lakes region. The 2010-2015 results in the Lower Green Bay-Fox River AOC indicate a lack of effect on tree swallow reproduction due to PCB contamination and concentrations of PCBs in eggs and nestlings were observed to decline by 70-80% after dredging at Ashwaubomay Park occurred (Custer et al., 2018). After the completion of the contaminated sediment projects (Fox River PCB cleanup and former MGP site), a repeat assessment of wildlife will be conducted in partnership with USGS from 2021-2022.

*A status check is currently scheduled for this BUI in 2023.*

## Management actions

- ➔ Complete the contaminated sediment projects (PCB and former MGP site)

## Additional Actions

- Repeat assessment of wildlife following completion of contaminated sediment projects

## RESTRICTIONS ON FISH AND WILDLIFE CONSUMPTION

Target	Status
The Fox River Contaminated Sediment Remediation has been completed and meets the target established in the plan (Surface Area Weighted Concentration of 0.25 ppm or that determined acceptable by the agencies for completion of the PCB remedial action)	In progress
Fish and wildlife consumption advisories are the same or lower than those in the associated Great Lake or appropriate control site.	Assessment in progress

**Status**

In 2018, the Lower Fox River PCB cleanup project continued downriver, with the active portion of the Fox River PCB cleanup anticipated to be complete in 2019. Dredging began in 2018 at the South Focus Area of the former MGP site located at the East River confluence. Remedial action work at the north Focus Area of the former MGP site is targeted to begin by mid-summer 2020. See the “Restrictions on Dredging” section for more details.

Monitoring to assess fish consumption advisories for PCBs will begin in 2020 following completion of the Lower Fox River PCB project and will be repeated every five years until targets are met through a combination of WDNR Fisheries Program and Responsible Party data.

Waterfowl consumption advisories were reassessed in 2016, using data from mallards and Canada geese collected from the AOC in 2014 and 2015. The results of the assessment indicated that PCB levels have remained virtually unchanged since the original consumption advisories were issued in 1987, and the advisory for mallards remains (Strom, 2016). A limited consumption advisory for mercury was also proposed with no more than one meal per week recommended for children and women of childbearing age (Strom, 2016). This change was published in the 2018 Migratory Bird Hunting Regulation booklet and online at <https://dnr.wi.gov/topic/hunt/waterfowl.html>. The waterfowl consumption advisories will be reassessed in 2020 after the Lower Fox River PCB project is complete.

*A status check is currently scheduled for this BUI in 2025.*

**Management actions**

- Complete the contaminated sediment projects (PCB and former MGP site)

**Additional actions**

- Assess waterfowl and fish consumption advisories after sediment cleanup projects have been completed

## RESTRICTIONS ON DREDGING ACTIVITIES

Target	Status
All remediation actions for known contaminated sediment sources are completed and monitored according to the approved remediation plans, the remedial action goals have been achieved, and institutional controls have been implemented.	In progress

**Status**

In 2018, 575,424 cubic yards of material were dredged as part of the in-river remedial action work for the Lower Fox River polychlorinated biphenyl (PCB) cleanup project. This was accomplished by the use of three hydraulic dredges working simultaneously around the clock over 33 weeks of field effort. 318,566 tons of material were sent to landfill, and 166,515 tons of clean sand were separated from the fine sediment and used beneficially offsite. 49 acres were sand covered with 3.4 acres stone capped. In addition, dredging was completed at the South Focus Area of the Green Bay Manufactured Gas Plant (MGP) site, located at the East River confluence, with approximately 7,600 cubic yards of material dredged and 7,000 tons of material sent to landfill. Remedial action work at the North Focus Area of the MGP site is targeted to begin by mid-summer 2019. The MGP site remedial action work is being conducted by the Fox River Group of Companies (FRG respondents) as part of a joint effort between the FRG and We Energies (trade name of Wisconsin Electric Power Co. and Wisconsin Gas LLC, subsidiaries of WEC Energy Group). PCB cleanup on the Fox River has been adjusted, and the active portion of the cleanup is anticipated to be complete in 2019.

*After completion of the contaminated sediment projects, WDNR anticipates drafting a BUI Removal Recommendation that will be submitted to USEPA GLNPO in 2022.*

**Management actions**

- ➔ Complete the contaminated sediment projects (PCB and former MGP site)

## DEGRADATION OF BENTHOS

Target	Status
All remediation actions for known contaminated sediment sources are completed and monitored according to the approved plan and have met their remedial action goal.	In progress
The benthic community IBI within the site being evaluated is statistically similar to a reference site with similar habitat and minimal sediment contamination.	Assessment in progress
Burrowing mayfly ( <i>Hexagenia</i> ) populations return to the AOC in stable annual abundances between 100-400 nymphs/m <sup>2</sup> (measured as a 3-year running average) or as otherwise indicative of adequate levels of dissolved oxygen in overlying waters and uncontaminated surficial sediments in Lake Michigan.	In progress
Sediment toxicity (due to ammonia, PCB, or dissolved oxygen) is not present at levels that are acute or chronically toxic (as defined by relevant, field validated, bioassays with appropriate quality assurance/quality controls) to the benthic community.	Assessment needed
Native benthic communities adequately support the trophic levels that depend upon them.	Assessment needed

**Status**

In 2018, the Lower Fox River PCB cleanup project continued downriver, with the active portion of the Fox River PCB cleanup anticipated to be complete in 2019. Dredging began in 2018 at the South Focus Area of the former MGP site located at the East River confluence. Remedial action work at the north Focus Area of the former MGP site is targeted to begin by mid-summer 2020. See the “Restrictions on Dredging” section for more details.

USGS completed an assessment that addressed the second portion of the target in 2012 and 2014 through a project in which both the planktonic and benthic communities of the Lake Michigan AOCs and reference rivers were assessed in 2012 and 2014. However, given the difficulty in finding an appropriate non-AOC reference site for the Fox River and lower bay of Green Bay, it is likely that a target revision and re-assessment of this portion of the target will be necessary following completion of the Fox River sediment remediation projects in 2020.

In response to this, WDNR staff began compiling historic benthic community data in 2018 that was collected within the AOC to share with a small benthos working group that can help interpret changes in the benthic community pre and post contaminated sediment remediation, to recommend any necessary target revisions, and to provide advice for a proposed assessment project that will address the second through fifth portions of the target in which additional assessment work is needed.

The proposed assessment will extend a grant awarded in 2018 by UW Sea Grant to UW-Green Bay researchers to evaluate the benthic community throughout the Bay of Green Bay. WDNR and UWGB plan to submit a grant proposal to USEPA GLNPO in early 2019 that would expand the area of interest to

include the Duck Creek Delta and Fox River and would evaluate the benthic community and habitat suitability in the AOC beginning in the Bay of Green Bay in 2019 and Fox River in 2020-2021. The results of this proposed assessment will allow WDNR to determine the status and next steps for this BUI and provide supplemental information to assist with management action development for the “Loss of Fish and Wildlife Habitat” and “Degradation of Fish and Wildlife Populations” BUIs.

*A status check is currently scheduled for this BUI in 2022.*

### **Management actions**

- Complete the contaminated sediment projects (PCB and former MGP site)

### **Additional actions**

- Implement a benthic community and habitat suitability (including substrate characterization, dissolved oxygen, and sediment toxicity) assessment
- Continue to work with the Benthos Working Group to identify any necessary target revisions

DEGRADATION OF PHYTOPLANKTON AND ZOOPLANKTON POPULATIONS

Target	Status
<p>Plankton and zooplankton structure and function do not significantly diverge from unimpaired reference conditions with comparable physical and chemical characteristics, recognizing the uncontrollable impact of invasive species. The following specific objectives should also be met:</p> <ul style="list-style-type: none"> <li>- Sources contributing to nutrient enrichment are identified and controlled; and</li> <li>- AOC total phosphorus concentrations consistently meet water quality standards and/or water quality targets of a State and US EPA approved TMDL; and</li> </ul> <p>In lower Green Bay, the amount of energy from phytoplankton and zooplankton that reaches the open water food chain has increased, and the amount of energy reaching the bottom sediments has decreased. (In other words, the carbon transfer efficiency of the phytoplankton and zooplankton levels of the food chain in lower Green Bay is increased such that the amount of energy channeled into the detrital food chain is decreased and the amount of energy channeled into the pelagic food chain is increased). This is expected to occur when phosphorus levels and the corresponding percentage of blue-green algae in the phytoplankton are reduced.</p>	<p>Assessment in progress</p>
<p>Phytoplankton or zooplankton bioassays confirm no significant toxicity in ambient waters in the AOC.</p>	<p>Unknown</p>

**Status**

In 2018, the Lower Fox River PCB cleanup project continued downriver, with the active portion of the Fox River PCB cleanup anticipated to be complete in 2019. Dredging began in 2018 at the South Focus Area of the former MGP site located at the East River confluence. Remedial action work at the north Focus Area of the former MGP site is targeted to begin by mid-summer 2020. See the “Restrictions on Dredging” section for more details. Discussions with USEPA and stakeholders continue regarding the AOC program’s role in addressing eutrophication in the Lower Green Bay and Fox River. More detailed information on the status of these discussions can be found in the “Eutrophication or Undesirable Algae” section.

USGS was contracted to assess both the planktonic and benthic communities of the Lake Michigan AOCs and reference rivers in 2012 and 2014. The 2012 report is complete, and a draft of the 2014 report is currently under review. Additionally, assessment data on soft algae collected via that Harmful Algal Blooms (HABs) project in support of the Beach Closings BUI will help inform the status of this BUI. When data analyses are complete and fully evaluated, any necessary next steps for this BUI will be determined in 2020 and beyond.

If the planktonic community is found to be impaired, there is a need to investigate if nutrient enrichment and/or water column toxicity are causes of the plankton impairment. Any additional management actions identified for this BUI would likely mirror management actions for sediment remediation and nutrient management. A target adjustment may also be needed depending on the results of the USGS and HABs studies.

*A status check is scheduled in 2019 for this BUI.*

**Management actions**

- Complete the contaminated sediment projects (PCB and former MGP site)

**Additional actions**

- Review the results of the USGS and HABs studies and determine next steps

## LOSS OF FISH AND WILDLIFE HABITAT

Target	Status
Fish and wildlife management goals are achievable as a result of the physical, chemical, and biological integrity of the AOC waters, including wetlands.	Assessment Completed
<p>A balance of diverse habitat types exists within the AOC that supports all life stage requirements of fish and wildlife populations including:</p> <ol style="list-style-type: none"> <li>1. Multiple wetland types (for example: submerged aquatic vegetation, emergent vegetation, sedge meadows, forested &amp; shrub) that adequately represent historic wetland types</li> <li>2. Quality fish spawning habitats</li> <li>3. Islands for colonial nesting birds, amphibians, and furbearers</li> <li>4. Intact migration corridors (both shoreline and water)</li> <li>5. Unconsolidated beaches (for shorebirds)</li> </ol> <p>Habitat for State or Federally listed species (special concern, threatened, or endangered)</p>	Assessment Completed
The hydrologic connectivity between wetlands and the AOC is maintained and restored sufficiently to support fish spawning and allow for fish passage.	In progress
The Green Bay portion of the AOC contains water clarity and other conditions suitable for support of a diverse biological community, including a robust and sustainable area of submersed aquatic vegetation in shallow water areas.	Action Needed
The AOC contains a diversity of plants, an abundance of submersed aquatic vegetation, and sufficient invertebrates to provide adequate food supplies to support a diverse assemblage of migratory diving ducks (both mussel and vegetation feeding), fish, and other wildlife (including aquatic invertebrates, amphibians, and reptiles).	Assessment Completed
The AOC meets water quality standards and/or water quality targets of a State and US EPA approved TMDL. The approved TMDL targets are summer median concentrations of 0.10 mg/L TP and 20 mg/L TSS at the mouth of the river.	Action Needed
The AOC meets Wisconsin water quality criteria for dissolved oxygen and water temperature that are protective of fish and wildlife populations.	Action Needed
No waterbodies within the AOC are listed as impaired due to physical or water chemistry conditions in the most recent Wisconsin Impaired Waters List (303(d) List).	Action Needed

**Status**

In early 2018, UWGB and TNC submitted the Habitat Restoration Plan and Path Toward Delisting Project Final Report which identified 18 priority habitats and their respective baseline condition score from which a cumulative AOC habitat condition score of 3.53 was calculated using the Fish and Wildlife BUI

Assessment Tools developed by UWGB (Appendix D). Following the completion of the final report, WDNR and UWGB received support from USEPA GLNPO in early 2018 to continue collaborating to:

1. Develop a list of high priority, impactful, and cost-effective AOC habitat improvement projects (e.g. management action list)
2. Provide technical assistance to partners when designing and implementing projects in the AOC
3. Quantitatively track progress made toward the recommended target cumulative habitat condition score as restoration activities are implemented
4. Develop and refine the Fish and Wildlife Habitat and Populations BUI Assessment Tools
5. Produce a user manual that will ensure consistent scoring of habitat restoration activities and condition scores using the Fish and Wildlife Habitat and Populations BUI Assessment Tools long-term.

To assist with developing the process for obtaining the management action list, WDNR convened the Fish and Wildlife Habitat and Populations Steering Committee in early 2018 which includes representation from WDNR, USEPA GLNPO, USFWS, UW Sea Grant, and UWGB. The committee determined that the assemblage of a panel of technical experts was necessary to assist with the development of the management action list, leading WDNR to re-convene a Fish and Wildlife Habitat and Populations Technical Advisory Committee (TAC) in April 2018. The steering committee also identified nine "Restoration Priority Areas" and the impacted priority habitats and populations included therein for the TAC to focus the development of goals, objectives, and activities that will inform management action development through a consensus-based process (please see Appendix D which includes the list of Restoration Priority Areas).

Additionally, in 2018 the TAC unanimously agreed to adopt the cumulative priority habitat target of 6.0 (+/- a 20% measurement error) recommended by UW-Green Bay and will work in 2019 to define the time necessary for observing the recommended cumulative condition score. WDNR will present the UWGB and TAC recommendation to revise the target in early 2019 to the broader stakeholder group for input before formally adopting the target revision.

Finally, by April 2019 WDNR will present a preliminary list of activities to USEPA GLNPO for each of the nine Restoration Priority Areas, followed by a period in which this preliminary list of activities will be packaged, prioritized, and vetted for feasibility using a "Management Action Evaluation Form" which is currently in development. By April 2020, WDNR will have prepared a list of management actions to present to USEPA GLNPO which, when implemented, is anticipated to lead to the removal of the BUI. Prior to submission of the preliminary list of activities and completed management action list to USEPA GLNPO, stakeholders will have the opportunity to provide input.

### **Management actions**

*Management actions are currently being developed for this BUI and are anticipated to be complete in 2020.*

### **Additional actions**

- ✓ Complete the fish and wildlife habitat and populations assessment
- ➡ Update the "Loss of Fish and Wildlife Habitat" BUI removal target

## DEGRADATION OF FISH AND WILDLIFE POPULATIONS

Target	Status
The AOC contains healthy, self-sustaining, naturally reproducing, and diverse populations of native fish species (including walleye, northern pike, yellow perch, lake sturgeon, Great Lakes spotted muskellunge, and centrarchids) in abundances sufficient to provide ecological function in the fish community	Assessment Completed
Populations of traditionally harvested fish species are capable of supporting some level of exploitation	Partially complete (walleye); more assessment needed
The AOC contains healthy, self-sustaining, naturally reproducing, and diverse populations of native furbearers (including mink, muskrats, and otter), amphibians (including spring peepers, leopard frogs, American toads, eastern gray tree frogs, green frogs, bullfrogs, and salamanders), reptiles (including snapping and painted turtles), terns (common and Forster's), migratory diving ducks, dabbling ducks, marsh nesting birds and island-dependent colonial nesting birds in abundances sufficient to provide ecological function	Assessment Completed
Populations of traditionally harvested wildlife species are capable of supporting some level of exploitation Invasive species (lamprey, carp, gobies, white perch, and others) expansion is minimized and controlled as needed to protect native species within the AOC and upstream	Assessment in progress  In progress
Contaminant levels in forage fish populations do not impair the reproductive success of fish-eating birds and wildlife (including predatory fish) and meet the criteria established in Annex 1 of the 1978 Great Lakes Water Quality Agreement as amended by Protocol in 1987, specifically "the concentration of total polychlorinated biphenyls in fish tissues (whole fish, calculated on a wet weight basis), should not exceed 0.1 micrograms per gram for the protection of birds and animals which consume fish"	Assessment in progress
The AOC supports fish and wildlife populations at levels consistent with extant fish and wildlife management plan objectives. Specifically, the following objectives should be met unless extant management plans have updated criteria (specific objectives identified in past RAP documents are listed in Appendix B)	Partially complete; more assessment needed

**Status**

In early 2018, UWGB and TNC submitted the Habitat Restoration Plan and Path Toward Delisting Project Final Report which identified 22 priority fish and wildlife populations and their respective baseline condition score from which a cumulative AOC fish and wildlife populations condition score of 4.65 was calculated using the Fish and Wildlife BUI Assessment Tools developed by UWGB (Appendix D). Following the completion of the final report, WDNR and UWGB received support from USEPA GLNPO in early 2018 to continue collaborating to:

1. Develop a list of high priority, impactful, and cost-effective AOC habitat improvement projects (e.g. management action list)

2. Provide technical assistance to partners when designing and implementing projects in the AOC
3. Quantitatively track progress made toward the recommended target cumulative populations condition score as restoration activities are implemented
4. Develop and refine the Fish and Wildlife Habitat and Populations BUI Assessment Tools
5. Produce a user manual that will ensure consistent scoring of restoration activities and condition scores using the Fish and Wildlife Habitat and Populations BUI Assessment Tools long-term.

To assist with developing the process for obtaining the management action list, WDNR convened the Fish and Wildlife Habitat and Populations Steering Committee in early 2018 which includes representation from WDNR OGW, USEPA GLNPO, USFWS, UW Seagrant, and UWGB. The committee determined that the assemblage of a panel of technical experts was necessary to assist with the development of the management action list, leading WDNR to re-convene a Fish and Wildlife Habitat and Populations Technical Advisory Committee (TAC) in April 2018. The steering committee also identified nine "Restoration Priority Areas" and the impacted priority habitats and populations included therein for the TAC to focus the development of goals, objectives, and activities that will inform management action development through a consensus-based process (please see Appendix D which includes the list of Restoration Priority Areas).

Additionally, in 2018 the TAC unanimously agreed to adopt the cumulative priority populations target of 6.5 (+/- a 20% measurement error) recommended by UW-Green Bay and will work in 2019 to define the time necessary for observing the recommended cumulative condition score. WDNR will present the UWGB and TAC recommendation to revise the target in early 2019 to the broader stakeholder group for input before formally adopting the target revision.

Finally, by April 2019 WDNR will present a preliminary list of activities to USEPA GLNPO for each of the nine Restoration Priority Areas, followed by a period in which this preliminary list of activities will be packaged, prioritized, and vetted for feasibility using a "Management Action Evaluation Form" which is currently in development. By April 2020, WDNR will have prepared a list of management actions to present to USEPA GLNPO which, when implemented, is anticipated to lead to the removal of the BUI. Prior to submission of the preliminary list of activities and completed management action list to USEPA GLNPO, stakeholders will have the opportunity to provide input.

### **Management actions**

*Management actions are currently being developed for this BUI and are anticipated to be complete in 2020.*

### **Additional actions**

- ✓ Complete the fish and wildlife habitat and populations assessment
- ➡ Update the "Degradation of Fish and Wildlife Populations" BUI removal target

## RESTRICTIONS ON DRINKING WATER CONSUMPTION, OR TASTE AND ODOR PROBLEMS

Target	Status
Densities of disease-causing organisms or concentrations of hazardous or toxic chemicals or radioactive substances do not exceed human health standards, objectives, or guidelines.	Assessment in progress
Taste and odor problems are not present.	Assessment needed
Treatment and costs needed to make raw water suitable for drinking is the standard treatment used in comparable portions of the Great Lakes which are not degraded, specifically disinfection, coagulation, sedimentation, and filtration.	Assessment needed

**Status**

The remediation to remove PCB-contaminated sediments from the Fox River continued through 2018 with the remedial action work anticipated to be complete in 2019. Once complete, water quality monitoring will be done in the lower part of the bay according to the long-term monitoring plan. Results from this monitoring can be used to assess whether PCBs exceed human health standards as indicated in the first portion of the target.

A status check is scheduled in 2019 for this BUI. The assessment of cyanobacteria and cyanotoxins caused by blue-green algae blooms completed its third year of monitoring in the lower bay. While the HABs study will be complete in 2021, enough results from this study will be available by 2019 that they can be used to evaluate raw water with source protection recommendations for drinking water.

WDNR also plans to investigate the treatment and added costs associated with obtaining drinking water from Lake Winnebago (a current source water) to better understand if surface water in the Bay of Green Bay would meet standard treatment methods if the ability to obtain drinking water in the bay was not limited by infrastructure constraints.

*If the drinking water BUI is found to be impaired following the 2019 status check, any management actions identified for this BUI would likely mirror management actions for sediment remediation and nutrient management.*

**Management actions**

- Complete the contaminated sediment projects (PCB and former MGP site)

**Additional Actions**

- Review the results of the HABs study and methods for obtaining drinking water from Lake Winnebago and determine next steps

## BEACH CLOSINGS

Target	Status
Public swimming beaches within the AOC, including Bay Beach, Communiversity Park, and Long Tail, are open for 95% of the swimming season (between Memorial Day and Labor Day) for any 5-year period based on Wisconsin Coastal Beach monitoring protocols for <i>E. coli</i> monitoring	Complete
Public swimming beaches within the AOC, including Bay Beach, Communiversity Park, and Long Tail meet the blue-green algae target for 95% of the swimming season (geometric means of phytoplankton samples contain less than 100,000 cyanobacterial cells/ml or less than 20 µg/L of microcystin-LR based on at least 5 monthly samples over at least 2 years)	Assessment in progress
No waterbodies within the AOC are included on the list of impaired waters due to pathogen contamination or blue-green algae in the most recent Wisconsin Impaired Waters list	Complete (assessment of blue-green algae data needed)

**Status**

Monitoring that commenced in 2016 continued through 2018 with both continuous monitoring at two buoys and sample collection at NEW Water's sites from the mouth of the Fox River to Long Tail Point and nearshore samples at Bay Beach and Joliet Park. NEW Water and University of Wisconsin - Milwaukee continued as primary project partners with sample collection assistance from students at University of Wisconsin – Green Bay. In addition to algal cell counts, toxins, chlorophyll *a* and phycocyanin (the pigment associated with cyanobacteria), monitoring includes selected nutrients and water quality parameters as well as meteorology. Data from 2017 suggested that toxin concentrations in algal blooms at the water surface could be orders of magnitude higher than subsurface samples. The project team adjusted the sampling plan at the NEW Water sites to include samples nearer the surface (approximately 0.3 meters) in addition to their standard depth of 1 meter to evaluate how sample depth may affect the assessment of microcystin concentrations and recreational exposure. As with the previous two seasons, the more intense blooms are observed from August through October-November. Analyses of samples collected in the 2018 monitoring season are expected to be complete in the first quarter of 2019. Two additional years of monitoring (both sample collection and buoy deployment) are currently being planned to provide comparable measurements with the USEPA proposed criteria, to assure that a representative data set is available for toxins and continuous measurements and to better understand algal dynamics in the long term. NOAA used project data in their effort to expand their CyanoHab satellite imagery to the Lower Fox River and Green Bay. Available images show bloom formation in the lower Bay and Lake Winnebago and suggest potential transport via the Lower Fox River. This visualization informs the monitoring plan.

Observations and experience on the Bay as well as the reintroduction of the Cat Island Chain led the project team to question whether existing currents and wave forecast data available through the NOAA would be adequate for developing predictive models for algal toxins. In July 2018, University of Wisconsin – Madison deployed instruments in the lower Bay to measure waves and currents. This data is being used to calibrate nearshore models with higher resolution than are currently available. Additional equipment deployments are planned for 2019 both for model validation and to refine the models in Duck Creek Delta and south of Long Tail Point where complex circulation patterns are apparent. AOC partners working on habitat restoration projects have indicated their interest this hydrodynamic modeling to inform

design plans. WDNR is working with the US Army Corps of Engineers to deploy additional equipment and develop models that meet the needs for designing habitat projects. Data collected through this effort will be made available for use by other interested groups working in Lower Green Bay.

USEPA released draft ambient water quality and recreational criteria for algal toxins microcystin and cylindrospermopsin in December 2016 that included a recommended analysis method for algal toxins. Related documents are available on USEPA's website: <https://www.epa.gov/wqc/microbial-pathogenrecreational-water-quality-criteria>. These draft criteria use the toxins microcystin and cylindrospermopsin as the primary measurements and recreational thresholds proposed focus on recreational risk to children. The proposed criteria do not establish thresholds for cyanobacterial cell counts. Although final criteria have yet to be issued, unofficial communications indicate that proposed criteria is likely to be revised. The 2017 RAP update identified the need to update removal criteria for this BUI. Proposed target revisions are anticipated in 2020.

### **Management actions**

*Management actions will be considered for this BUI upon completion of the study in 2021.*

### **Additional Actions**

- ➔ Update the "Beach Closings" BUI removal target based on the 2016-2018 harmful algal bloom assessment results.



1. Practice can be completed in the short term
2. Practice requires little maintenance
3. Practice existence and performance easy to monitor
4. Practice can feasibly be placed on the landscape
5. Practice has ability to persist on the landscape in the long-term (i.e. hard vs. soft practice)

Using these attributes, and with input from technical stakeholders, WDNR and USEPA GLNPO arrived at a set of five “AOC-like” practices for nutrient management that could be installed on the landscape including:

1. Streambank protection/stabilization
2. Constructed/treatment wetlands (biofilters)
3. Wetland creation/enhancement/restoration
4. Two-stage ditches
5. Saturated buffers

In 2017 and 2018, WDNR continued to build upon this momentum by convening a steering committee and facilitator to develop a process for identifying: 1) the opportunities to implement the five “AOC-like” practices within the Lower Fox Basin landscape, 2) estimate how much phosphorus reduction would be experienced if these practices were implemented on the landscape, and 3) explore how funding from GLRI Focus Areas 1 (AOC) and 3 (Nearshore/Nonpoint) could work in concert to implement these practices so that they complement each other and ensure optimal performance (i.e., create a nutrient “treatment train”).

Going forward into 2019, WDNR will: 1) continue to develop rough estimates for the set of five “AOC-like” practices and present the methods and results for obtaining estimates to stakeholders in early 2019, 2) use the rough estimates as the starting point for discussions of specific project opportunities for the AOC-like practices; and 3) explore opportunities for leveraging the AOC GLRI funds and the Nearshore/Nonpoint GLRI funds to ensure the optimal performance and lifespan for the selected AOC-like practices that are identified.

Additionally, several assessment projects are underway to inform the status of the BUI, support stakeholder discussions, and engage the community in learning about AOC water quality. USGS is leading sediment fingerprinting studies in the Plum and Apple watersheds. The results will characterize sources of sediment (upland vs. streambank), thereby ensuring effective siting of conservation practices. The Plum study results are anticipated to be available in 2019. Sampling for the Apple study occurred in 2018. Outagamie County’s Land Conservation Department has continued developing 9 key element plans for Bower Creek and the Lower East River HUC 12s, adding to the plans already available for the Lower Fox Basin. The plans are important for ensuring coordinated implementation of conservation practices and provide important data for the AOC-like practice estimates. A tributary monitoring program completed its 4<sup>th</sup> year in 2018 which engaged volunteers in collecting water quality data to help characterize phosphorus levels in tributaries. Volunteers gained a valuable connection to the AOC and learned about water quality issues.

### **Management actions**

*Management actions are currently being developed for this BUI and are anticipated to be complete by calendar year 2019.*

## DEGRADATION OF AESTHETICS

Target	Status
Total phosphorus and total suspended solid concentrations at the mouth of the Lower Fox River meet water quality standards and/or water quality targets specified in a State and US EPA approved Total Maximum Daily Load (TMDL). The approved TMDL targets are summer median concentrations of 0.10 mg/L TP and 20 mg/L TSS at the mouth of the river.	Action needed
Monitoring data within the AOC and/or surveys for any five-year period indicates that water bodies in the AOC do not exhibit unacceptable levels of the following properties in quantities which interfere with the Water Quality Standards for Surface Waters: (a) Substances that will cause objectionable deposits on the shore or in the bed of a body of water shall not be present in such amounts as to interfere with public rights in waters of the state or impair use. (b) Floating or submerged debris, oil, scum, or other material shall not be present in such amounts as to interfere with public rights in waters of the state or impair use. (c) Materials producing color, odor, taste, or unsightliness shall not be present in such amounts as to interfere with public rights in waters of the state or impair use.	Assessment complete (initiated 2011)

**Status**

The final year of aesthetics monitoring was completed in 2018 in collaboration with the Fox-Wolf Watershed Alliance (FWWA), a local nonprofit organization that implemented this volunteer program for three consecutive years. The intent of the program was to 1) better understand the public's perception of AOC waters by providing an empirical method of determining whether there are specific aesthetic-related issues that limit use or discourage access in AOC waterways relative to the BUI removal targets, 2) use the results to define what, if any, projects are needed to improve aesthetics within the AOC, and 3) expand public participation and outreach in the AOC through monitoring.

This project's quality assurance plan outlined the need for each station to obtain 30 independent monitoring observations before final scores were tallied, of which each of the 12 monitoring stations achieved (Table 1).

Table 2. Total number of aesthetic monitoring surveys completed from 2011-2018 at all survey locations.

Station Name	2011-2013	2015	2016	2017	2018	Total
Bay Beach	9	5	14	8	12	48
Communiiversity Park	7	5	12	7	12	43
Fox Point Boat Launch	20	10	11	1	24	66
Leicht Park	11	8	8	4	24	55
Metro Boat Launch	14	6	13	8	13	54
Perkofski Boat Launch	11	9	6	6	12	44
Porlier Pier	9	9	11	5	12	46
Regatta 220	-	8	10	5	12	35
Riverview Place Park	9	7	12	5	12	45
Voyageur Park	20	10	16	19	13	78
Weitor Wharf	-	4	8	4	25	41
West Lazarre Avenue	16	8	10	5	12	51
Total	126	89	131	77	183	606

The aesthetic impression score was determined by the surveyor as the overall impression of the site:

- Very pleasing (0),
- Somewhat pleasing (1),
- Neutral (2),
- Somewhat displeasing (3),
- Very displeasing (4).

Aesthetic assessment scores were determined through identification by the surveyor of a select list of displeasing parameters present at a given survey location (i.e. water clarity, submerged or shoreline garbage, animal-related issues, nuisance vegetation, etc.). Action criteria were developed based on the results of these scores which established numeric thresholds in which some action would be recommended to improve aesthetic value at survey locations that exceeded the action criteria values.

*Table 3. Table includes action criteria values for the 2011-2013 and 2015-2018 survey periods. Any survey locations determined to be exceeding the action criteria values were considered to be in need of some action taken to improve aesthetic value.*

Survey Period	Average Impression Score	Average Assessment Score	Average % Surveys
2011-2013	3.0	5.0	75
2015-2018	3.0	4.0	75

After a preliminary review of the 2011-2018 data, only one survey location (Riverview Place Park) exceeded the aesthetic impression threshold of 3.0 in the 2011-2013 survey years, though none of the 12 monitoring stations exceeded the 3.0 threshold in the 2015-2018 survey years. Similarly, only one survey location (Riverview Place Park) exceeded the aesthetic assessment threshold in the 2011-2013 survey years, though none of the 12 monitoring stations exceeded the threshold in the 2015-2018 survey years.

Surveyors indicated that at least one displeasing parameter was present in greater than or equal to 75% of surveys completed at Bay Beach, Leicht Park, and Riverview Place Park in the 2011-2013 survey period, and Porlier Pier, Regatta 220, and Riverview Place Park in the 2015-2018 survey period (Table 3). This portion of the survey was intended to identify possible community engagement or other such activities that could be implemented locally.

*Table 4. Table includes action criteria exceedances observed in the 2011-2013 and 2015-2018 survey periods.*

Survey Period	Exceeded Impression Score Threshold	Exceeded Assessment Score Threshold	Exceeded % Surveys Threshold		
2011-2013	Riverview Place Park	Riverview Place Park	Bay Beach	Leicht Park	Riverview Place Park
2015-2018	-	-	Porlier Pier	Regatta 220	Riverview Place Park

In 2019, WDNR will continue to evaluate these results and present them to USEPA GLNPO and stakeholders to inform the discussion on ways in which the AOC program can address degraded aesthetics in the AOC.

## Management actions

*WDNR will work with stakeholders and USEPA GLNPO to identify what, if any, management actions should be implemented for this BUI after a complete analysis of the survey data in 2019.*

**Additional actions**

- Complete five years of aesthetics monitoring and review results to determine next steps

TAINTING OF FISH FLAVOR

Target	Status
No target was developed in 2009, as this is a suspected impairment.	BUI Removal Recommendation in Progress

**Status**

Having reviewed with stakeholders the historic and recent information that can help inform the status of this BUI, WDNR has concluded that there is sufficient evidence available to remove this suspected BUI. In response, WDNR has drafted a BUI removal recommendation that will be available for stakeholder review in early 2019, followed by submitted to USEPA for concurrence.

**Management actions**

Given that this is a suspected BUI in the AOC as there is no data or information to support its designation as a BUI, no management actions have been established to date.

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**APPENDICES**

Appendix A – Acronyms

Appendix B – Definitions

Appendix C – BUI Track Matrix

Appendix D – Lower Green Bay-Fox River Habitat and Populations BUI Assessment Tools and AOC  
Restoration Priority Areas

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## Appendix A

### List of Acronyms

AOC	Area of Concern
BUI	Beneficial Use Impairment
GLNPO	Great Lakes National Program Office
GLRI	Great Lakes Restoration Initiative
µg/L	Micrograms per liter
mg/L	Milligrams per liter
MGP	Manufactured Gas Plant
MS4	Municipal Separate Storm Sewer System
NRCS	Natural Resources Conservation Service
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
ppm	Part per million
RAP	Remedial Action Plan
TMDL	Total Maximum Daily Load
TP	Total phosphorus
TSS	Total suspended solids
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
UWGB	University of Wisconsin – Green Bay
UW-Oshkosh	University of Wisconsin - Oshkosh
WDNR	Wisconsin Department of Natural Resources
WPS	Wisconsin Public Service

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## Appendix B

### Definitions

#### **Area of Concern (AOC)**

Defined by Annex 2 of the 1987 Protocol to the U.S.-Canada Great Lakes Water Quality Agreement as “geographic areas that fail to meet the general or specific objectives of the Agreement where such failure has caused or is likely to cause impairment of beneficial use of the area’s ability to support aquatic life.” These areas are the “most contaminated” areas of the Great Lakes, and the goal of the AOC program is to bring these areas to a point at which they are not environmentally degraded more than other comparable areas of the Great Lakes. When that point has been reached, the AOC can be removed from the list of AOCs, or “delisted.”

#### **Beneficial Use Impairment (BUI)**

A "beneficial use" is any way that a water body can improve the quality of life for humans or for fish and wildlife (for example, providing fish that are safe to eat). If the beneficial use is unavailable due to environmental problems (for example if it is unsafe to eat the fish because of contamination) then that use is impaired. The International Joint Commission provided a list of 14 possible beneficial use impairments in the 1987 Great Lakes Water Quality Agreement amendment.

#### **Delisting Target**

Specific goals and objectives established for beneficial use impairments, with measurable indicators to track progress and determine when BUI removal can occur.

#### ***Escherichia coli (E. coli)***

A bacterium commonly found in natural bodies of water that serves as an indicator of the possible presence of other health risks in the water, such as bacteria, viruses, and other organisms.

#### **Fish Consumption Advisory**

Some fish from certain waterbodies contain harmful chemicals. These chemicals build up in the fish over time, and can build up in people when they eat the fish. The WDNR routinely tests fish and issues recommendations typically to “eat no more than” or “eat up to,” on how much fish a person could eat based on protecting human health from contaminants that may be found in fish. Current Wisconsin fish consumption advisories are available online at <http://dnr.wi.gov/topic/fishing/consumption/>.

#### **Microcystins**

A class of toxins produced by freshwater cyanobacteria (also known as “blue-green algae”). These chemicals include microcystin-LR, which is the most common type. Microcystins can be produced in large quantities during algal blooms, and can cause adverse reactions in humans and animals that come in contact with the toxin.

#### **Remedial Action Plan (RAP)**

According to the 1987 Protocol to the U.S.-Canada Great Lakes Water Quality Agreement, a RAP is a document that provides “a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses in Areas of Concern...” RAPs were required by the 1987 Protocol to be submitted to the International Joint Commission at three stages:

- Stage 1: Problem definition
- Stage 2: When remedial and regulatory measures are selected
- Stage 3: When monitoring indicates that identified beneficial uses have been restored

Note that a renegotiated Great Lakes Water Quality Agreement was signed in 2012 by the U.S. and Canada which removed the “stage” terminology from the AOC Annex, and simply requires Remedial Action Plans to be “developed, periodically updated, and implemented for each AOC.”

**Total Maximum Daily Load (TMDL)**

A TMDL is the amount of a pollutant a waterbody can receive and still meet water quality standards. It can be thought of as a pollution “budget” for a water body or watershed that establishes the pollutant reduction needed from each pollutant source to meet water quality goals.

**Waterfowl Consumption Advisory**

Some waterfowl from certain waterbodies contain harmful chemicals. These chemicals build up in the birds over time, and can build up in people who eat them. The WDNR tests waterfowl and issues recommendations on how much a person could eat based on protecting human health from contaminants that may be found in waterfowl. Current Wisconsin waterfowl consumption advisories are available in the Migratory Bird Hunting Regulation booklet and online at <https://dnr.wi.gov/topic/hunt/waterfowl.html>.

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## **Appendix C**

### **BUI Tracking Matrix**

#### Appendix C

Note that projects listed in the table below are the next clearly delineated action steps that have been identified by WDNR in collaboration with AOC partners and stakeholders to make progress toward delisting the AOC. This list does not necessarily reflect all actions that will ultimately be needed to remove impairments, and will be updated as more information is collected and as actions are completed.

**Lower Green Bay and Fox River BUI Tracking Matrix**

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## **Appendix D**

### **Lower Green Bay & Fox River AOC Fish and Wildlife Habitat and Populations Assessment Tools and AOC Restoration Priority Areas**





**AOC Restoration Priorities**

<b>Restoration Priority Area</b>	<b>Definition</b>	<b>Geographic Focus Area(s)</b>	<b>Impacted Habitat(s)</b>	<b>Impacted Population(s)</b>
AOC Islands	Longtail Point, Cat Island Restoration Chain, Lone Tree Island, Renard Island, Pt. au Sable	<ul style="list-style-type: none"> <li>• Cat Island Restoration Chain</li> <li>• Lone Tree Island</li> <li>• Renard Island</li> <li>• Long Tail Point</li> </ul>	<ul style="list-style-type: none"> <li>• Great Lakes Beach</li> <li>• Shrub Carr</li> </ul>	<ul style="list-style-type: none"> <li>• Bald Eagle (winter)</li> <li>• Coastal Terrestrial Macroinvertebrates</li> <li>• Colonial Waterbirds (breeding)</li> <li>• Piping Plover</li> <li>• Shorebirds (migratory)</li> <li>• Shoreline fish</li> <li>• Turtles</li> </ul>
Great Lakes Beach	Stretches of shoreline along the bay of Green Bay's water/land interface that consist of sand and/or cobble and may be sparsely vegetated.	<ul style="list-style-type: none"> <li>• Undeveloped east shore beaches <ul style="list-style-type: none"> <li>○ Point au Sable</li> <li>○ UWGB Bay Shore Woods</li> <li>○ Joliet Park</li> <li>○ Bay Beach area</li> </ul> </li> <li>• Longtail Point</li> </ul>	<ul style="list-style-type: none"> <li>• Great Lakes Beach</li> </ul>	<ul style="list-style-type: none"> <li>• Coastal wetland mustelids</li> <li>• Coastal terrestrial macroinvertebrates</li> <li>• Shorebirds (migratory)</li> <li>• Turtles</li> <li>• Piping Plover</li> <li>• Shoreline fish</li> <li>• Landbirds (migratory)</li> <li>• Coastal birds (breeding)</li> <li>• Bats</li> </ul>
Green Bay Open Water and Nearshore Fish Habitat	Coarse woody debris, rock reefs, gravel, cobble, and other underwater features that promote spawning, foraging, and nursery habitat of fish.	<ul style="list-style-type: none"> <li>• Nearshore/littoral and pelagic zones of bay of Green Bay</li> <li>• Renard Island</li> </ul>	<ul style="list-style-type: none"> <li>• Green Bay Open Water</li> </ul>	<ul style="list-style-type: none"> <li>• Shoreline fish</li> <li>• Colonial waterbirds (breeding)</li> </ul>
Fox River	The floodplain, shoreline, backwaters, underwater habitats (e.g., fish rock reefs, woody debris), and open channel of the Fox River.	<ul style="list-style-type: none"> <li>• Leo Frigo bridge inlet on east side of Fox River mouth</li> <li>• De Pere Dam</li> <li>• Ashwaubomay Park</li> <li>• National Railroad Museum</li> <li>• St. Francis Park</li> </ul>	<ul style="list-style-type: none"> <li>• Fox River Open Water</li> <li>• Emergent Marsh (riparian)</li> </ul>	<ul style="list-style-type: none"> <li>• Fox River fish</li> <li>• Stream macroinvertebrates</li> <li>• Waterfowl (migratory)</li> <li>• Turtles</li> <li>• Bald Eagle (winter)</li> </ul>
AOC Tributaries and Deltas	The floodplain, shoreline, backwaters, underwater habitats (e.g., fish rock	<ul style="list-style-type: none"> <li>• Mahon Creek</li> <li>• Wequiock Creek</li> <li>• Duck Creek</li> </ul>	<ul style="list-style-type: none"> <li>• Tributary Open Water</li> <li>• Emergent Marsh (riparian)</li> </ul>	<ul style="list-style-type: none"> <li>• Tributary fish</li> <li>• Stream macroinvertebrates</li> </ul>

	<p>reefs, woody debris), and open channel of tributaries entering the AOC and river mouth areas of all AOC tributaries and Fox River where they empty into the lower Bay of Green Bay.</p>	<ul style="list-style-type: none"> <li>• East River</li> <li>• Other west and east shore tributaries</li> </ul>	<ul style="list-style-type: none"> <li>• Submergent Marsh</li> </ul>	<ul style="list-style-type: none"> <li>• Coastal wetland aquatic macroinvertebrates</li> </ul>
<p>Coastal Forests and Inland Waters</p>	<p>Forested wetlands dominated by broadleaf, deciduous trees that occur along the bay of Green Bay, Fox River, and tributaries, especially in lowland areas that are poorly drained. Canopy dominants include green ash (<i>Fraxinus pennsylvanica</i>), red maple (<i>Acer rubrum</i>), eastern cottonwood (<i>Populus deltoides</i>), and swamp white oak (<i>Quercus bicolor</i>).</p> <p>Inland waters are characterized by areas providing aquatic habitat not directly connected to Green Bay or the Fox River and are often surrounded by emergent marsh (inland), shrub carr, and hardwood swamp habitats. These habitats may also be surrounded by developed areas.</p>	<ul style="list-style-type: none"> <li>• Barkhausen Waterfowl Preserve</li> <li>• Malchow-Olson Tract</li> <li>• Bay Beach Wildlife Sanctuary</li> <li>• UW-Green Bay's Bay Shore Woods</li> <li>• Point au Sable</li> <li>• East and west shore suburban ponds</li> <li>• Pulliam Plant pond/marsh</li> <li>• Malchow/Olson inland pond</li> <li>• Abbey Pond</li> </ul>	<ul style="list-style-type: none"> <li>• Hardwood Swamp</li> <li>• Shrub Carr</li> <li>• Northern Mesic Forest</li> <li>• Southern Dry Mesic Forest</li> <li>• Other Forest</li> <li>• Open Water (inland)</li> <li>• Emergent Marsh (roadside)</li> <li>• Emergent Marsh (inland)</li> </ul>	<ul style="list-style-type: none"> <li>• Anurans</li> <li>• Coastal terrestrial macroinvertebrates</li> <li>• Wooded wetland birds (breeding)</li> <li>• Waterfowl (migratory)</li> <li>• Landbirds (migratory)</li> <li>• Bats</li> <li>• Bald Eagle (winter)</li> <li>• Turtles</li> <li>• Coastal birds (breeding)</li> </ul>

<p>Emergent Marsh and Submergent Aquatic Vegetation</p>	<p>Marshes occurring along Green Bay's coastal zone that are dominated by open herbaceous, emergent vegetation (e.g., cattail [<i>Typha</i> spp.], bulrush [<i>Schoenoplectus</i> spp.] and submersed aquatic vegetation (e.g., pondweeds [<i>Potamogeton</i> spp.] and wild celery [<i>Vallisneria americana</i>]) that are regularly affected by fluctuating lake levels. Emergent and submergent marshes grade into each other.</p>	<ul style="list-style-type: none"> <li>• Dead Horse Bay</li> <li>• Longtail Point</li> <li>• Peters Marsh</li> <li>• Duck Creek delta</li> <li>• Point au Sable</li> <li>• Malchow-Olson Tract</li> </ul>	<ul style="list-style-type: none"> <li>• Emergent Marsh (high energy coastal)</li> <li>• Submergent Marsh</li> </ul>	<ul style="list-style-type: none"> <li>• Anurans</li> <li>• Coastal birds (breeding)</li> <li>• Coastal wetland aquatic macroinvertebrates</li> <li>• Coastal wetland mustelids</li> <li>• Marsh breeding birds</li> <li>• Muskrat</li> <li>• Shoreline fish</li> <li>• Waterfowl (migratory)</li> <li>• Wetland terns</li> </ul>
<p>Grasslands and Wet Meadows</p>	<p>Open wetland plant and upland grassland communities dominated by sedges (e.g., <i>Carex</i> sp.) and grasses (e.g., <i>Calamagrostis</i> sp.) and typically occurs in between coastal emergent marsh and shrub carr at or near the coastal zone.</p>	<ul style="list-style-type: none"> <li>• Malchow-Olson Tract</li> <li>• Point au Sable</li> <li>• Fort Howard Wildlife Area</li> <li>• Duck Creek</li> <li>• Upstream areas along East River</li> <li>• Northern Duck Creek Delta area</li> </ul>	<ul style="list-style-type: none"> <li>• Southern Sedge Meadow</li> <li>• Shrub Carr</li> <li>• Emergent Marsh (high energy coastal)</li> <li>• Emergent Marsh (inland)</li> <li>• Surrogate Grassland Restored</li> <li>• Surrogate Grassland (old field)</li> </ul>	<ul style="list-style-type: none"> <li>• Coastal terrestrial macroinvertebrates</li> <li>• Coastal wetland aquatic macroinvertebrates</li> <li>• Anurans</li> <li>• Marsh breeding birds</li> </ul>
<p>Freshwater Mussels</p>	<p>Freshwater mussels, including Unionid mussels (i.e. giant floater [<i>Pyganodon grandis</i>]) and fingernail clams (<i>Sphaeriidae</i> spp.).</p>	<ul style="list-style-type: none"> <li>• TBD</li> </ul>	<p>N/A</p>	<ul style="list-style-type: none"> <li>• Freshwater mussels</li> </ul>

