REMEDIAL ACTION PLAN UPDATE

for the

MILWAUKEE ESTUARY AREA OF CONCERN

December 2012

Wisconsin Department of Natural Resources
Office of the Great Lakes

2012 Remedial Action Plan Update
for the
Milwaukee Estuary Area of Concern

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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 in nature. Any actions identified in this document as needed to remove the impaired beneficial uses are not subject to enforcement or regulatory actions.

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List of Acronyms

AOC	Area of Concern
BCOC	Bioaccumulative chemicals of concern
BUI	Beneficial Use Impairment
CDF	Confined disposal facility
CSO	Combined sewer overflow
GLRI	Great Lakes Restoration Initiative
GLWI	Great Lakes Water Institute
KK	Kinnickinnic
km	Kilometers
LaMP	Lakewide Management Plan
LOEL	Lowest observable effect level
mg/L	Milligrams per liter
MMSD	Milwaukee Metropolitan Sewerage District
NOAA	National Oceanic and Atmospheric Administration
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
RAP	Remedial Action Plan
SIG	Stakeholder Input Group

TMDL	Total Maximum Daily Load
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UW-Extension	University of Wisconsin-Extension
UWM	University of Wisconsin-Milwaukee
WDNR	Wisconsin Department of Natural Resources

EXECUTIVE SUMMARY

The Milwaukee Estuary Area of Concern (AOC) is very large and many partners are working to reduce pollution to AOC waterways. Thus, the focus in 2012 was to learn about on-going efforts and to re-introduce stakeholders to the AOC program while exploring ways that their efforts align with AOC program goals. Priority activities for the AOC emerged from many individual conversations and several stakeholder meetings. In 2012, the Wisconsin Department of Natural Resources (WDNR) with its partners made substantial progress on many of the impaired beneficial uses for the Milwaukee Estuary AOC.

Changes from the 2011 Draft Stage 2 Remedial Action Plan to this document are summarized below, in order to assist the reader in better understanding the changes between the two documents:

Summary of Changes for Restrictions on Fish and Wildlife Consumption

- WDNR successfully obtained Great Lakes Restoration Initiative (GLRI) funding to collect current data to update the waterfowl consumption advisory that has existed for the AOC since 1987, but not been reassessed since that time. Sampling should commence in fall of 2012.
- The cleanup of polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) from Lincoln Park Phase 1 area concluded in 2012. Phase 2 area is being planned and designed in 2013.
- A feasibility study is underway for cleanup of the Cedar Creek Superfund site.

Summary of Changes for Degradation of Fish and Wildlife Populations

- WDNR worked with its newly-minted Milwaukee Estuary fish and wildlife technical team to develop assessment proposals to assess fish and wildlife populations in the AOC.
- Separate proposals for assessment of fish and wildlife can be found in Appendix A.
- As outlined in the assessment for fish, final quantitative targets have been selected, although they require further refinement.
- As outlined in the assessment for wildlife, a process has been identified for determining and selecting focal species. Focal species selection is a key aspect of target refinement.

Summary of Changes for Fish Tumors or Other Deformities (potentially impaired)

- WDNR successfully obtained GLRI funding to sample fish for contaminant-related tumors for the AOC. Sampling should commence in 2013.

Summary of Changes for Bird or Animal Deformities or Reproduction Problems (potentially impaired)

- No change reported for 2012.
- U.S. Geological Survey (USGS) tree swallow data examining hatching effects was collected from many sites across the Great Lakes, including two sites in the AOC.
- National Oceanic and Atmospheric Administration's (NOAA's) mussel watch also collects *Dreissena* mussel (i.e., zebra and quagga mussel) data throughout the Great Lakes, including some locations in the AOC.

Summary of Changes for Degradation of Benthos

- The cleanup of PCBs and PAHs from Lincoln Park Phase 1 area concluded in 2012. Phase 2 area is being planned and designed in 2013.
- In 2012, USGS collected data from the AOC and several other Lake Michigan sites (including other AOC sites and non-AOC sites) to determine if there was a difference between the benthic communities at the different sites. This work may continue in 2013.

Summary of Changes for Restrictions on Dredging

- The cleanup of PCBs and PAHs from Lincoln Park Phase 1 area concluded in 2012. Phase 2 area is being planned and designed in 2013.

- Other cleanups and assessments are still necessary to continue making progress on this impairment. See Figure 1.

Summary of Changes for Eutrophication or Undesirable Algae

- No change reported for 2012.
- Results for the Milwaukee Basin Total Maximum Daily Load (TMDL) study for phosphorus have been delayed, and are expected in spring/summer of 2013. A TMDL implementation plan was originally expected in September 2013, but may also be delayed.

Summary of Changes for Beach Closings/Recreational Restrictions

- We are proposing target revision to be consistent with WDNR wastewater permitting and impaired waters program.
- In 2012, Milwaukee County hired a contractor to conduct a feasibility study of moving South Shore Beach to improve water quality. A public meeting is expected at some point in the future, although the timing is currently unknown.
- Addressing non-point source bacteria loading to the AOC remains a critical issue in removing this impairment. WDNR has partnered with Milwaukee Riverkeeper and the Great Lakes Water Institute (GLWI) to develop a proposal to determine loading of pathogens from the Menomonee and Kinnickinnic Rivers to the AOC. This work is based on and expands the work that GLWI and Milwaukee Riverkeeper have already begun in characterizing and prioritizing strategies for addressing non-point source bacteria loading to the estuary. Furthermore, this work is necessary to implement the Milwaukee River Basin TMDL study, and thus, it is a necessary action to address and remove the impairment.

Summary of Changes for Degraded Aesthetics

- In 2012, WDNR worked with several partners including UW-Extension, the Urban Ecology Center, and the Alliance for the Great Lakes to pilot a citizen aesthetics monitoring program. Citizen monitors collected data at 12 stations in the original boundaries of the AOC.

Summary of Changes for Degraded Phytoplankton and Zooplankton Populations

- In 2012, USGS collected data from the AOC and several other Lake Michigan sites (including other AOC sites and non-AOC sites) to determine if there was a difference between the plankton communities at the different sites. This was done in concert with the USGS benthos sampling described above.

Summary of Changes for Loss of Fish and Wildlife Habitat

- WDNR worked with its Milwaukee Estuary fish and wildlife technical team to develop assessment proposals to assess fish and wildlife populations in the AOC.
- The technical team also developed a draft list of interim habitat goals and developed a preliminary prioritization framework for habitat projects in the AOC.
- Using the prioritization framework and habitat goals, the group was able to develop an interim habitat project list. That list can be found on pages 48 and 49.

Next Steps

Sediment cleanups are critically important for removing nearly all impairments. While several sediment cleanups have been completed and others are currently underway, additional assessment and cleanup work is needed. Figure 1 shows the status of contaminated sediment projects in the AOC.

Note that the following actions are still necessary to address aspects of the impairments that are associated with contaminated sediment:

- Remove/manage PCB-contaminated sediments from the Cedar Creek Superfund Site.
- Assess the Milwaukee River downstream of its confluence with Cedar Creek to the Milwaukee River Channels/Lincoln Park Great Lakes Legacy Act projects.

- Complete Phase 2 of the Milwaukee River Channels/Lincoln Park Great Lakes Legacy Act project.
- Assess the Menomonee River downstream of its confluence with the Little Menomonee River to the estuary.
- Complete the evaluation/cleanup of PAHs and metals at the Burnham Canal Superfund Alternative Site.
- Complete the evaluation/cleanup of PAHs and metals at the Solvay Coke Superfund Alternative Site.
- Complete other evaluations/cleanups of contaminated sediment as identified and needed.

For 2013, the Milwaukee AOC Coordinator will be focused on continuing to engage the fish and wildlife technical team to assemble a fish and wildlife plan. Additionally, the AOC Coordinator will be working with the Natural Resources Educator and the Stakeholder Delegation to identify funding priorities for AOC Public Advisory Committee support funds.

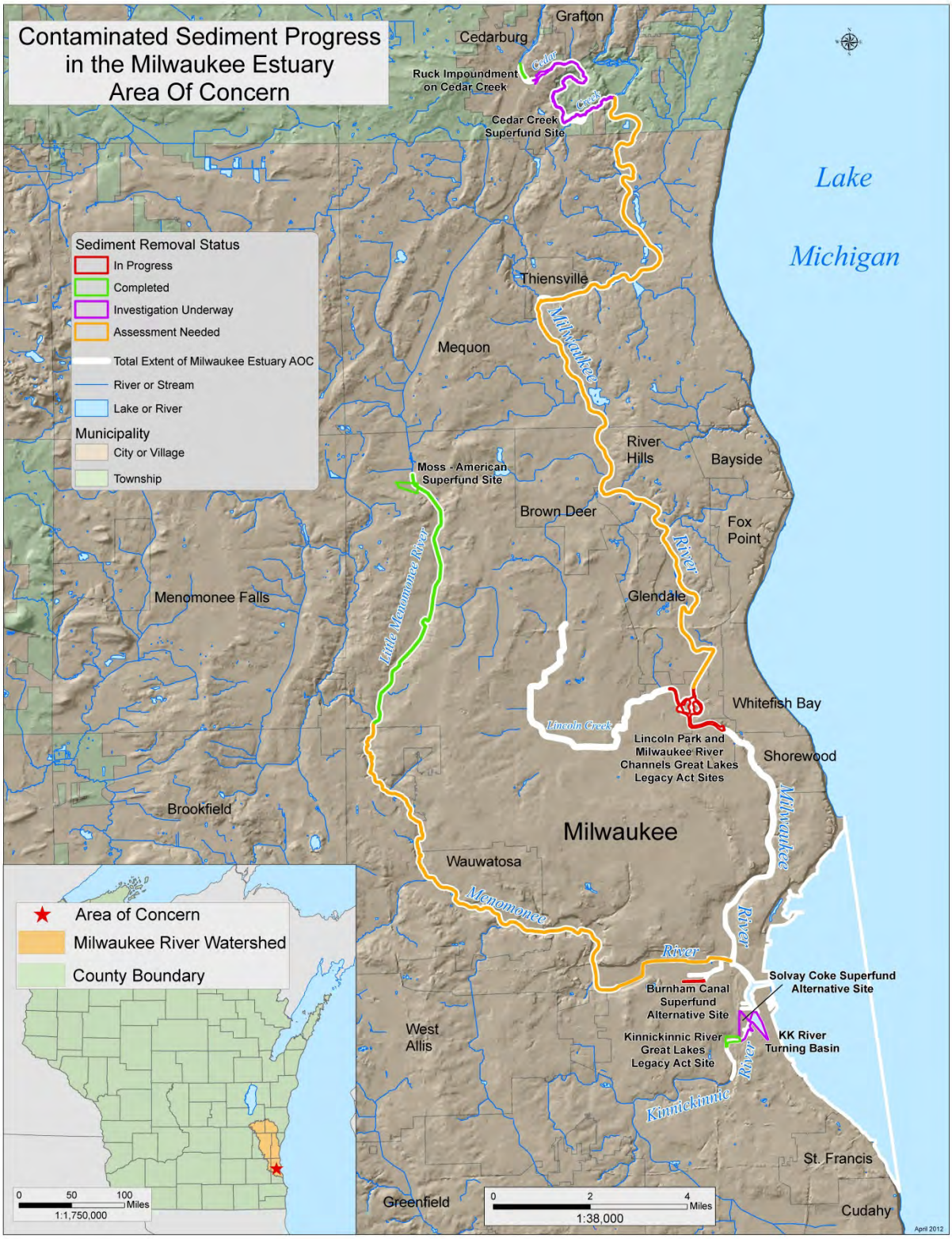

Figure 1. Sediment progress and sites needing action in the Milwaukee Estuary AOC. Note that several reaches still need to be characterized before WDNR will be able to identify all areas that will need to be addressed as part of the AOC program.

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. Targets should be locally derived.

Goal
Goals are broad ideas that may take a long time to achieve. They usually don't change significantly over the life of a project. An example goal statement is, "*Nesting populations of a diverse array of wetland-dependent and riparian-associated birds are consistently present within the AOC."* The delisting targets for the impairments may also be considered the goal statements (in some cases they may be objectives).

Hotspot
An area where additional characterization is needed to determine if further remedial actions are necessary. Typically, potential hotspots are identified by information related to historic or adjacent land use.

Objective
Objectives are the detailed activities that are needed in order to meet goals. Objectives are normally accomplished in less time than goals. They are important because they provide a means of measuring progress toward plan implementation. Objectives should be SMART: Specific, Measurable, Achievable, Realistic, Time-Constrained.

Project
As defined for this document, a project is a specific activity that has been defined with enough detail to understand who will do the work, how it will be done, and where it will be done. The end result of the activity should be visible and concrete. One or more projects may be defined to meet the goals and objectives for the impairments, if the AOC is not yet eligible for delisting. With this definition, "Coordinating with partners to make sure data is consistently collected and used" would not be a project. However, "XY Agency will Host a data 'slam' and write a set of standards for data collection and analysis for the Example AOC," would be a project.

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.

PURPOSE STATEMENT

The purpose of this document is to serve as a Remedial Action Plan (RAP) update. 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 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.

The Wisconsin Department of Natural Resources prepares the RAPs in consultation with its partners. This RAP, which updates the 2011 draft document, is intended to be a concise summary of beneficial use impairment status and specific actions that will be important for reaching the delisting targets. “Actions” may include on-the-ground restoration projects, monitoring and assessment projects, and stakeholder engagement processes. It is also a tool for documenting and communicating progress to agency partners and technical stakeholders. Subsequent updates will be completed as needed to incorporate new information that may become available.

INTRODUCTION

Areas of Concern (AOCs) are severely degraded geographic areas within the Great Lakes. The areas – 43 within the Great Lakes region – were designated as AOCs primarily due to contamination of river and harbor sediments by toxic pollutants. Cleaning up these severely degraded areas is a first step toward restoring the chemical, physical, and biological integrity of the lakes as required by the Great Lakes Water Quality Agreement. When the areas have been cleaned up to the point where they are not more degraded than other, comparable non-AOC areas, they are "delisted" as AOCs; they are then managed in accordance with the Lakewide Management Plan (LaMP) program, a "whole lake" program that is also set forth in the Agreement. The Agreement is the means for the U.S. and Canada to work together to jointly manage the lakes.

The Milwaukee Estuary AOC is one of five Areas of Concern in Wisconsin (Figure 2). It was designated an AOC in 1987 for several reasons. Sediments contaminated with toxic pollutants such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and heavy metals contributed to nearly all of the eleven beneficial use impairments (BUIs) within the original boundaries of the AOC. While loading of toxic substances was one of the primary drivers behind the AOC program, impacts from urbanization and terrestrial and aquatic habitat fragmentation also contribute to the impairments. The rivers within the AOC were also historically modified (straightened and dredged) to accommodate large vessel commercial shipping. Combined sewer overflows from wastewater treatment plants and soil erosion and nutrient enrichment from throughout the estuary's watershed contributed to degraded water quality.

These sources of impairment led to designation of eleven of the possible fourteen BUIs as applicable to the Milwaukee Estuary AOC (two of the eleven were identified as "suspected"). In 2008, the AOC boundary was expanded to account for the discovery of additional contaminated sediment sites (Figure 3). In the expanded AOC boundary, the BUIs that are most closely tied to sediment contamination (e.g., fish and wildlife consumption, restrictions on dredging, degradation of benthos, degraded fish and wildlife populations[1]) are identified as impaired (USEPA, 2009, p. 1-3). Milwaukee Estuary AOC beneficial use impairments and sources are summarized in Table 1. Impairment status is summarized in Table 2. Note that some impairments must be addressed broadly for the whole AOC, while others must be addressed on a geographic basis (i.e., tributaries are different from each other and are different than the estuary). While significant progress has been made since the first Remedial Action Plan (RAP) document in 1991, no impairments have been removed for this AOC to date.

The original boundaries of the AOC included the lower 5 kilometers (km) of the Milwaukee River downstream of North Avenue Dam (which has since been removed); the lower 4.8 km of the Menomonee River downstream of 35th Street; the lower 4 km of the Kinnickinnic (KK) River downstream of Chase Avenue; the inner and outer harbors; and the nearshore waters of Lake Michigan, bounded by a line extending north from Sheridan Park to the City of Milwaukee's Linnwood water intake.

The Wisconsin Department of Natural Resources (WDNR) worked with community stakeholders to develop a RAP in 1991, with updates in 1994 and 1999. In 2011, WDNR began working again with

[1] Note that the Lincoln Park/Milwaukee River Channels Sediment project is a prime example of why the AOC boundaries were expanded. That particular site contributes the greatest mass loading of PCBs to the Milwaukee River and Harbor, and remediation of contaminated sediment within this area is expected to result in a long-term reduction in PCB mass transport in the Milwaukee River of up to 70 percent. The impairments listed above are specifically associated with this site, and are likely the impairments that also apply to the expanded portions of the Milwaukee River portion of the AOC.

stakeholders to identify goals and actions necessary to address the impairments of the AOC. To do this, WDNR developed a Draft Stage 2 RAP to summarize completed work progress toward improving conditions in the AOC.

The main priorities for the Milwaukee Estuary AOC include the following: remediation of contaminated sediments in tributaries and nearshore waters of Lake Michigan; nonpoint source pollution control; improvement of water quality for recreational purposes; enhancement of fish and wildlife populations; and habitat rehabilitation.

Many projects have occurred in the AOC that have helped to address the impairments. Several formerly contaminated sites have been assessed and remediated through the Great Lakes Legacy Act, the Superfund program, or other efforts. Moreover, a total maximum daily load study for the Menomonee, Kinnickinnic, and Milwaukee Rivers and the Milwaukee Estuary will be completed in 2013 for phosphorus, fecal coliform bacteria, and sediment loading. The Total Maximum Daily Load (TMDL) implementation plan, expected in 2013, will identify the next steps needed to reduce pollution and meet water quality criteria in the AOC.

This RAP concisely lists the current status of each BUI, the next actions needed, and potential issues. This RAP is a work in progress, and represents progress made from the last draft completed in December of 2011 through October 2012. An updated version will be submitted again in at the end of 2013. Citizen engagement has been an integral component of the AOC program since the beginning and continues to be a priority as additional actions are identified and implemented.

Stakeholder Engagement

As of early 2011, the Milwaukee Estuary AOC did not have an established stakeholder group. In the early days of the RAP program, there was both a technical advisory committee and a citizen advisory committee, but both stopped meeting in the mid-1990s. During delisting target development in 2007, a steering committee was established and met several times to provide technical input to the targets. The *Delisting Targets for the Milwaukee Estuary Area of Concern* document (WDNR, 2008) came out of that work and provides an important basis for further target refinement. Since the report's release, however, a specific AOC stakeholder group had not existed.

The stakeholders have an active interest in the AOC and seeing progress. WDNR, assisted by the University of Wisconsin-Extension (UW-Extension), re-convened a stakeholder input group (SIG) in 2011. The stakeholder input group's purpose is to provide two–way communication between WDNR and the stakeholders as program goals and priority projects are identified. The SIG is the AOC staff's primary and direct conduit with the communities within the AOC. As such, they are called upon to provide feedback on goals and project plans from an integrated community viewpoint and to serve as ambassadors to the greater community. During 2011, the group met in April, June, July, and September.

In 2012, two new subgroups were brought together of the Stakeholder Input Group to help provide specific feedback about issues related to the RAP program. The AOC Coordinator assembled a Fish and Wildlife Technical Team to help identify key projects necessary for habitat restoration. The Technical Team also helped develop proposals to assess fish and wildlife populations in the AOC so that critical information gaps could be filled, and progress on the AOC could continue. The proposals can be found in Appendix A. In 2013, the group will continue its discussions of which additional habitat projects may be necessary for the AOC. As of October 17, 2012, the group had agreed on an interim list of habitat projects necessary for addressing the Loss of Fish and Wildlife Habitat impairment. The interim list can be found under the "Next actions needed" heading of the Loss of Fish and Wildlife Habitat section.

The UW-Extension Natural Resources Educator established a 12-person Stakeholder Delegation to serve as an outreach advisory panel on behalf of the more than 250 SIG members. The Stakeholder Delegation's role is to provide guidance and review of strategic materials and programs designed to better inform citizens about the process and progress of the RAP, create meaningful public engagement opportunities, and identify priority issues to communicate to the community. They will also identify new community partnership opportunities to foster initiatives to advance community support for and endorsement of the AOC clean-up and enhancement projects that lead to delisting.

Appendix C shows the various components of the education and outreach campaign in the AOC.

Figure 2. Wisconsin's five Great Lakes Areas of Concern. Note that two of the five are bi-state Areas of Concern, the Lower Menominee River AOC (Wisconsin and Michigan) and the St. Louis River AOC (Wisconsin and Minnesota).

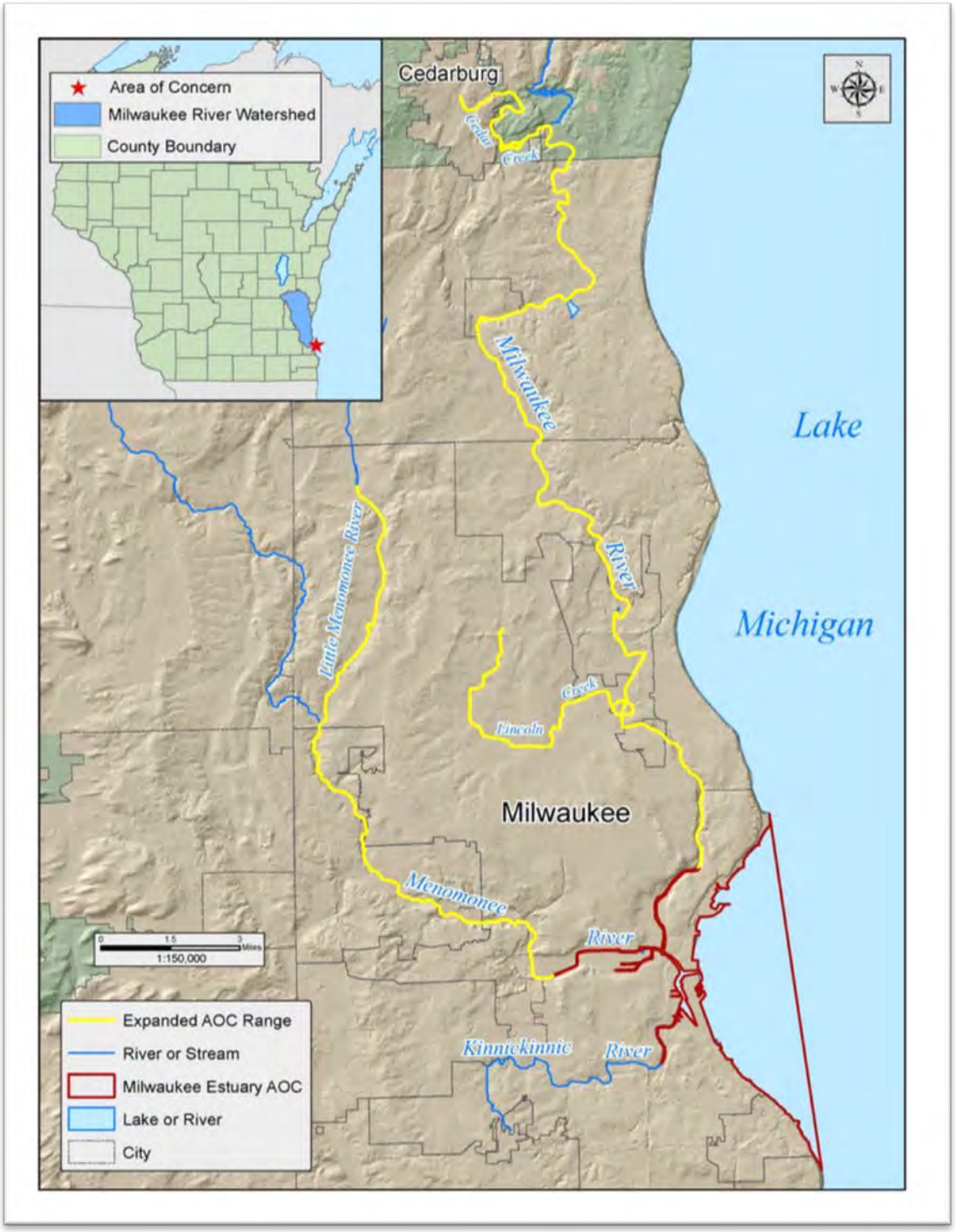

Figure 3. The Milwaukee Estuary AOC. The original boundaries are shown in red and the expanded boundaries that were added because of additional contributions of contaminated sediment in the upper watersheds are shown in yellow.

Table 1. Causes of Beneficial Use Impairments in the Milwaukee Estuary Area of Concern.

	Sources of Pollution or Problem			
Impaired Beneficial Use (Original AOC boundaries)	Toxic Substances	Point Source and Runoff Pollution	Physical Habitat Alteration	Other
Degradation of fish and wildlife populations	**X**	**X**	**X**	**X**
Loss of fish and wildlife habitat	**X**	**X**	**X**	**X**
Degradation of benthos	***x***	**X**	***x***	**X**
Restrictions on dredging	**X**	**X**		
Restrictions on fish and wildlife consumption	**X**	**X**		
Bird/animal deformities or reproduction problems (suspected)	***x***	***x***		
Fish tumors or other deformities (suspected)	***x***	***x***		
Beach closings/recreational restrictions	**X**	**X**		
Degraded phytoplankton and zooplankton populations	**X**	**X**	**X**	
Eutrophication or undesirable algae		**X**	**X**	**X**
Degradation of aesthetics	***x***	**X**	***x***	**X**

Note: A lower case *x* indicates that at the time of the original RAP, these sources were not understood to be part of the source contributing to a particular impaired beneficial use, but are now considered to be a component of the impairment.

Pollution Source Explanations

Toxic Substances

Loading of toxic substances into AOCs was one of the primary drivers behind the AOC program. Sources of toxic substances include contaminated sediments, spills of such chemicals within the watershed, and atmospheric deposition.

Point Source and Runoff Pollution

This category includes loading of sediment, nutrient, and/or bacteria as a result of nonpoint, or diffuse, sources of pollution and includes urban stormwater runoff. Point sources, such as sewer overflows, are also a source of sediment, nutrients, and bacteria into the AOC and are included in this category. Additionally, noncontact cooling water is a significant source of phosphorus, a nutrient, into the waters of the AOC.

Physical Habitat Alteration

Dams, drop structures, concrete-lined channels, and poorly-sized culverts and stream crossings degrade aquatic habitat by impeding the fishes' ability to get to suitable spawning habitat further upstream. This category also includes shoreline alteration, such as sheet piling, that doesn't provide high-quality habitat the same way that more naturalized, meandering streambanks would. Alterations in riparian habitats ecologically connected to the stream have the ability to impair the life cycles of wildlife, such as the ability of fish to spawn in floodplain wetlands, and ducks to nest in riparian grasslands.

Other

In the time since the original RAP documents were written, there has been recognition of the importance of thermal discharges in affecting water quality, specifically dissolved oxygen levels. As water temperature increases, its ability to carry oxygen decreases. Therefore, discharges of water with elevated temperatures can have a significant negative impact on aquatic communities. “Other” for the Degradation of Aesthetics impairment is listed because litter was a primary source of pollution for that impairment.

Table 2. Milwaukee Estuary Beneficial Use Impairment Status Summary (refer to Appendix I for more detail).

Beneficial Use Impairment	Beneficial Use Remains Impaired	Summary Status
Restrictions on dredging	Yes	Several sediment cleanup projects have been completed, including Phase 1 of the Lincoln Park/Milwaukee River Channels sediment project; additional sediment cleanups are needed. Projects are in line for Great Lakes Legacy Act funding or are being addressed by Superfund or other remediation programs.
Restrictions on fish and wildlife consumption	Yes	Waterfowl consumption assessments have been funded by GLRI and are in progress. Fish consumption is impaired so long as contaminated sediments are present and is reassessed on a 5-year monitoring cycle.
Degradation of benthos	Yes	USGS benthos study under way in 2012; study will provide information for refining the target and determining if additional information is needed (there are different benthic communities in tributaries than in the estuary; may need separate targets).
Degradation of fish and wildlife populations	Yes	WDNR convened a technical team for fish- and wildlife-related BUIs. The team is developing specific measures and projects. The group is compiling existing information to determine if current plans, reports, and projects provide adequate population & habitat characterization (and restoration progress) or if there are gaps that should be addressed. A summary of findings and recommendations is being addressed in a habitat plan for the AOC.
Loss of fish and wildlife habitat	Yes	
Bird/animal deformities or reproduction problems (potentially impaired)	Suspected	Assess whether existing information is enough to characterize impairment. With input from fish and wildlife technical team, determine if USGS tree swallow and NOAA mussel data collection should be expanded or if other data is needed for assessing this impairment.
Fish tumors or other deformities (potentially impaired)	Suspected	USFWS study collected 40 fish in 2011 for fish tumors; another fish tumor study (set to begin in 2013) has also been funded under GLRI, and will collect and examine 200 fish (white suckers) to determine if this use is impaired.
Beach closings/recreational restrictions	Yes	Target may need to be refined to be tributary- and estuary-specific. Bacterial contamination source identification is needed to address recreational restrictions. Support efforts to address bacterial contamination at South Shore Beach, as appropriate.
Degraded phytoplankton and zooplankton populations	Yes	USGS phyto- and zooplankton study under way in 2012. Study will provide information for refining the target and determining if additional information is needed.
Eutrophication or undesirable algae	Yes	Target may need to be refined to be tributary- and estuary-specific. TMDLs will inform sources and phosphorus loading reductions needed; TMDLs and a TMDL implementation plan expected to be completed in 2013.
Degraded aesthetics	Yes	Developed a process with stakeholders to begin a citizen-based monitoring project that will help characterize the impairment and determine what or how it would need to be addressed.

BENEFICIAL USE IMPAIRMENT UPDATES

The following pages summarize the current status of each Beneficial Use Impairment using the format below. An explanation of each section is provided after the heading. Note that the order in which the impairments are listed below is different than in the tables on pages 7 and 9; Impairments are addressed by the order in which the International Joint Commission lists them.

Target and Status

Updated Targets	Status
The updated target based the 2011 Draft Stage 2 modifications to the 2008 targets for the Milwaukee Estuary AOC are listed here as separate components on each row to clearly show the status of each part of the target.	May be: – "Complete" – "In progress" – "Addressed by current projects" – -"Action needed" – "Unknown" – "Assessment in progress" (data collection occurring in years listed in parentheses) – "TBD" (to be determined)

Target Rationale

May list one or more of the following:

- Relevant background and explanation related to the target and any applicable modifications.
- If applicable, an explanation of why the updates or clarifications were necessary for the 2008 target updates.

Please note that the information referring to the 2008 delisting targets can be found in the document *Delisting Targets for the Milwaukee Estuary Area of Concern: Final Report.*

Rationale for Listing

The section briefly summarizes the reason the BUI was known or suspected at the time of listing. If sources contributing to the impairment have been identified since listing, those are included in this section as well. Typically, the information from this section is drawn from the existing RAPs for the Milwaukee Estuary that were developed in 1991 and 1994.

Summary of Key Remedial Actions since the 2011 RAP Update and Current Status

"Key remedial actions" are those that directly contribute to the current status of the BUI. Note that any items listed here are not an exhaustive list of all the remedial actions completed that may have helped make progress toward removing the BUI. The items listed here are any key actions that were completed since the draft 2011 RAP. The narrative here explains and leads to the "Next action needed."

Next action(s) needed

This section is a narrative listing of assessments and on-the-ground projects that are clearly delineated and directly address the specific BUI. This is also not an exhaustive list of all actions needed to address the impairment, but rather a list of actions that we know must be implemented to make progress toward removing the impairment. Plans for verifying achievement of delisting targets are listed here, if known. Please also note that because of the urban nature of the AOC, contaminated sediment projects listed in

this section are not necessarily the only cleanups that would need to occur before removal of a particular impairment. Rather, the projects listed reflect the current knowledge of what must be addressed so that progress on an impairment can continue.

It is important to keep in mind that the primary goal of the AOC program is to address legacy contamination and issues related to severe water quality degradation. While there are some other important and necessary considerations for making progress toward removing impairments, areas with high concentrations of contaminated sediment that contribute to loading of toxic substances into the AOC may need to be addressed before additional work can occur, especially in the case of any physical habitat improvements. That said, it should be noted that more than contaminated sediment remediation will be required to remove all BUIs.

Issues (challenges, risks) affecting progress on this BUI

This section lists project contingency (i.e., one thing has to happen before another can occur), funding obstacles, and any other considerations that could affect the timeline for delisting.

RESTRICTIONS ON FISH AND WILDLIFE CONSUMPTION

Target and Status

Updated Target	Status
Fish Approach to be used with current level of monitoring for fish consumption advisories within the AOC (every five years):	
• All known man-made sources of BCOCs (including PCBs, mercury, dioxins, and furans) within the AOC and tributary watershed have been controlled or eliminated; and	In progress, *and* Action needed
• State fish tissue monitoring confirms that waterbody-specific fish consumption advisories are no longer needed for PCBs for waters in the AOC.	TBD
• Waters within the Milwaukee Estuary AOC are not listed as impaired due to fish consumption advisories in the most recent Clean Water Act 303(d) and 305(b) Wisconsin Water Quality Report to Congress (submitted to USEPA every two years).	Assessment in progress (on-going)
Approach to be used with funding to support additional monitoring: • All known man-made sources BCOCs (including PCBs, mercury, dioxins, and furans) within the AOC and tributary watershed have been controlled or eliminated; and	TBD
• A multi-year comparison study of fish tissue contaminant levels demonstrates that there is no statistically significant difference (with a 95% confidence interval) in fish tissue BCOC concentrations in the AOC compared to fish tissue BCOC concentrations in a representative non-impacted control site within the Lake Michigan Basin.	TBD
Wildlife There are no waterfowl consumption advisories for resident waterfowl due to contamination originating within the AOC.	Assessment in progress (2013-2016)

*Note: 10-year timeline cited in the second part of the target begins with the end of the last sediment cleanup project.

Target Rationale

Contaminated sediments are the primary contributor of PCBs to fish and wildlife within the AOC. An effective source control and remediation program is therefore necessary in order to meet delisting goals. Post-remedial actions and taking appropriate source control measures and evaluation monitoring must be conducted to determine the state of recovery for this impairment. Please note that for this impairment, PCBs are the contaminant of concern; there are no additional fish consumption advisories pertaining to mercury in the AOC (i.e., beyond the state-wide fish consumption advice that applies for mercury). Please refer to WDNR's *Fish Consumption Advice for the Milwaukee Estuary Area of Concern* (WDNR,

2011b) and *Choose wisely: A health guide for eating fish in Wisconsin* (WDNR, 2012) documents for more information about fish consumption advisories.

It should be noted that unrestricted consumption, as proposed in the 2008 targets, is not a goal that can be supported by the AOC program. For this reason, the target was updated to reflect that waters in the AOC should be no worse than other unimpaired waters of the state. There is, however, statewide fish consumption advice because of other, more widespread sources of contamination.

Fish

According to Candy Schrank, WDNR fish toxicologist, WDNR monitors fish for contaminant burdens from rivers within the Milwaukee River basin (including the AOC) on a five-year schedule and from the open waters of Lake Michigan every other year. New data are reviewed in the context of the existing advisories and previous data. Fish consumption advisories are updated by the WDNR and Department of Health and Family Services as needed based on WDNR sampling results. The most current fish consumption advisories for the AOC are available at http://dnr.wi.gov/fish/pages/consumption/. Because the state regularly monitors fish tissue concentrations for the waters of the state, a new monitoring program is not necessary to assess this impairment. Additionally, the state Impaired Waters List is updated every two years, which means that the state evaluates new data are and analyzes trends over time. If tissue concentrations consistently improve to the point where fish consumption advisories can be lifted so that there are no waterbody-specific advisories, then the desired outcome has been met and there is no need to wait to remove the impairment.

Listing guidelines for the state Impaired Waters Program considers a waterbody impaired for fish consumption if a water body has special PCB-based fish consumption advice of one meal per month or less frequent for resident fish species (like walleye, carp, smallmouth bass and others) or 1 meal per week or less frequent for resident panfish (like yellow perch or bluegill). Special advice for PCBs currently applies to several of these more resident fish species. There are no special fish consumption advisories due to mercury for the Milwaukee AOC.

The fish consumption advice that applies to fish from the Milwaukee Estuary AOC depends on the type of fish. Fish consumption advice is also provided for the Milwaukee River from Estabrook Falls downstream to the estuary and includes the Menomonee and Kinnickinnic Rivers and Lincoln Creek. This advice is for species primarily resident within these rivers and the inner harbor. These advisories will be used to determine when the Restrictions on Fish and Wildlife Consumption BUI in the Milwaukee AOC can be considered for removal.

Fish species like trout and salmon are migratory and may at times be found or caught in the river. However, these species spend most of their time in Lake Michigan; therefore, removal of the fish consumption BUI will not be dependent on these migratory species or on the Lake Michigan fish consumption advisory.

The Milwaukee River downstream from Estabrook Falls, the Menomonee, and Kinnickinnic Rivers (which include the river portions of the AOC) contain special advice for PCBs for several species. Since these species tend to be resident within the AOC and have no barriers to migration, it is appropriate to base delisting targets on resident species. The resident species that exceed the AOC delisting targets include:

- Yellow perch—1 meal/week
- Rock bass, smallmouth bass, walleye less than 18”—1 meal/month
- Black crappie, northern pike, walleye greater than 18”, redhorse, white suckers—6 meals/year
- Carp—do not eat

Additionally, fish caught in Cedar Creek and Zeunert Pond should not be eaten (Candy Schrank, *personal communication*, 2011; WDNR, 2011b; WDNR, 2012).

Wildlife

In the 2008 target document, there were no targets proposed for wildlife. The AOC does have a waterfowl consumption advisory that was issued in 1987, and since that time, no new data have been collected to evaluate the consumption advisory. Unlike fish consumption advisories, which are assessed for in all waters of the state in Wisconsin, waterfowl advisories are only assessed in areas with suspected contamination issues. Because of its legacy of contamination, the Milwaukee Estuary was assessed to determine if a waterfowl consumption advisory should exist for certain waterbodies or portions of waterbodies. According to the state guidelines for developing waterfowl consumption advice, portions of the Milwaukee Estuary AOC did exceed state waterfowl criteria, and thus, the state issued a waterfowl consumption advisory for portions of the AOC. Since the advisory was issued in 1987, no additional data, to date, have been collected.

In the AOC, the following waterfowl consumption advisories apply (please note that in some cases a relevant structure or landmark may no longer be present. Assessing the waterfowl consumption advisory will be necessary to determine the exact locations of any waterfowl consumption advisory, should such advisories still be necessary after reassessment):

- Milwaukee River from Highway 167 (Thiensville) upstream to Lime Kiln Dam at Grafton and Cedar Creek from the Milwaukee River up to Bridge Road in the Village of Cedarburg—do not eat mallard ducks using this water
- Milwaukee Harbor—do not eat black ducks, mallards, scaup, and ruddy ducks using this water
- Waters in the City of Cedarburg—do not eat Canada geese using these waters

Rationale for Listing

Fish samples taken from the Milwaukee River system (which includes the Menomonee and Kinnickinnic Rivers) exceed standards established by the state of Wisconsin for the consumption of sport fish. The state issues consumption advisories for various population groups based on fish species and size classes. Advisories are collectively issued for the presence of mercury and PCBs. The Milwaukee River system has had waterbody-specific fish consumption advisories listed for PCBs for decades. As there is no waterbody-specific advice for mercury for waters of the AOC, waters within the AOC fall under the statewide consumption advisory for mercury.

Summary of Key Remedial Actions since the 2011 RAP Update and Current Status

Because contaminated sediments are the primary contributor of contaminants to fish within the AOC, contaminated sediment cleanups (especially for PCBs) are necessary in making progress toward addressing this impairment. In 2012, Phase 1 of the Lincoln Park/Milwaukee River Channels Great Lakes Legacy Act project (Figure 4) was successfully completed. The project removed 120,000 cubic yards of PCB- and PAH-contaminated sediments from the AOC. The total project cost was approximately $25 million dollars.

Mercury Marine is working in consultation with the U.S. Environmental Protection Agency (USEPA) and WDNR on a feasibility study for the Cedar Creek Superfund Alternative Site. This site is a source of PCBs to the AOC and needs to be remediated for BUI removal to occur.

Under a Great Lakes Restoration Initiative (GLRI) grant, WDNR will also be collecting new data to re-examine the state of the waterfowl consumption advisories and determine if any of the existing advisories

can be removed or if any additional advisories are warranted. Data collection will begin in late 2012, and is proposed to continue for nearly three years, until spring of 2015. The proposal and budget for the project can be found in Appendix D.

Next action(s) needed

Work is still needed to assess and remediate areas contaminated with PCBs. The waterfowl consumption advisory that was issued in 1987 also needs to be re-evaluated to determine if the wildlife component of the impairment can be removed.

At this time, the following specific actions are needed:

- Complete the cleanup of PCBs at the Cedar Creek Superfund Alternative Site.
- Complete Phase 2 of the cleanup of PCBs from the Lincoln Park/Milwaukee River Channels Great Lakes Legacy Act project site.
- Assess the sediment in the Menomonee River downstream of its confluence with the Little Menomonee River.
- Ensure on-going funding over the next three years to re-evaluate the waterfowl consumption advisory.
- Assess areas on the Milwaukee River downstream of confluence with Cedar Creek to the estuary.

Issues (challenges, risks) affecting progress on this BUI

The main barrier to progress is ensuring enough funding through programs or responsible parties to complete all the contaminated sediment projects (both assessment and remediation) in a timely manner.

Figure 4. Map of the Lincoln Park/Milwaukee River Channels Great Lakes Legacy Act site. Phase 1 was completed in 2012, and a feasibility study is underway for Phase 2 of the project.

DEGRADATION OF FISH AND WILDLIFE POPULATIONS

Target and Status

Updated Target	Status
Fish This BUI will be considered to be eligible for removal when the following have occurred:	
• All contaminated sediment hotspots within the AOC have been identified, and implementation actions to remediate contaminated sites have been completed.	In progress, *and* Action needed
• A local fish and wildlife management and rehabilitation plan has been compiled for the estuary that: o Defines the causes of all population impairments within the AOC o Establishes site specific local population targets for native indicator fish and wildlife species within the AOC o Identifies all fish and wildlife population rehabilitation programs/activities within the AOC and establishes a mechanism to assure coordination among all these programs/activities, including identification of lead and coordinative agencies o Establishes a time table, funding mechanism, and lead agency or organization responsibility for all fish and wildlife population activities needed within the AOC. o The actions/projects necessary to accomplish the recommendations of the fish and wildlife management and restoration plan are implemented.	In progress
• Populations for native indicator fish species are statistically similar to populations in reference sites with similar habitat but little to no contamination.	Unknown
Wildlife Assess wildlife populations and the possible extent of any impairment within the AOC before setting specific wildlife population targets.	In progress, *and* Action needed

Target Rationale

Many partners in the AOC have developed plans that can be drawn from to determine the actions that are a priority to address this BUI. (Please see the References section for a list of resources related specifically to the fish- and wildlife-related impairments.) In 2012, WDNR assembled a team of fish and wildlife experts and began facilitating a process to determine measures of success, develop scopes of work for necessary assessments, and identify interim habitat projects that would help assess and address this impairment. Proposals for separate fish and wildlife assessments, as well as an outline of potential fish and wildlife goals and measures of success, can be found in Appendices A and B. The work of the fish and wildlife technical team will be assembled into a Habitat Plan for the AOC. Being able to define the causes of all population impairments is contingent upon completion of the assessments.

Rationale for Listing

The Stage 1 RAP (WDNR, 1991) and 1994 RAP update (WDNR, 1994) indicated that fish populations in the AOC were severely degraded and that the fish species resident in the AOC were mostly pollution tolerant species due to poor water quality. The lack of natural shoreline and channel features throughout the AOC, urban runoff, point sources, and sediment accumulation were the major factors noted for this impairment (WDNR, 1994, p. 2-17). In terms of the wildlife component of this goal, at the time that the RAP documents were written, there was essentially no data about wildlife populations. In the first RAP document written in 1991, the wildlife component was not considered to be part of the impairment for the Milwaukee Estuary AOC (WDNR, 1991, p. V-3). The RAP revision in 1994 stated that declines in wildlife populations were likely attributable to degraded water quality and loss of habitat, especially the loss of wetlands (WDNR, 1994, p. 2-17). The 1994 RAP also said that contaminants present in the AOC are known to affect wildlife reproduction and growth, and so the use should be considered impaired (WDNR, 1994, p. 2-18).

According to Waller and Rooney, studies published in 2008 assessed ecological change in Milwaukee County and concluded there have been substantial losses of species richness with declines of 20-70% for bird, amphibian, and reptile groups, resulting mainly from habitat loss (2010).

Historically, there is a component of these impairments that has been viewed as being tied to contamination. While is it unclear from the scientific literature the degree to which contamination contributes to the decline of fish and wildlife populations, cleanup of contaminated sites in the AOC remains a key management action for this impairment. The lack of suitable physical habitat in order to support populations of desired fish and wildlife species is also a key feature that will need to be addressed to make progress on this impairment.

Summary of Key Remedial Actions since the 2011 RAP Update and Current Status

In 2012, the City of Milwaukee embarked on a project to restore the Grand Trunk Wetland on Port of Milwaukee property (Figure 5). This wetland restoration is a unique opportunity to restore approximately 8 acres of wetland, and represents just a very small fraction of the total wetlands that have been lost in the Estuary. The City Department of Community Development was successful in obtaining two grants for the project, one from the WI Coastal Zone Management Program, and another grant from the Fund for Lake Michigan. The project is still in its early stages, and the wetland restoration project team is negotiating with the Port of Milwaukee and its lessee, Gillen Foundations to ensure that the wetland restoration and Gillen's expansion are both successful.

Additionally, the Milwaukee Metropolitan Sewerage District (MMSD) removed concrete on the Kinnickinnic River from 6th St. downstream to I-94. The concrete removal will help improve aquatic habitat in the AOC.

Furthermore, the Milwaukee Estuary Fish and Wildlife Technical Team has developed fish and wildlife community assessment proposals in order to determine the extent of this impairment. The two proposals have been submitted to USEPA for funding. Doing this work will help us fill in some necessary information, and identify further management actions that are necessary for removing the fish and wildlife populations and habitat BUIs. We submitted the proposals to USEPA on October 26, 2012 for funding consideration. The technical team also identified some interim habitat projects that would enhance habitat for some species of local conservation interest in the AOC. That list of interim projects can be found on p. 44 of this plan.

Next action(s) needed

Continue working with stakeholders to determine which benchmarks are desirable and achievable for this impairment. There are a few projects in the AOC that will help in making progress toward removing this impairment in the meantime. They are:

- Assess and remediate contaminated sediment projects.
- Complete the fish and wildlife community assessments, as per the fish and wildlife technical team project proposals that were submitted to USEPA (Appendix A).
- Continue working with the technical team to develop the AOC fish and wildlife plan that identifies species of local conservation interest, fish and wildlife-related objectives, and potential habitat enhancement projects in the AOC.

Issues (challenges, risks) affecting progress on this BUI

Answering the question of when do we know we have created/enhanced enough habitat will be challenging to determine, although the assessments' results will help make the determination. We are aware of the difficulties with establishing population-related objectives for this BUI since attracting desired species can be more complicated than just providing them with suitable habitat. Just because habitat is created does not necessarily mean that the desired species can colonize those areas and persist as viable populations. Securing funding for the assessment proposals is absolutely necessary so that we can determine what other management actions are necessary, and create a list of species of local

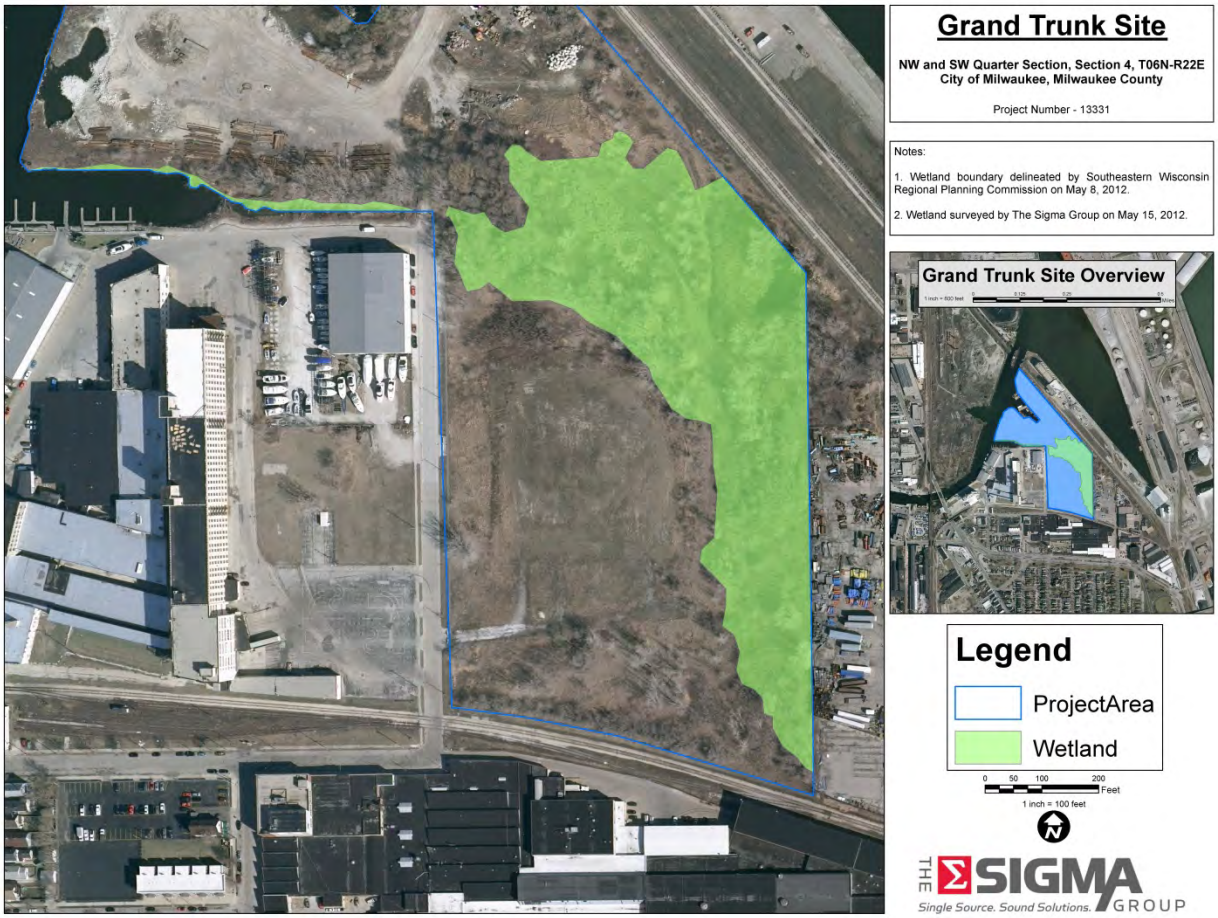

Figure 5. Map of the Grand Trunk Wetland Site in Milwaukee. The City has obtained funding to restore the wetland, which is currently very degraded.

conservation interest for the AOC. These assessments will determine what species can still be viably sustained within the AOC, given the constraints imposed by the limited amount of habitat extent and diversity that can be restored in an urban environment.

FISH TUMORS OR OTHER DEFORMITIES (POTENTIALLY IMPAIRED)

Target and Status

Updated Target	Status
Removal may occur if:	
• All known major sources of PAHs and chlorinated organic compounds within the AOC and tributary watershed have been controlled or eliminated	In progress *and* Action needed
• 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 reference sites.	Assessment in progress (2011, 2012-2013)
OR, in cases where tumors have been reported:	
• A comparison study of 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.	TBD

Target Rationale

The 2008 document stated that the first step toward removing this impairment would be to determine if the use was impaired by sampling 50 fish to determine whether the tumor incidence rate was greater than 5%. WDNR's Office of the Great Lakes has used documented incidence rates and performed rigorous statistical analyses to help guide its approach to assessing the fish tumor impairment. The sampling design suggests a relatively large data collection effort in an attempt to achieve an acceptably high and known degree of confidence in the study results. For more detailed information about WDNR's sampling strategy for the 2012-2013 evaluation of this BUI, please see Appendix E.

The updated target stipulates that the appropriate reference sites would be minimally impacted, as opposed to non-impacted, and that the tumors and deformities need to be contaminant-related since there can be other causes, like pathogens, of tumors and deformities in fish. A zero-percent incidence rate is not achievable, since tumors occur naturally in fish even in the absence of contaminants. How the term "minimally impacted reference site" is defined will be discussed and decided upon with local stakeholders, if it is determined that a comparison study is needed. The updated target also removed a previous provision stating that resident non-benthic fish should be sampled for this impairment. Given the nature of this particular impairment, and its close connection to contaminated sediments, there was no justifiable basis for this provision, so it was removed in last year's RAP update.

Rationale for Listing

The 1994 RAP included this BUI as suspected because the concentrations of certain PAHs and metals in AOC sediments were similar to concentrations in areas with verified fish tumors. As of 2008, no fish health surveys had been conducted within the AOC to determine the extent (or existence) of the impairment. This has since changed (see information in next two sections).

Summary of Key Remedial Actions since the 2011 RAP Update and Current Status

In 2011, the U.S. Fish and Wildlife Service (USFWS) collected fish tumor data in Milwaukee for a study of contaminants of emerging concern in the Great Lakes. The results of this study were expected at the end

of 2011, but are not yet available. Although this study collected a small sample size (N=20 for white suckers and N=20 for small mouth bass), this data could be used as a screening-level study in order to determine if a larger-scale study would be likely to conclude that incidence rates in the Milwaukee Estuary AOC are similar to minimally impacted sites. While the 2011 analysis is not yet complete, at least a few of the fish collected for the USFWS study did have contaminant-related tumors (Sarah Warner, 2011, personal communication).

In 2012, a proposal was developed to robustly assess the fish tumors impairment for the Milwaukee Estuary. The proposal was developed by WDNR, and received endorsement from the Milwaukee Estuary Fish and Wildlife Technical Team. As part of this assessment, 200 white suckers will be collected and analyzed for contaminant-related tumors.

During Phase 1 of the Lincoln Park/Milwaukee River Channels Great Lakes Legacy Act project, sediments contaminated with PAHs were discovered and remediated along with the PCB-contaminated sediments.

Next action(s) needed

Sites that contain elevated amounts of PAHs, metals, and other substances that cause fish tumors and deformities must be addressed before removal of this impairment can occur. These actions include:

- Completing the assessment and clean up PAHs and metals from the Solvay Coke Superfund Alternative Site.
- Completing the assessment and clean up PAHs and metals from the Burnham Canal Superfund Alternative Site.
- And other necessary projects to clean up PAH-contaminated sediment.

Fish tumor sampling is necessary in order to confirm whether this BUI is impaired for the AOC. For our scheduled assessment, the sampling target is 200 fish. If the 200 fish sample yields below 5% within the 95% confidence interval (i.e., 5 or fewer tumors out of 200) we will consider the site for BUI removal. Similarly, if fewer fish are captured, we will consider the BUI for removal if the 95% confidence interval of the tumor incidence rate is less than or equal to 5%. Although a background tumor incidence rate of approximately 2% may be more appropriate (Baumann 2010), the most likely point estimate of 5 or fewer fish out of 200 is 2.5%. As such, given our conservative approach, we feel that a point estimate of 2.5% with a 95% confidence interval that does not include 5% is sufficient to consider BUI removal.

If results from the intensive AOC sampling suggest that the upper 95% confidence limit of the tumor incidence rate is not below 5%, we will compare data obtained from the AOC with a suitable reference site which has available data (such as Jackfish Bay in Lake Superior) or data will be collected from a suitable reference site again with the target of 200 fish. Furthermore, if the results from the 2012-2013 sampling show that there are higher than background tumor rates, then sources of contaminants that may be contributing to the problem will have to be re-examined and controlled or eliminated.

Issues (challenges, risks) affecting progress on this BUI

Although sampling is necessary to confirm whether this impairment exists, we also need to continue making progress on cleaning up PAH-contaminated sites in the AOC.

BIRD OR ANIMAL DEFORMITIES OR REPRODUCTION PROBLEMS (POTENTIALLY IMPAIRED)

Target and Status

Updated Target	Status
This BUI can be removed if:	
• Studies conducted in the AOC indicate that the beneficial use should not be considered impaired, or	Assessment in progress
• If studies conducted in the AOC determine that this use is impaired, then two approaches can be considered for delisting: o Approach 1 – Observational Data and Direct Measurements of Birds and other Wildlife ▪ Evaluate observational data of bird or 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 within the AOC are statistically higher than the reference site it may indicate a source from either within or from outside the AOC. Therefore, if the rates are statistically higher or the data are insufficient for analysis to achieve agreed upon statistical power, then… ▪ Evaluate 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. ▪ Where direct observation of wildlife and wildlife tissue data are not available, the following approach should be used:	TBD

o Approach 2 – Fish Tissue Contaminant Levels as an Indicator of Deformities or Reproductive Problems ▪ If fish tissue concentrations of contaminants known to cause deformities or reproductive suppression identified in the AOC are at or lower than the LOEL known to cause reproductive or developmental problems in fish-eating birds and mammals, the BUI can be delisted, or ▪ If fish tissue concentrations of contaminants known to cause deformities or reproductive suppression identified in the AOC are not statistically different than Lake Michigan (at 95% confidence interval with sufficient and agreed upon statistical power), then the BUI can be removed. Fish of a size and species considered prey for the wildlife species under consideration must be used for the tissue data.	

Target Rationale
Before targets can be developed with confidence for the AOC, sufficient studies must be conducted to determine if this beneficial use is impaired. The targets identified above should be reviewed following completion of the studies and modified in accordance with the findings of those studies.

Rationale for Listing
Insufficient data are available to show if these problems exist with birds or other animals within the AOC. The 1991 RAP considered this use unimpaired because of lack of information. Because contaminants like PCBs and heavy metals that are found in AOC sediments may have the potential to impair reproduction and development in wildlife, this use was considered impaired in the 1994 RAP.

Summary of Key Remedial Actions since the 2011 RAP Update and Current Status
In 2012, there has been essentially no change in this impairment. The U.S. Geological Survey (USGS) has been using tree swallows as indicators of environmental contamination in areas across the United States, and they have at least one site in the Milwaukee Estuary. At the time of writing, no new data was available. Please see the 2011 update for a further description of the tree swallow study.

Additionally, researchers with the National Oceanic and Atmospheric Administration (NOAA) have been collecting data around the Great Lakes for several years using resident *Dreissena* species of mussels (more commonly known as zebra and quagga mussels) to monitor for toxicity as part of the Mussel Watch program. This data may also provide some necessary information about this impairment. A few sites have been included for this study in the Milwaukee Estuary, and data is also collected from other non-AOC sites around the Great Lakes, and could aid in providing a comparison between the mussel toxicity in the sites monitored in Milwaukee and other similar non-AOC sites. As of October 15, 2012, no information was available about results from either late 2011 or 2012.

Next action(s) needed
In the future, we will have to determine which data are necessary to determine whether this is an impaired use in the AOC. We may be able to draw on some of the already existing data being collected by federal partners, but may need more funding if we need additional monitoring stations in the AOC.

Issues (challenges, risks) affecting progress on this BUI

There has been limited data until recently to aid in the assessment of this impairment, and further data collection will probably be necessary.

DEGRADATION OF BENTHOS

Target and Status

Updated Target	Status
Removal may occur if:	
• Known contaminant sources contributing to sediment contamination and degraded benthos have been identified and control measures implemented; and	In progress
• All remediation actions for contaminated sediments are completed and monitored according to an approved plan; or	In progress, *and* Action needed
• The benthic community within the site being evaluated is statistically similar to a reference site with similar habitat and minimal sediment contamination.	Assessment in progress (2012-2013)

Target Rationale

There are several considerations for this impairment. First, the harbor portion of the AOC will support different benthic communities than will the tributaries. Benthic communities in the harbor/estuary are subjected to regularly disturbed and altered physical conditions (like dredging and shoreline hardening from the installation of sheet piling). Second, benthic communities, either in the harbor or in the tributaries, would also be impacted from pollution[2]. The rationale for this target is to clean up contaminants so that they aren't substantially impacting benthic communities, and then determine if the degradation of communities in the harbor is likely being caused by the poor physical conditions for which there is little feasible remedy. If there are degraded benthic communities in the tributaries, the main causes could be the presence of contamination or degraded physical habitat (e.g., substrates that don't provide adequate conditions for higher quality benthic communities). For both the harbor and the tributaries, contaminants and pollution must be assessed. Physical habitat should also be assessed to determine whether this could be contributing to the degraded communities, and, where feasible, habitat improvements should be made.

Measures such as sediment quality guidelines, equilibrium partitioning sediment benchmarks, and other sediment guidelines are part of the WDNR review to arrive at an approved remediation plan.

Rationale for Listing

According to earlier RAP documents, this beneficial use is considered impaired because of degraded physical habitat, low dissolved oxygen concentrations, and constituents in sediment toxic to macroinvertebrates, but the extent of the impairment is not well defined. The 1991 and 1994 RAP documents recognize that monitoring is required to better define this impairment. Furthermore, because physical conditions within the AOC are diverse, different final targets may be required for different habitat types within the AOC.

[2] The *Consensus-Based Sediment Quality Guidelines* for Wisconsin (WDNR, 2003; see References) were developed through an assimilation of results from multiple published effects-based toxicity testing to freshwater benthos, so there is a clear and documented connection between contamination and deleterious benthic community impacts.

The RAPs also cite results of several benthic surveys in the AOC that showed benthos were lacking in diversity and were dominated by pollution-tolerant species. It was because of the lack of diversity and the prevalence of pollution-tolerant organisms that this impairment was listed.

Summary of Key Remedial Actions since the 2011 RAP Update and Current Status

Cleaning up toxic sites, minimizing sewer overflows, improving physical habitat, and reducing runoff pollution where feasible are the necessary actions to help make progress toward removing this impairment from the Milwaukee Estuary AOC. We assume that cleanups for reducing ecological risk should also result in an improved benthic community. Based on this assumption, Phase 1 of the Lincoln Park/Milwaukee River Channels Great Lakes Legacy Act completed in 2012 have helped improve conditions for benthos.

In 2012, USGS surveyed parts of the AOC and other non-AOC reference sites to see how the benthic communities compare. Benthic communities are important because they are the base of the food web, and if there aren't sufficient conditions for them to thrive, then we would expect there to be constraints on the populations of fish and other wildlife. The proposal for this project can be found in Appendix F. A map of sites that were surveyed is shown in Figure 6.

Next action(s) needed

Contaminated sites within the AOC need to be remediated. We will need to evaluate the findings of the USGS benthos study, assess the need to supplement the study (to adequately characterize the range of benthic conditions in the AOC), and re-examine whether the beneficial use is impaired based on findings.

Issues (challenges, risks) affecting progress on this BUI

Given the urban nature of all of the AOC waterways, it is unlikely that high quality benthic communities can be established at all sites. Reference sites, if used, must be in areas that are urban. Reference sites will likely be degraded and the target will need to take into consideration the achievability of targets for BUI removal.

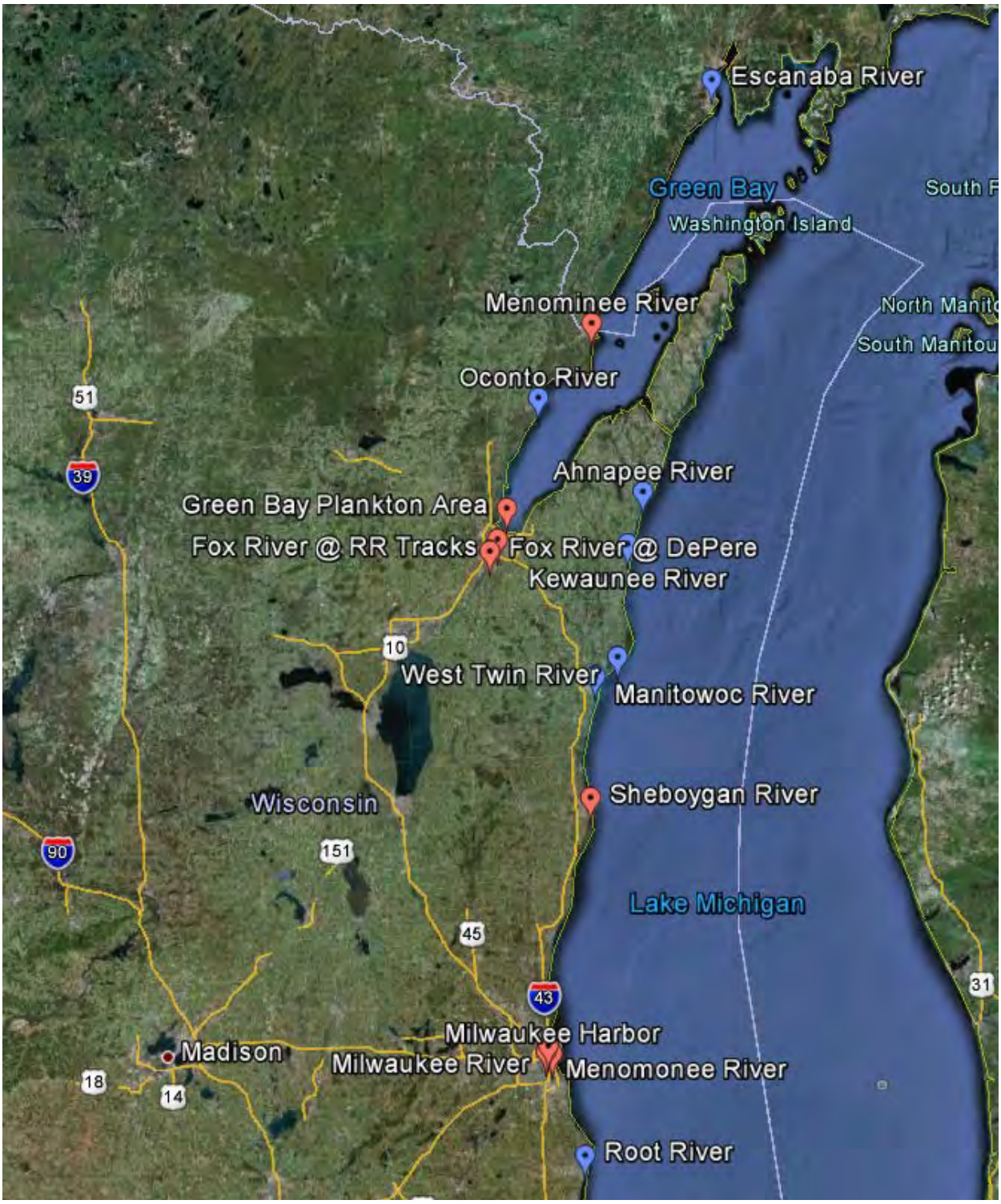

Figure 6. USGS benthos and plankton sampling locations. Sites with a red label indicate sampling sites within an AOC, while blue shows sampling sites in a non-AOC reference location.

RESTRICTIONS ON DREDGING ACTIVITIES

Target and Status

Updated Target	Status
Removal of this BUI can occur when:	
• Contaminated sediment hotspots within and upstream from the AOC have been identified.	In progress and Action needed
• Implementation actions to remediate contaminated sites have been completed. As a source control measure and for AOC remediation, known contaminated sites must be addressed before BUI removal is possible.	In progress
• There are no special handling requirements of material from routine navigational dredging due to contamination originating from controllable sources within the AOC.	In progress

Target Rationale

While many of the AOCs have defined this BUI to only federally maintained navigation channels, the Milwaukee Estuary RAP took a broader view of this issue. The Technical Advisory Committee for the 1994 RAP update recognized that contaminated sediments are linked to most of the BUIs in the AOC. Therefore, addressing contaminated sediments is central to removing this impaired beneficial use.

The intent is to eliminate special handling requirements that go beyond the normal handling requirements for dredged sediments. If sediments that are dredged for navigation, either by the U.S. Army Corps of Engineers or by private companies, contain moderate to high levels of contaminants, then there are additional costs incurred from the proper disposal of such sediments. We seek to eliminate those additional burdens imposed by the presence of contaminants so that parties can dredge and dispose of sediment by simply following required standard testing and disposal as mandated by state law.

Rationale for Listing

Contaminated sediments are recognized as one of the primary sources of pollution in the Milwaukee Estuary AOC. Historically, most of the AOC was modified, dredged, and maintained for large vessel navigation, making the estuary a settling basin for sediments. Over time, sections of the rivers that were previously maintained are no longer needed for deep draft navigation, but the sediments and their associated contaminants remain. This impairment was listed due to the presence of a number of contaminated sediment sites. Contaminants that are issues within the AOC include PAHs, heavy metals, and PCBs.

Summary of Key Remedial Actions since the 2011 RAP Update and Current Status

Remediation of contaminated sediment hotspots is necessary before this BUI can be removed. In 2012, the completion of Phase I of the Lincoln Park/Milwaukee River Channels Great Lakes Legacy Act Project was a key project that helped address this impairment.

Next action(s) needed

Investigate suspected areas of contaminated sediment in areas of the Milwaukee and Menomonee River portions of the AOC to identify the need, if any, for cleanup actions. An investigation of the upper

Milwaukee River is currently underway. With regard to contaminated sediment projects, there are still some necessary actions that must be taken before the impairment can be removed. They are:

- Complete the cleanup of PAHs and metals from the Solvay Coke Superfund Alternative Site.
- Complete the cleanup of PAHs and metals from the Burnham Canal Superfund Alternative Site.
- Complete the cleanup of PCBs at the Cedar Creek Superfund Alternative Site.
- Complete the cleanup of PCBs from Phase 2 of the Lincoln Park/Milwaukee River Channels Great Lakes Legacy Act project site.
- Assess the sediment in the Menomonee River downstream of its confluence with the Little Menomonee River.
- Assess areas on the Milwaukee River downstream of confluence with Cedar Creek to the estuary.

For contaminated sediment cleanups, when possible upstream sources/sites should be addressed before addressing sites further downstream; however, anytime opportunities present themselves to address contamination, they should be taken, even if a downstream site is cleaned up ahead of a site further upstream.

Issues (challenges, risks) affecting progress on this BUI

Cleanup timelines are uncertain and this affects the ability to delist this impairment. Any reductions in federal Great Lakes Legacy Act funding could affect progress as well.

EUTROPHICATION OR UNDESIRABLE ALGAE

Target and Status

Updated Target	Status
Removal of this BUI can occur when:	
• Total phosphorus (TP) concentrations within the AOC rivers, harbors, and nearshore waters meet the criteria recommended for the State of Wisconsin, as established by WDNR.	In progress *and* Action needed
• When the results from the total maximum daily load study for phosphorus, total suspended solids, and bacteria are completed for the Menomonee, Kinnickinnic, and Milwaukee Rivers.	In progress
• Measures to meet the Total Maximum Daily Loading Implementation Plan are being completed.	TBD
• No water bodies within the AOC are included on the list of impaired waters due to nutrients or excessive algal growths in the most recent WI Impaired Waters list.	Action needed
• Chlorophyll-*a* concentrations within the AOC lake and impoundment areas do not exceed 4.0 µg/L.	Unknown
• There are no beach closures in the AOC due to excessive nuisance algae growth.	Unknown

Target Rationale

The target revision was needed because at the time that the proposed targets were being developed in 2008, Wisconsin did not have any criteria for nutrients, but was in the process of developing them. Phosphorus criteria have since been established, and in the AOC, the Menomonee, Milwaukee, and Kinnickinnic Rivers (as well as many of their tributaries) are listed as impaired because of low dissolved oxygen concentrations caused by excessive phosphorus pollution (WDNR, Impaired Waters Program). MMSD has received funding to determine where the sources of contamination are coming from (i.e., a total maximum daily load study, or TMDL), and the results of the study should inform future actions that will be necessary in order to reduce phosphorus pollution to the AOC.

The estuary rivers currently have variance criteria (see NR 104.06 of the Wisconsin Administrative Code) for dissolved oxygen concentrations (2 mg/L), indicating that the estuary is not capable of supporting full fish and aquatic life use designations that would require dissolved oxygen concentrations of at least 5 mg/L. Stakeholders have indicated that they would like waters of the AOC to meet the full fish and aquatic life standard of 5 mg/L, and significant strides have been made in improving water quality. We'd like to aim for attaining the full fish and aquatic life standard in cases where there are sometimes lower dissolved oxygen concentrations (e.g., on portions of the Kinnickinnic River).

Rationale for Listing

The 1994 RAP considered this use impaired because phosphorus, nitrogen, and chlorophyll *a* concentrations within the AOC indicated eutrophic conditions (WDNR, 1994, p. 2-19). Low dissolved oxygen concentrations were also common within the AOC rivers. The estuary acts as a settling basin for suspended materials. The organic portion is broken down through chemical and biological processes that demand oxygen from the water column, leading to lower concentrations. The Milwaukee Estuary, including the lower Menomonee, Milwaukee, and Kinnickinnic Rivers are regularly listed as impaired waters (as part of the state's Clean Water Act/ 303(d) program) for excess phosphorus and low dissolved oxygen concentrations. In the 1994 RAP, total phosphorus levels in the AOC exceeded 0.1 mg/L in 40 to 75 percent of the samples taken from the Inner Harbor, and 10 to 25 percent of the time from the Outer Harbor.

Summary of Key Remedial Actions since the 2011 RAP Update and Current Status

While dissolved oxygen levels used to be low in the rivers because of sewer overflows, overflows have decreased substantially since the Deep Tunnel project went online in 1994. Despite these improvements, the estuary and large portions of the AOC rivers are included on Wisconsin's list of impaired waters as per section 303(d) of the federal Clean Water Act because of insufficient dissolved oxygen concentrations to support the designated fish and aquatic life uses of the rivers. Many waterbodies in the AOC are also listed as impaired under the Clean Water Act because of phosphorous, total suspended solids (TSS), and bacteria pollution that exceed state criteria. Under federal law, TMDL studies are needed in order to determine the amount of a pollutant a waterbody can receive and still meet water quality standards. The TMDL also functions as a planning tool within the process of delisting impaired waters.

MMSD received GLRI grants from USEPA to complete third-party TMDL analyses on four water bodies in the Milwaukee River basin. The MMSD projects will focus on the Kinnickinnic, Menomonee, and Milwaukee Rivers and the Milwaukee Estuary. The Milwaukee River TMDL will focus on the reaches of that river that are included in the State's 303(d) Impaired Waters List. The project consultant will complete the final TMDL report by the end of 2012. The implementation plan is scheduled to be completed in September 2013. Meetings and workshops with stakeholders began in late 2011 and continued throughout 2012, and are expected to continue until the completion of the TMDL modeling effort in 2013.

The following is a list of the waters in the original AOC boundaries that are proposed for listing as impaired for the year 2012. The listing is for low dissolved oxygen attributed to phosphorus pollution:

- Last 2.8 river miles of the Kinnickinnic River
- Last 2.7 river miles of the Menomonee River
- Last 2.9 river miles of the Milwaukee River

The results from the TMDL study should be helpful in determining what progress can be made with regard to the issue of phosphorus loading in the estuary, and improving water quality. Once the TMDL has been completed and the implementation plan has been prepared, we will have a better idea if we will need to do anything further in order to remove this BUI.

Additionally, the River Alliance of Wisconsin and Milwaukee Riverkeeper received AOC funding in 2011 for a pilot volunteer phosphorus monitoring project. In 2011, 26 monitoring sites were established in the Menomonee, Kinnickinnic, and Milwaukee River watersheds. Most volunteers began to monitor in July and monitored monthly through October. Monitoring continued at those sites in May 2012 while, in addition, 26 new sites were established for a total of 52 monitoring sites. Currently, volunteers collect water samples to analyze total phosphorus levels at 6 sites in the Kinnickinnic River watershed, 15 sites

in the Menomonee River watershed, and 31 sites in the Milwaukee River watershed. The state's standard for total phosphorus provides a reference point for assessing the water quality of rivers and streams. The data collected for this project, from July 2011 and June 2012, shows that 80% of the 52 monitoring sites exceeded the phosphorus standard at least once. Two-thirds of the 52 sites exceeded the standard at least half the number of times each was monitored. And 35% of the 52 sites exceeded the standard every time they were monitored. Phosphorus data were in short supply on important tributary streams and in the more rural parts of the basin, and this project has helped fill some of the gaps. Milwaukee Riverkeeper has found resources to continue and expand this monitoring effort, and given all the activities that are currently happening in the Milwaukee River Basin, this project is in a good position to provide key information to stakeholders working to reduce eutrophication upstream of and inside the Milwaukee Estuary AOC.

Next action(s) needed

Nonpoint source pollution is a challenge to making progress on this impairment. Therefore, addressing nonpoint source pollution throughout the AOC watersheds is a priority issue for continuing to make progress in the estuary itself. Green infrastructure projects and implementation of other stormwater best management practice projects should be a priority to address this impairment.

The TMDL study, which includes an examination of phosphorus loading, is scheduled to be completed in 2013, at which point the following action will be necessary to address this impairment:

- Re-evaluate the chlorophyll-*a* portion of this target to determine if it is an appropriate measure.

Support for the TMDL implementation will also be critical, and specific actions will be identified in the TMDL implementation plan.

Issues (challenges, risks) affecting progress on this BUI

The physical conditions within the estuary itself have not changed, so despite the substantially decreased contributions of organic material from sewer overflows, meeting the designated fish and aquatic uses may still be difficult. Another challenge for addressing this impairment will be the contribution of orthophosphate to total phosphorus levels in waterbodies in the AOC. Some municipal water supplies in the AOC add orthophosphate as an anticorrosive agent. Under Wisconsin state statute and administrative code (Section 283.35, Wis. Stats. and Section NR 205.08, Wis. Adm. Code), this treated water is used in some non-process waters, (e.g., cooling systems) and directly discharged without having the orthophosphate removed. The orthophosphate increases the total phosphorus concentrations in waterbodies and can contribute to further algal growth. It is currently estimated that this contribution of phosphorus is quite significant in the AOC, but this will be examined in greater detail as part of the TMDL.

BEACH CLOSINGS/RECREATIONAL RESTRICTIONS

Target and Status

Updated Target	Status
This BUI will be considered removed when:	
• All known sources of bacterial contamination to the AOC and tributary watersheds have been identified and, if feasible, have been controlled or treated to reduce possible exposures; and	Action needed
• No unpermitted overflows (either from sanitary sewers or combined sewers) have occurred within the AOC during the previous five year period.	Unknown
• All municipalities within the AOC have adopted and are implementing storm water reduction programs including an illicit discharge elimination program; and	Complete
• No water bodies within the AOC are included on the list of impaired waters due to contamination with pathogens or chemicals having a public health concern (i.e., carcinogenic, mutagenic) in the most recent Wisconsin Impaired Waters list that is submitted to USEPA every two years; and	In progress *and* Action needed
• No local or state contact advisories related to the presence of a chemical contaminant have been issued within the AOC during the previous five years.	Unknown
• No water bodies (including beaches) within the AOC are included on the list of impaired waters for recreational restrictions in the most recent Wisconsin Impaired Waters list.	In progress, *and* Action needed
• Implementation of the Milwaukee River Total Maximum Daily Load Study for bacteria is complete.	In progress, *and* Action needed

Target Rationale

At the time the time that the targets were being proposed, there were several beaches listed for pathogens, and there had been problems in the recent past with pathogens at beaches. Bradford Beach was closed 28 days in 2006 and South Shore Beach was closed 43 days in 2006. Bradford, McKinley, and South Shore Beaches were listed on the Wisconsin Impaired Waters list because they were not meeting their full recreational uses due to bacterial contamination.

Since that time, conditions at several of the beaches have substantially improved, and for the 2010 impaired waters list, Wisconsin recommended delisting, or removing, Bradford and McKinley beaches from the impaired waters list for pathogens.

For 2012, there are proposed modifications to the targets for this impairment (refer to WDNR, 2011c, p. 37-38). The second bullet specifying that there should be no sanitary sewer overflows or unpermitted

combined sewer overflows for a less than 25-year rainfall event has been revised, since this language is inconsistent with WDNR's wastewater permitting language. Additionally, two items of the target relating to no water bodies or beaches in the AOC being listed for recreational restrictions have been combined into one target item. Additionally, a target item related to implementation of the TMDL for bacteria was necessary, since implementation of the TMDL should lead to removing the AOC waterbodies from the impaired waters list.

Since the Deep Tunnel system came online in 1994, the frequency of sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs) has decreased dramatically. Complicating matters is that water quality models have shown that 60-75% of the fecal coliform loads cannot be explained by nonpoint source runoff from rooftops, parking lots, streets, and other impervious surfaces (SEWRPC, 2008), especially for the Menomonee and KK Rivers. The Great Lakes Water Institute's preliminary data demonstrates that exfiltration (leaking) from failing sanitary sewer infrastructure is a major source of fecal indicator bacteria and pathogens in urban stormwater that impacts the AOC. This means that stormwater systems are acting as conduits for conveying sewage from failing infrastructure into surface waters used for drinking water and recreation. This sanitary waste poses a more direct threat to human health, since it is more likely to contain pathogens than urban stormwater runoff. This problem is particularly difficult to address because thousands of localized breeches within the sanitary sewage system are much more difficult to address than combined and sanitary sewage overflows, where sources and system capacities are well understood. Pathogen loading from non-point sources is quite high and must be addressed before state water quality standards for recreation can be met. This is why we are proposing that the TMDL be implemented first before BUI removal occurs. In order to implement the TMDL, there is a need to understand where sewage is getting into the AOC waterways. To this end, we have assembled a proposal to both help with TMDL implementation and BUI removal. This proposal can be found in Appendix G.

Although the 2008 targets address some aspects of source control, actions that will address the problems caused by bacteria loading need to be considered, e.g., excessive beach closures or recommended limits for body contact on AOC rivers attributed to high pathogen levels. This means that additional reductions through the abatement of non-point source loading of bacteria will be necessary in order to remove this impairment.

According to the current methodology in the Wisconsin Consolidated Assessment and Listing Methodology (WisCALM), waters can be listed as impaired for having contaminated sediments that would pose a risk to public welfare and safety (WDNR, 2011a, p. 55). While contaminated sediments are a problem in the AOC, high counts of pathogens are a more widespread recreational hazard.

Rationale for Listing

The 1991 RAP indicates that although there are no beaches within the river system, there are several public beaches within the Lake Michigan portion of the AOC that consistently do not meet water quality standards for recreation. Data from the lower river system also exceeds the state recreation standards. The 1994 RAP Update indicates that there were essentially no changes in the status of this BUI between the initial RAP document and the update. Beach closings and recreational restrictions was still considered an impaired beneficial use in the AOC. Potential sources of contamination are indicated as CSO events and both urban and rural stormwater. In the early 1990s, South Shore beach along Lake Michigan closed periodically, for 48 to 96 hours, when high bacteria counts occur after CSO events (WDNR, 1994, p. 2-19).

In summary, the waters of the AOC have frequently exceeded state water quality standards for recreation.

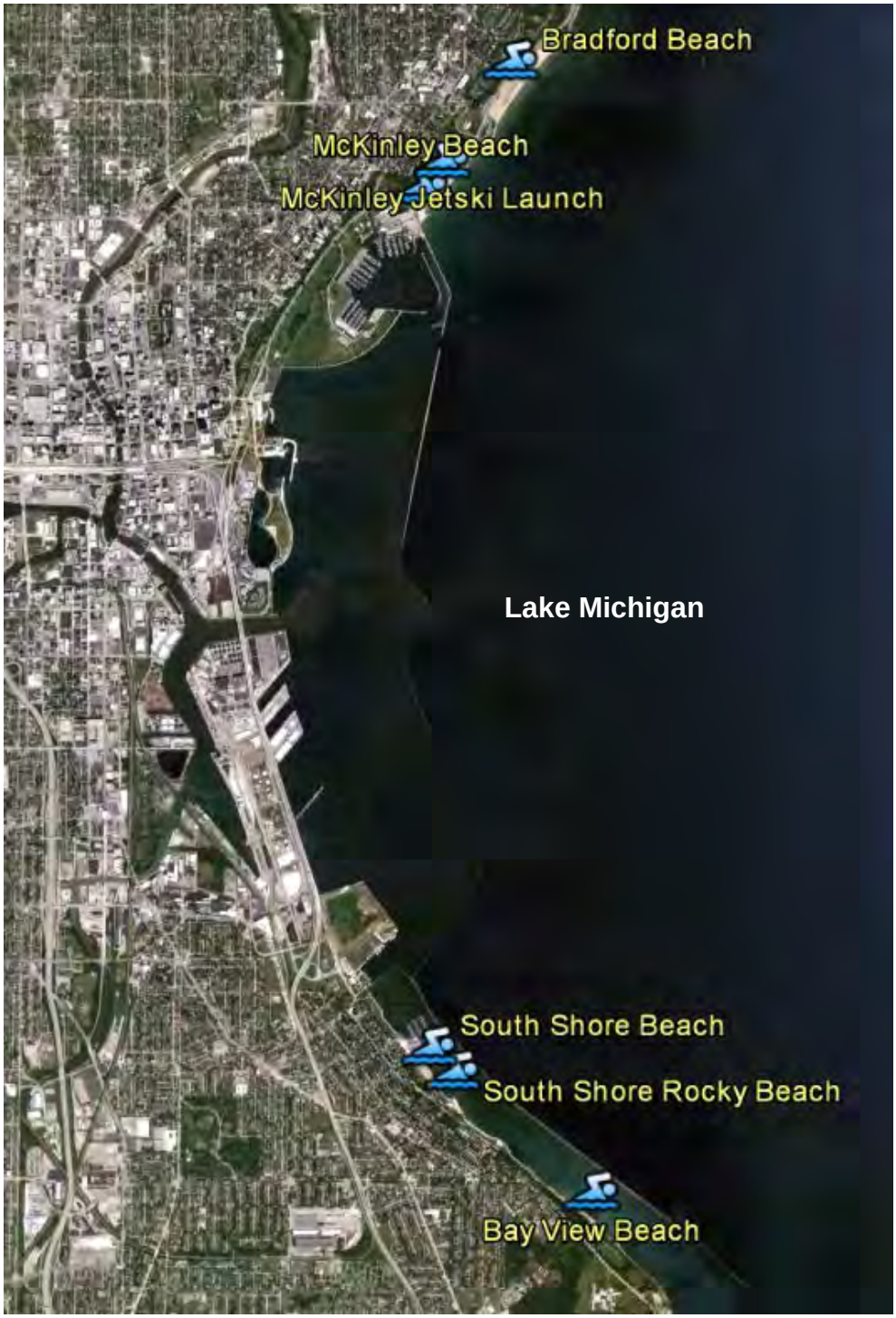

Figure 7. Beaches in the Milwaukee Estuary AOC.

Summary of Key Remedial Actions since the 2011 RAP Update and Current Status
There are six beaches within the AOC: Bradford Beach, McKinley Beach and Jet Ski Launch, South Shore Beach, South Shore Rocky Beach, and Bay View Beach (Figure 7). Conditions have improved greatly at McKinley and Bradford Beaches. Bradford Beach received Blue Wave Certification through the Clean Beach Council in 2009 (see the 2011 Draft Stage 2 RAP for the Milwaukee Estuary for more details).

While there have been successes with regard to beaches, South Shore Beach continues to be on the impaired waters list for bacteria due to its specific location. According to Sandra McLellan, a researcher with the UW-Milwaukee (UWM) Great Lakes WATER Institute, relocating South Shore Beach to the Rocky Beach location would contribute significantly toward achieving the goals for this BUI, since bacteria counts at the South Shore Rocky Beach are typically 10 times lower than those at South Shore Beach proper (2012, personal communication). Milwaukee County hired a contractor in 2012 to conduct a feasibility study to determine if moving the beach 100 yards to the south of its present location (the Rocky Beach location) would significantly improve water quality. JS article: http://www.jsonline.com/news/milwaukee/county-considers-moving-south-shore-beach-ja505iu-147414785.html. The results of the modeling done as part of the feasibility study suggested that moving the beach may only have a moderate effect on improving water quality. The county plans to share these results with the public before deciding how to move forward on the issue. In the interim, implementing some stormwater best management practices may help in addressing water quality at the current beach location. If the beach is moved, effective management of stormwater will be necessary in order to ensure that sources of pollution are controlled.

In addition to addressing beach issues in the AOC, however, the main impediment toward making progress on this impairment is that bacteria levels in the rivers themselves continue to be high and have, in many instances, actually increased (see next section for further details and recommendations).

In 2011 and 2012, Milwaukee Riverkeeper and UWM's Great Lakes WATER Institute received funds through an AOC support grant to analyze data for pathogen source identification. The analysis from this project will be combined with similar projects to determine areas where human waste is getting into storm sewers. These studies can then inform where the most significant sources of bacteria are originating and, where feasible, measures can be taken to reduce this especially harmful source of bacteria to the AOC waterways. The results from 2011 can be found in Appendix H.

Next action(s) needed
Early RAP documents (WDNR 1991, WDNR 1994) stated that the use was impaired because of high bacteria counts and sewer overflows in the AOC that caused beach closings and recreational hazards. While sewer overflows closed beaches in the AOC, high bacteria counts from urban nonpoint pollution throughout the AOC waterways often exceeded water quality standards for recreation. Since the early 1990s, sewer overflows have decreased substantially, largely as a consequence of the MMSD's Deep Tunnel system. Before the wastewater storage tunnel became available, rain storms caused more than 50 combined sanitary and storm sewer overflows each year to local rivers and Lake Michigan. Construction of the 19.4-mile-long original tunnel was completed in 1993 and its first full year of operation was 1994. Since the Deep Tunnel system came online, there has been an average of 2.5 overflows a year from 1994 through 2011.

Despite this substantial improvement in sewage treatment in the AOC, water quality standards for recreation are still regularly exceeded in the AOC, and pose a significant challenge to removing the beach closings and recreational restrictions impairment. The cause of these exceedances is largely attributed to

contamination of urban stormwater. High levels of fecal indicator bacteria have been found in urban stormwater discharges, and are the largest contributor to water quality impairments for bacteria in Milwaukee's urban rivers (SEWPRC, 2008). Complicating matters is that water quality models have shown that 60-75% of the fecal coliform loads cannot be explained by nonpoint source runoff from rooftops, parking lots, streets, and other impervious surfaces (SEWRPC, 2008), especially for the Menomonee and KK Rivers. The Great Lakes Water Institute's data demonstrates that exfiltration (leaking) from failing sanitary sewer infrastructure is a major source of fecal indicator bacteria and pathogens in urban stormwater that impacts the AOC. This means that stormwater systems are acting as conduits for conveying sewage from failing infrastructure into surface waters used for drinking water and recreation. This sanitary waste poses a more direct threat to human health, since it is more likely to contain pathogens than urban stormwater runoff. This problem is particularly difficult to address because thousands of localized breeches within the sanitary sewage system are much more difficult to address than combined and sanitary sewage overflows, where sources and system capacities are well understood.

We need to identify and quantify sanitary sewage contamination of stormwater in the AOC because doing so would provide a crucial, and currently missing, link in efficiently and effectively addressing the beach closings and recreational restrictions impairment.

The Milwaukee Estuary AOC and its constituent waterways are listed on Wisconsin's 303(d) list as impaired because they frequently do not meet the variance standard (1000 fecal coliforms/100 ml), much less the water quality standard (200 fecal coliforms/100 ml), for recreation. TMDL studies to address bacteria are underway for the three AOC tributaries and the estuary. The TMDL, however, focuses on using *E. coli* and fecal coliform bacteria indicators, which can come from a variety of sources. Some sources, namely sewage, pose a greater human health risk than other sources of fecal contamination because of extremely high concentrations of viruses, protozoa, and pathogenic bacteria associated with human waste. ***Identifying the source of contamination is integral to TMDL development because it allows for the prioritization of implementation strategies to target pathogens, which pose the greatest risk to human health.*** The risk to human health is the actual water quality impairment, and is the reason that recreation in the AOC is restricted. The lack of source information (e.g. human vs. nonhuman), therefore, hampers implementation plans that are intended to ultimately reduce pathogens and remove the recreational restrictions beneficial use impairment in the AOC.

We are requesting funding for a proposed project that would <u>fill critical data gaps</u> by identifying human versus nonhuman sources of stormwater contamination and estimating loads of sewage-derived pathogens for the two watersheds that contribute high loadings of human waste and pathogens into the AOC. The challenge is to identify, prioritize, and remediate failing sewer infrastructure systematically so that limited fiscal resources can be directed to the largest problem areas; a challenge this project would address. Specifically, the proposed project corrects the impediments to TMDL implementation by identifying the most critical infrastructure failures, and assisting decision-makers in determining their policy priorities for stormwater management and infrastructure investment. Based on source testing results, we will map and disseminate the locations of stormwater outfalls that are discharging sewage to the municipalities, so they can effectively direct their limited budgets toward projects that would make the greatest impact on improving water quality in the Milwaukee Estuary AOC, thus helping to bring the AOC into compliance with water quality standards.

In order to truly make effective and efficient progress in the AOC, the Identification and Quantification of Sanitary Sewage Contamination in the Milwaukee Estuary Area of Concern proposal (Appendix G) should be funded. This work will also allow for the successful implementation of the bacteria TMDL. Work to

address high bacterial levels at South Shore beach should continue. The following actions should be supported, as appropriate, through the AOC program:

- Fund the Identification and Quantification of Sanitary Sewage Contamination in the Milwaukee Estuary Area of Concern proposal.
- Control stormwater on South Shore Beach; explore other options for improving beach water quality (e.g., moving the beach).

Where feasible, actions should be taken to control sources of bacteria that cause recreational restrictions on AOC waters.

Issues (challenges, risks) affecting progress on this BUI

Bacterial levels will continue to increase as infrastructure ages and lateral sewer lines continue to fail, posing a significant obstacle toward making progress on the recreational restrictions portion of this impairment.

DEGRADATION OF AESTHETICS

Target and Status

Updated Target	Status
This delisting target is consistent with Chapter NR 102, Water Quality Standards for Surface Waters. Delisting shall occur when 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.	Assessment in progress
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.	Assessment in progress
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.	Assessment in progress
The following target will also be met to determine when restoration has occurred: Corrective action plans are in-place and being implemented for all known sources of materials contributing to the degradation of aesthetics within the AOC.	TBD

Target Rationale

The proposed target is consistent with existing state water quality standards, but because of its arbitrariness, we should evaluate with the Stakeholder Delegation whether a five year period is the appropriate amount of time necessary to determine when impairment removal can occur. .

Rationale for Listing

This beneficial use is considered impaired because of the poor visual quality of the water resources and adjacent land. The 1994 Milwaukee RAP attributed the likely cause of the impairment to surface water debris, oil and grease, and overdevelopment along the estuary. The likely sources of these causes include point source pollution, nonpoint source pollution, and litter.

After storms, considerable debris can be seen near almost every combined sewer overflow and storm sewer outfall. Floating litter significantly degrades aesthetic value and recreational enjoyment of our urban waterways. Floatable trash likely comes from many sources, including illegal dumping of trash into streams; littering into the drainage area of our rivers; ill-maintained dumpsters; improper streambank modifications; sanitary sewer overflows and combined sewer overflows; marine sources and recreational users; and, most importantly, from stormwater runoff.

Summary of Key Remedial Actions since the 2011 RAP Update and Current Status

In 2012, a Volunteer Aesthetics Monitoring program was piloted in the AOC. The model closely followed the one developed in Green Bay in 2011. The program utilized several partner organizations to help organize and train volunteers to have them monitor at 12 sites throughout the original boundaries of the AOC during the spring, summer, and fall seasons by different volunteers. Figure 8 shows the 2012

monitoring sites.

Benefits of this approach include expanding public participation in AOC activities, generating needed data at minimal cost, and incorporating public perceptions in evaluation of this BUI. The Urban Ecology Center and Alliance for the Great Lakes Adopt-a-Beach program assisted in developing the project and the initial volunteer base. Results will be incorporated into the BUI removal strategy for this BUI.

Next action(s) needed

Continue the aesthetics monitoring program to collect more data and determine what else must be done to address this BUI. In 2012, the Alliance for the Great Lakes and the Urban Ecology Center received AOC support funds to engage citizens in a pilot aesthetics monitoring program. Results of that monitoring program will be evaluated in early 2013.

Issues (challenges, risks) affecting progress on this BUI

The visual appearance and odor of the water were reasons that this impairment was listed. It is difficult to compare those properties to conditions today. For odor, in particular, there may not be much that can be done to control or eliminate sources.

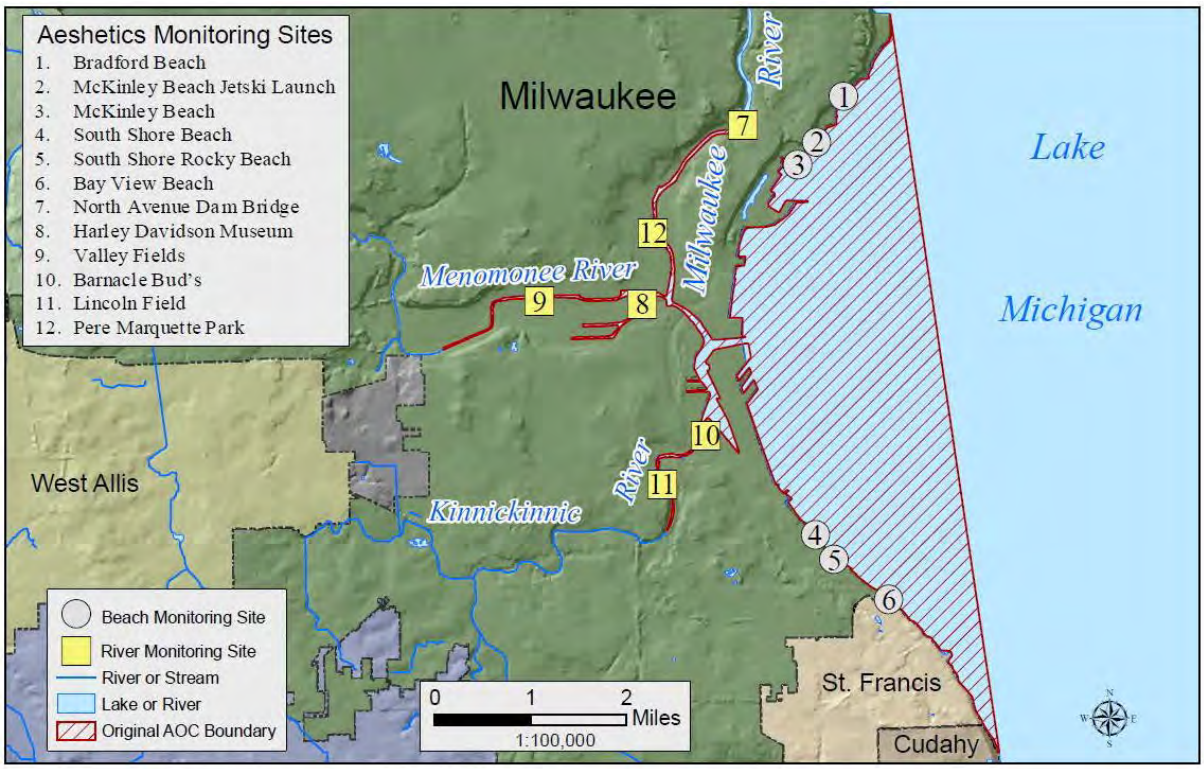

Figure 8. Aesthetics Monitoring Sites for 2012.

DEGRADED PHYTOPLANKTON AND ZOOPLANKTON POPULATIONS

Target and Status

Updated Target	Status
A stepped approach is needed for delisting for this impairment:	
1. The first step toward delisting will be to establish a baseline condition for the estuary to evaluate the extent of this impairment. Phytoplankton and zooplankton community surveys should be conducted and compared to a non-impacted or minimally impacted reference site to set the baseline condition. If the community structure is statistically different than the reference conditions, this BUI should be considered impaired.	Assessment in progress (2012-2013)
2. Identify the factors leading to this impairment. a) Ambient water chemistry sampling should be conducted to determine if nutrient enrichment is the main contributor. If nutrients are the main contributor, sources causing nutrient enrichment to the outer harbor and nearshore waters are identified and controlled. b) If nutrient enrichment is not considered the cause of the impairment, conduct bioassays to determine if ambient water toxicity is causing impairment.	TBD
3. The Milwaukee Estuary AOC is not listed as impaired due to phytoplankton and/or zooplankton toxicity in the most recent Wisconsin Impaired Waters list (submitted to USEPA every two years).	Not applicable, recommend removing this from the targets.

Target Rationale

Basic information regarding this impairment is lacking. Assessment is needed to verify the impairment before factors leading to the impairment can be identified.

The 1994 RAP indicated that this beneficial use was impaired because of the poor diversity of plankton, attributed to the eutrophic conditions and the increased conductivity in the estuary and Outer Harbor (WDNR, 1994, p. 2-20).

WDNR is proposing this year to remove the third item in the targets to reflect the current listing guidance for impaired waters in the state. As of the most current impaired waters guidance, there are no considerations for listing waterbodies as impaired due to plankton toxicity (WDNR, 2011a). Pending assessment of the plankton communities, we will then try to determine any causes of the impairment. Item two in the targets captures the necessity to look at both water chemistry and possible toxicity effects on plankton communities.

Rationale for Listing

This BUI is relevant to the Outer Harbor and nearshore Lake Michigan portions of the Milwaukee Estuary AOC. The 1994 RAP Update indicated that both phytoplankton and zooplankton populations within the Outer Harbor and near shore Lake Michigan are impaired. Like the eutrophication and undesirable algae BUI, these organisms are most affected by nutrient loading and dynamics in the estuary and lake.

According to the 1994 RAP, phytoplankton population data collected by MMSD in the Outer Harbor were representative of nutrient enriched (eutrophic) conditions. Nearshore phytoplankton assemblages had some tolerant organisms, but were more indicative of mesotrophic conditions. The data indicated that the three rivers draining to the Estuary have a significant influence on the phytoplankton community in the Outer Harbor. The nearshore waters in the AOC are also affected by the rivers, but to a lesser extent. Phytoplankton populations were noted to be affected by high nutrient loads to the rivers and harbor. An increase in species tolerant of eutrophic conditions indicated degraded water quality conditions.

Zooplankton populations were also affected. Studies in the 1980s done by MMSD found declining species richness, and dominance of pollution tolerant species in the outer harbor compared with the community structure of the open lake. Species abundance was greater in the Outer Harbor compared to the lake, which indicates nutrient enrichment (WDNR, 1994).

Summary of Key Remedial Actions since the 2011 RAP Update and Current Status

The MMSD had a phytoplankton and zooplankton monitoring program from 1979 to 1988, which provided the basis for listing this use as impaired. The program was suspended in 1988, and since that time there has not been consistent phytoplankton and zooplankton monitoring in the Estuary.

In 2012, USGS assessed plankton populations in the AOC and reference sites to provide necessary data so that we can decide how to move forward on this impairment. Locations were sampled throughout the state to see how the AOC sites compared to other similar areas that do not have the designation. Figure 6 on page 28 shows a map of the locations that were sampled for benthos and plankton communities as part of this study. Appendix F contains the proposal for the assessment.

Next action(s) needed

See above.

Issues (challenges, risks) affecting progress on this BUI

There is a lot of uncertainty about this impairment since we do not know much about the plankton communities in the AOC. It is likely that plankton communities have been affected by ecological changes in Lake Michigan, and actions carried out through the Lakewide Management Plan (LaMP) for Lake Michigan may be able to better address the root causes of degraded plankton communities.

LOSS OF FISH AND WILDLIFE HABITAT

Target and Status

Updated Target	Status
This BUI will be considered to be eligible for removal when the following have occurred:	
• All contaminated sediment hotspots within the AOC have been identified, and implementation actions to remediate contaminated sites have been completed.	In progress
• A local fish and wildlife management and rehabilitation plan has been compiled for the estuary that: o Defines the causes of all habitat impairments within the AOC o Establishes site-specific habitat and population targets for native indicator fish and wildlife species within the AOC o Identifies all fish and wildlife habitat rehabilitation programs/activities within the AOC and establishes a mechanism to assure coordination among all these programs/activities, including identification of lead agencies o Establishes a time table, funding mechanism, and lead agency or organization responsibility for all fish and wildlife habitat rehabilitation activities needed within the AOC.	In progress
• The programs and actions necessary to accomplish the recommendations of the fish and wildlife habitat plan are implemented, and modified as need to ensure continual improvement.	Action needed

Target Rationale

Contaminated sediments in the AOC must be addressed in order for this impairment to be removed. A plan also needs to be developed that will list measures of success, and focal species, and projects that will help address the physical habitat issues in the AOC.

Rationale for Listing

This beneficial use is considered impaired by the 1994 Milwaukee AOC RAP. The 1994 RAP cites urban development in areas adjacent to the estuary as having greatly diminished aquatic and wildlife habitat. Natural stream banks did not, and still do not, exist below the former North Avenue Dam on the Milwaukee River. Almost no natural areas exist on adjacent streambanks in the harbor or along the rivers. The rivers within the estuary have been heavily engineered for shipping and commerce, producing unnatural shorelines and a virtual “ecological desert” for many aquatic and semi-aquatic wildlife species. The habitat in the lower reaches of each of the watersheds draining into the Milwaukee Harbor estuary is typical of that found in a highly urbanized environment, with extensive channelization and placement of sheet piling for bank stabilization. From a water quality perspective, fish and aquatic habitat is impaired by excessive sedimentation (including contaminated sediments) and poor ambient water quality. Nutrient loading and low dissolved oxygen concentrations further degrade habitat available for fish forage and spawning. More natural habitat can be generally found in upstream areas of each of the major rivers. There is little cover for resident fish species, and few trees, shrubs and other vegetation to provide shade that could temper high water temperatures in summer months.

Loss of wildlife habitat was not considered impaired in the 1991 RAP because it was not considered to be caused by contamination, but by lack of physical habitat (WDNR, 1991, p. V-12). The 1994 RAP expanded the scope to include lack of physical habitat as an impairment. There is very little loafing and resting habitat for migratory waterfowl--it is not uncommon to see mallards and other ducks resting on submerged logs, and other floating debris as well as boats due to general lack of natural resting areas in our urban waterways (WDNR, 1994, p. 2-21).

The 1994 RAP added that the confined disposal facility (CDF) near Jones Island may be a source of contaminants for waterfowl. The CDF within the outer harbor provides sheltered water habitat and is used for loafing and forage by many migratory and resident duck species and geese. A sentinel duck study was conducted in the summer of 1990 to determine if waterfowl were accumulating contaminants from the Milwaukee CDF. The study concluded that ducks released into the CDF did not accumulate significant concentrations of contaminants compared to field and background levels (WDNR, 1994, p. 2-16). This may be due to the fact that the most contaminated sediments within the CDF were originally deposited in the 1970s and are buried to the extent that they are no longer available to wildlife.

More recent studies documented substantial losses of species richness in Milwaukee County in other wildlife, with declines of 20-70% for bird, amphibian and reptile groups, resulting mainly from habitat loss (Chapters 20 and 25 in D. Waller and T. Rooney (eds), *The Vanishing Present: Wisconsin's Changing Lands, Waters, and Wildlife*, The University of Chicago Press. 507pp.). Habitat restorations within the AOC will be key to addressing these more regional losses.

Summary of Key Remedial Actions since the 2011 RAP Update and Current Status

In 2012, the City of Milwaukee embarked on a project to restore the Grand Trunk Wetland on Port of Milwaukee property (Figure 5, p. 19). This wetland restoration is a unique opportunity to restore approximately 8 acres of wetland, and represents just a very small fraction of the total wetlands that have been lost in the Estuary. The City Department of Community Development was successful in obtaining two grants for the project, one from the WI Coastal Zone Management Program, and another grant from the Fund for Lake Michigan. The project is still in its early stages, and the wetland restoration project team is negotiating with the Port of Milwaukee and its lessee, Gillen Foundations to ensure that the wetland restoration and Gillen's expansion are both successful.

In 2012, the Urban Ecology Center, the Menomonee Valley Partners, in partnership with the State of Wisconsin, broke ground for a large project in the Menomonee Valley known as the "Airline Yards." Among other benefits, this project includes stabilizing shoreline and rehabilitating habitat along the Menomonee River.

Many partners in the AOC have developed plans that can be drawn from to determine the actions that are a priority to address this BUI. (Please see the References section for a list of resources related specifically to the fish- and wildlife-related impairments.) In 2012, WDNR assembled a team of fish and wildlife experts and began facilitating a process to determine measures of success, develop scopes of work for necessary assessments, and identify interim habitat projects that would help address the degraded physical habitat in the AOC. Proposals for separate fish and wildlife assessments in the AOC can be found in Appendix A. The work of the fish and wildlife technical team will be assembled into a Habitat Plan for the AOC. <u>Being able to define the causes of all population impairments is contingent upon completion of the assessments.</u>

In 2011, a monitoring project, funded through AOC support funds administered by WDNR, assessed habitat in the Little Menomonee River. This work closely follows the remediation of contaminated

sediments at the Moss-American Superfund site that was completed in December 2009. A report from this monitoring project was completed in 2012. The information and methods outlined in the report were used for the development of the wildlife assessment proposal (see Appendix A), and the recommendations within the report for habitat work are being reviewed along with other potential habitat projects by the rest of the tech team. The list of interim habitat projects that have been identified at this time are listed in the "Next actions needed section."

Next action(s) needed

While not all habitat projects have been identified at this time, the fish and wildlife technical team was able to identify a list of interim habitat goals (Appendix B). Each of these goals addresses a critical aspect of physical habitat in the AOC. We will continue working with stakeholders to determine which additional goals and measures of success are desirable and achievable for this impairment.

Using the interim habitat goals as a guide, we also were able to develop an interim list of habitat projects that needs to be completed if the habitat impairment can be removed. Each of the interim habitat projects addresses at least one of the habitat goals. Additionally, for each goal, appropriate measures of success are also listed for each project to help measure progress toward removing the impairment.

Candidates for interim physical habitat projects are listed here because they generally met several key criteria:

- By helping to accomplish at least one of the interim physical habitat goals, they would substantively help improve physical habitat in the AOC,
- They have a discrete area/geographic location associated with them,
- They have a cooperative landowner (typically public ownership),
- And they potentially have a willing and interested implementer to spearhead the work.

Interim physical habitat goals:

1. Enhance/improve aquatic habitat.
    a. Identify and enhance fish spawning sites from Lake Michigan to the tributaries and headwaters where opportunities exist (e.g., Inner and Outer Harbors, Milwaukee River downstream of the North Ave. Dam pedestrian bridge).
    b. Insert value-added habitat projects where possible with Kinnickinnic River Concrete Removal.
    c. Reconnect [x amount] of high quality habitat downstream of the Bridge Street Dam and Lepper Dam to the main stem rivers of the AOC.
2. Improve aquatic habitat connectivity.
    a. Improve linear connectivity by restoring or enhancing fish and aquatic organism passage from Lake Michigan to the tributaries and headwaters.
    b. Improve lateral connectivity by connecting aquatic habitat to floodplain wetland with suitable hydroperiod, whenever possible.
3. Moderate flow regimes to decrease flashiness.
4. Provide and preserve sufficient baseflow.
5. Enhance/improve terrestrial, semi-aquatic, and/or riparian habitat.
    a. Expand habitat buffer width to a minimum of 75 feet.
    b. Where possible, expand buffer 400 feet to 1,000 feet to meet core or habitat area needs.
    c. Expand species of local conservation interest habitat.
    d. Construct ephemeral wetlands where feasible and where optimally beneficial, addressing target species' critical habitat needs (TBD through wildlife assessment), relevant biological and human constraints, and with metrics for monitoring success (i.e., increases in species richness on a landscape).
    e. Identify and enhance existing and potentially restorable habitat areas through fish and wildlife assessments, whenever possible. (For portions of the Little Menomonee River

and some county park lands, this process is already underway from a 2011 wildlife habitat assessment and natural area plans being developed by Milwaukee County Parks.)

6. Improve terrestrial riparian habitat connectivity.
    a. Expand riparian buffer habitat continuity.
7. Protect high-quality areas or environmentally sensitive lands, especially those supporting rare and protected species.

Table 3 lists interim habitat projects for the AOC, including measures of success that each project would help address.

Table 3. Milwaukee Estuary Interim Fish and Wildlife Habitat Projects.

Project name	Landowner/s	Potential implementer/project overseer	Estimated uncovered cost	Interim habitat goals project addresses	Potential measure of success
Grand Trunk Wetland Restoration	City/Port of Milwaukee	City of Milwaukee	$125,000	1a, 2a, 5d	Number of structures removed/retrofitted; area of native wetland or upland constructed
*Burnham Canal Wetland Restoration (Phases 1 and 2)	Miller Compressing & City of Milwaukee	MMSD	$3,200,000	5a, 5e	Area of native wetland or upland constructed/rehabilitated
*Wheelhouse Gateway Riparian Restoration	River Revitalization Foundation (RRF)	RRF	$268,000	5a, 5e, 6	Stream length of continuous buffer widths of 75' or greater preserved or established; area of land protected
Menomonee River Concrete Removal	Milwaukee Co.	MMSD	$3,000,000	1, 2a, 2b, 3	Length of river/stream connected and functional as fish and aquatic organism habitat; stream length of concrete removed
Removal of Five Low-Flow Barriers on the Menomonee River	MMSD and Milwaukee Co.	MMSD	$450,000	1, 2a, 2b	Length of river/stream connected and functional as fish and aquatic organism habitat; number of structures removed/retrofitted
*Little Menomonee River, Little Menomonee Creek, and/or Menomonee River Floodplain Reconnection	Milwaukee Co.	?	TBD	2b, 3	Area of native wetland or upland constructed/rehabilitated
*Little Menomonee Parkway Grassland Restoration	Milwaukee Co.	Milwaukee Co. Parks	$30,000	5a, 5b, 5e	Area of native wetland or upland constructed/rehabilitated; stream length of buffer width 75 feet or greater preserved or established
Concrete Removal on the Underwood Creek	Milwaukee Co.	MMSD	$2,000,000	1, 2	Length of river/stream connected and functional as fish and aquatic organism habitat; stream length of concrete removed

Project name	Landowner/s	Potential implementer/project overseer	Estimated uncovered cost	Interim habitat goals project addresses	Potential measure of success
Kletzsch Dam Fish Passage	Milwaukee Co./private	?	TBD	1, 2	Length of river/stream connected and functional as fish and aquatic organism habitat; stream length of concrete removed; number of structures removed/retrofitted
Estabrook Dam Fish Passage	Milwaukee Co.	Milwaukee Co.?	TBD	1, 2a	Length of river/stream connected and functional as fish and aquatic organism habitat; stream length of concrete removed; number of structures removed/retrofitted
*Soil Remediation/Floodplain Lowering at Former North Ave Dam Impoundment	City of Milwaukee	City of Milwaukee?	TBD	2b, 5a, 6	Area of native wetland or upland constructed/rehabilitated
*KK River Dredging From Becher St. to Chase Ave.	City of Milwaukee	MMSD	TBD	1a, 2a	Length of river/stream connected and functional as fish and aquatic organism habitat
Ulao Creek Fish Passage Restoration	Multiple private, with prior agreement	Ozaukee County	$1,900,000	1, 2	Length of river/stream functional as fish and aquatic organism habitat
Fish Passage and Habitat Enhancement (aka “Rock Ramps”) at the Former North Avenue Dam Impoundment	City of Milwaukee	City of Milwaukee?	TBD	1a, 2a	Length of river/stream connected and functional as fish and aquatic organism habitat

* Project also has potential for water quality/contaminant load reduction benefit.

Securing funding for the assessment proposals is absolutely necessary so that we can determine which other management actions are necessary, and identify wildlife species of local conservation interest for the AOC.

Issues (challenges, risks) affecting progress on this BUI

Answering the question of when do we know we have created/enhanced enough habitat will be challenging to determine, but will be possible once we have the results of the fish and wildlife assessments. Actions to address the habitat needs of local fish and wildlife populations may need to take into account connected habitat areas somewhat beyond the AOC boundary, which contribute to habitat quality within the AOC. For example, restoring hydrologic connections between wetlands and the AOC may depend on implementing projects not only within the original AOC boundaries but outside the AOC as well. Greater improvements in water quality in the AOC may be best and/or most effectively achieved by implementing projects in the upstream watersheds of the Menomonee, Milwaukee, and Kinnickinnic Rivers. Finally, the continued influx of invasive species may make any habitat goals difficult to maintain in the long term and will be addressed in sustainability assessments.

CONCLUSION

Working with the stakeholders and project partners will be critical to securing support for projects and making overall progress in the AOC. Several key partnerships have been developed through the program, and with the GLRI, a lot of data have been collected around the Great Lakes that pertain to different BUIs. These partnerships help ensure efficiency in the AOC program, both in the state of Wisconsin and throughout the Great Lakes.

Although progress has been made in the AOC, there are still several key actions that need to continue or occur in order to address the impairments. First, the assessment and remediation of contaminated sites is necessary in order to address many of the impairments. Several sites to date have been addressed, but other parts of the AOC need to be characterized and addressed before contamination-related issues in the AOC no longer pose a substantial threat to fish and aquatic life in the AOC.

Second, the TMDL must be completed and implemented so that issues related to eutrophication, body contact, beach closings, and habitat (as a result of high sediment loads) are no longer impacting the AOC. Source identification of bacteria will also be necessary to fully implement the TMDL for bacteria so that projects related to bacteria loading in the AOC are done in an efficient manner that will truly reduce human health risks related to recreation in the AOC.

Additionally, we need to continue monitoring aesthetics in the AOC in through at least 2013. The project data, monitoring forms, and sites will be re-evaluated to see if there are any necessary improvements for moving into 2013. Securing an overall project coordinator will also be necessary for 2013.

The fish and wildlife technical team will continue to meet and make progress on identifying necessary actions for the fish and wildlife impairments, and will continue to provide input for any fish and wildlife assessments.

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APPENDICES

Appendix A	Fish and Wildlife Population Assessment Proposals
Appendix B	Goals and Measures of Success for Fish and Wildlife in the Milwaukee Estuary AOC
Appendix C	Education, Information, and Outreach Campaign Tracking
Appendix D	Milwaukee Estuary Wildlife Consumption Advisory Evaluation Proposal
Appendix E	Milwaukee Estuary Fish Tumor Evaluation Proposal
Appendix F	Benthos and Plankton BUIs Evaluation in Wisconsin's Lake Michigan Areas of Concern Proposal
Appendix G	Identification and Quantification of Sanitary Sewage Contamination in the Milwaukee Estuary Area of Concern
Appendix H	Results from 2011 Bacteria Source Tracking
Appendix I	BUI Tracking Matrix

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Appendix A

Fish and Wildlife Population Assessment Proposals

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Project Title: Milwaukee Estuary Area of Concern Fish Population Assessment

Project Location: Milwaukee Harbor, Milwaukee River, Kinnickinnic River, and the Menomonee River.

Problem Statement:

Relevance: The Milwaukee Estuary Area of Concern Beneficial Use Impairment "Degraded Fish and Wildlife Populations" was identified by the International Joint Commission in 1987. A comprehensive survey of relative population abundance of native species compared to abundances prior to 1987 will provide an understanding of the degree of improvement in fish populations. In addition, surveys will allow consideration of potential removal of this beneficial use impairment or, in the case that it is determined that conditions are not sufficient for its removal, the surveys will aid in targeting locations and species for future restoration work. Ideally, an increase of all native fish populations would be evident. However, declines (or even increases) in the populations of some native fish species may be due to conditions external to the AOC. Therefore, identification of native fish species most indicative of improvements in the AOC will be advantageous.

This BUI will be considered to be eligible for removal when the following have occurred:

- All contaminated sediment hotspots within the AOC have been identified, and implementation actions to remediate contaminated sites have been completed.

-A local fish and wildlife management and rehabilitation plan has been compiled for the estuary that:

- Defines the causes of all population impairments within the AOC
- Establishes site specific local population targets for native indicator fish and wildlife species within the AOC
- Identifies all fish and wildlife population rehabilitation programs/activities within the AOC and establishes a mechanism to assure coordination among all these programs/activities, including identification of lead and coordinative agencies
- Establishes a time table, funding mechanism, and lead agency or organization responsibility for all fish and wildlife population activities needed within the AOC.
- The actions/projects necessary to accomplish the recommendations of the fish and wildlife management and restoration plan are implemented.

-Populations for native indicator fish species are statistically similar to populations in reference sites with similar habitat but little to no contamination.

For the purposes of removal of this beneficial use impairment, specific native indicator species will include northern pike, greater redhorse, lake sturgeon, and walleye. Since fish population levels present in 1987 (when the BUI was designated) were unacceptable, we will consider a 100% increase of relative density (as measured by survey wide catch per effort in Holey 1984) of these four species as central to consideration of BUI removal,

except in the case of lake sturgeon. Lake sturgeon were not captured in the original survey so their presence in the proposed survey will be evidence of population increase.

Although these four species are thought to be broadly representative of fish of life histories and morphometry of various fish species, the direct correlation of their population success to those of other fish populations is not defined. As such, we also rely on two other measures of relative fish population abundance to consider removal of this BUI. As a very conservative baseline we will also require an increase in relative density of 95% of the other native species captured in the original 1983 study, regardless of magnitude. However, the possibility exists that native fish species not present in the 1983 survey may appear in the currently proposed sampling effort. In this case, these species may be included in the "95% of the other native species" target. In other words, the presence of a native species in the proposed survey that did not exist in the 1983 can be substituted for a species that was sampled in 1983 but showed stable or declining relative abundance. For example, if the relative abundance of lake whitefish (present in the 1983 survey) declined but a longear sunfish (not present in the 1983 survey) was documented in the proposed survey, longear sunfish could "substitute" for lake whitefish with regard to evaluating the "95% of other native species" target. Stocked fish will not be included in relative abundance estimates unless their year of capture is at least one year removed from the associated stocking event. In 2013 (or 2014, depending on funding), we propose to evaluate the list of originally captured native fish species to refine the list of species and acceptable increases in relatively density based on life history, ecology, and utilization of the AOC proper. Likely mechanisms of population level increases or decreases external to the AOC will be documented. The results of this evaluation will likely result in a less conservative but more precise targets with regard to species and relative densities.

While these two measures (focal species and all native species) provide an opportunity to examine relative population density in a temporal context, a spatial comparison to reference site is also necessary. To compare the Milwaukee AOC fish populations of native indicator species to reference sites we will rely on large river IBI scores. Large-river IBI scores (Lyons et al. 2001) are constructed, by definition, to represent the range of values present in similar communities (i.e., reference sites). We will have relatively intense characterization of IBI scores within the AOC in a given year (11 sites) and also between years (3 years). An overall mean value from all IBI sampling efforts of "fair" or better (i.e., 40-69) will be considered adequate for removal of this BUI.

The methodology above focuses on the relative abundance of fish populations within the estuary area of the Milwaukee Estuary AOC. The status of fish population within the expanded AOC boundary are not necessarily reflected by the proposed methodology. Fish populations are expected to be considerably more robust within the expanded AOC boundary. However, to ensure that this circumstance is supported, we propose a review of existing fish population data for fish-based IBI scores within the expanded AOC as part of the individual species evaluation. We will consider a mean value of "Fair" from at least 5 appropriate IBI scores that occur in at least 3 separate years to be evidence that fish populations are not substantially impaired within the expanded AOC boundary.

Objectives: Determine the current status of populations of native fish species relative to their status that led to the inclusion of the "degraded fish and wildlife populations"

beneficial use impairment for the Milwaukee Estuary Area of Concern as outlined in Holey (1984).

Rationale: Improvements that benefit fish populations have been made in the Milwaukee Estuary Area of Concern since its designation by the International Joint Commission in 1987. In particular, the completion of the Deep Tunnel project has dramatically decreased the incidence of combined sewer overflows. Understanding the response of fish populations to the Deep Tunnel construction as well as other improvements necessitates a representative survey.

Proposed Work: Replicate monthly fyke netting and electrofishing portions of fish population monitoring completed just prior to AOC designation following Holey (1984). Total catch per effort from fyke nets and electrofishing will be used to evaluate population level recovery. Nonwadeable river indices of biotic integrity will be calculated and evaluated in order to validate relative population abundances of native fish species. Since all environmental metrics have inherent temporal variance, we will continue with electrofishing surveys for an additional two years. In addition, concurrent but separate work will occur in 2014 to refine the species of interest and acceptable increases in relative densities of native fish species.

Collaboration with partners: This proposal was developed with input from the Milwaukee Estuary Fish and Wildlife Technical Team, which includes representatives from a variety of state, local, and federal agencies and nonprofit organizations. The Technical Team has endorsed this proposal and the provisions therein.

Deliverables and Timetable: Sample collection: March 2014-October 2017 (work could begin in 2013 depending on timing of grant award). Data summary and : January 2014-November 2014. Effort: 5 electrofishing efforts x 11 sites (Years 1, 2, and 3), 10 fykenetting efforts x 21 sites (Year 1 only). Index of Biotic Integrity Scores will be available as a result of the electrofishing efforts.

Project Budget:

Year 1

- Surveys: 3 weeks per month, 3 person crew $7500 /week, 5 months =$112,500
- Equipment: 10 fyke nets ($1,000 ea) = $10,000
- Data management: $2000
- Fish species population target refinement = $25,000

Year 2

-Surveys: 1.5 weeks per month, 3 person crew $7500/week, 5 months = $56,250

Year 3

--Surveys: 1.5 weeks per month, 3 person crew $7500/week, 5 months = $56,250

Total: $262,000

Project Duration: January 2014-June 2017.

References

Holey, M.E. 1984. Milwaukee Harbor estuary fish survey and toxic substance evaluation 1983. Wisconsin Department of Natural Resources, 600 E. Greenfield Avenue, Milwaukee WI 53204.

Lyons, J., R.R. Piette, and K.W. Niermeyer. 2001. Development, validation, and application of a fish-based index of biotic integrity for Wisconsin's large warmwater rivers. Transactions of the American Fisheries Society 130: 1077-1094.

Appendix B

Goals and Measures of Success for Fish and Wildlife in the Milwaukee Estuary AOC

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Goals and Measures of Success for Fish and Wildlife for the Milwaukee Estuary AOC

I. In-stream-based Measures

A. Fish Habitat Goal: Restore fish and aquatic organism passage from Lake Michigan to the headwaters and tributaries.

- Potential measures of success
  - Stream-miles of concrete removed (habitat)
  - Number of native species present or some equivalent biological indicator (e.g, native species richness, Index of Biotic Integrity, etc.) (populations)
  - Number of impediments removed and/or retrofitted (e.g., bridge crossings or drop structures) (habitat)
  - Stream-miles of enclosed channel daylighted or retrofitted, number of tributary miles connected to mainstem, or miles of stream channel restored (habitat)

B. Fish Habitat Goal: Restore or enhance fish and aquatic organism habitat from Lake Michigan to the headwaters and tributaries.

Objective 1: Enhance fisheries spawning sites in the Inner and Outer Harbors.

Objective 2: Insert Value-Added Habitat Projects as Possible with KK Concrete Removal (6th-43rd).

Objective 3: Reconnect [x amount] of high quality habitat downstream of the Bridge Street Dam and Lepper Dam to the main stem rivers of the AOC.

- Potential measures of success
  - Stream-miles of habitat protected and/or created (habitat)
  - Number of stream miles connected and functional as fish and aquatic organism habitat (habitat)
  - Number of native species present or some equivalent biological indicator (populations)
  - Area of adjacent floodplain reconnected for the 2-yr and 5-yr events (habitat)
  - Area of adjacent wetlands reconnected and/or restored/created (habitat)
  - Area of adjacent potentially restorable wetlands reconnected, as applicable (habitat)

C. Fish Population Goal: Restore a sustainable fishery for warmwater, coolwater, coldwater, and intermittent stream communities, as appropriate.

- Potential measures of success (all populations)
  - Number/proportion, type, and life stages of native species observed
  - Area cleared or tons removed of nonnative species
  - Total abundance
  - Shannon's diversity index

- Index of Biological Integrity (IBI) for various temperature and flow regimes (e.g., warmwater, coldwater, intermittent).
- Number and proportion of species intolerant to pollution
- Number and proportion of species tolerant to pollution
- Cool and warmwater transitional fish species

➢ Potential Umbrella Fish Species (all populations)

- Lake Sturgeon (Was extirpated and currently undergoing re-establishment; good long-term goal species representing connection between Lake Michigan and upstream mainstem of the Milwaukee River; benthic feeder, so also good candidate for achievement of sediment toxicity remediation; main stem river spawner, good candidate for assessing access to high quality main stem habitat, susceptible to impediments.)
- Northern Pike (Coolwater species; poor swimmer = good candidate for connectedness assessment, susceptible to impediments, particularly within and among headwater tributaries and wetlands; wetland spawner, especially good candidate for stream connectedness with riparian land, i.e., buffers.)
- Greater Redhorse (Threatened species; intolerant; benthic feeder = good candidate for water quality achievements and achievement of sediment toxicity remediation; main stem river spawner, susceptible to impediments = good candidate for assessing access to high quality main stem habitat.)

➢ Restoration of Fish Diversity

- Increases in native species richness (populations)

D. Non-fish Biodiversity Goal: Identify and enhance non-fish aquatic organism habitat from Lake Michigan to the headwaters and tributaries.

Objective 1: Identify non-fish aquatic organism status through surveys and conservation assessments (i.e., turtles, amphibians, mussels, odonates, crayfishes, aquatic plants, etc.)

Objective 2: Restore non-fish aquatic biodiversity where opportunities exist.

➢ Potential measures of success

- Number of existing critical habitat areas identified and protected, enhanced, reconnected, or re-created (habitat)
- Number of native species present or some equivalent biological indicator (populations)
- Number of species of local conservation interest (SLCIs) restored or enhanced (populations)
- Increase in species richness (populations)

II. Land-Based Measures

A. Wildlife Habitat Area Goal: Expand riparian buffer width to a minimum of 75 feet; where possible, expand buffer 400 feet to 1,000 feet to meet core or habitat area needs.

- **Potential Measures of Success**
  - Stream-miles inventoried and area of potential suitable buffer habitat identified (habitat)
  - Stream-miles with suitable buffer habitat width of 75 feet or greater preserved or established (habitat)
  - Volume of historic fill and/or tons of trash removed from riparian areas (habitat)
  - Area of native wetland or upland suitable habitat reconstructed (habitat)
  - Area of Advanced Identification of Wetland Disposal Areas (ADID wetlands), upland within PEC, and/or 100-yr floodplain limits protected (habitat)
  - Number of native species restored (populations)
  - Area of exotic invasive species removed (habitat)

B. Wildlife Habitat Connectivity Goal: Expand riparian buffer continuity (connectedness).

- **Potential Measures of Success**
  - Stream-miles of continuous suitable buffer habitat widths of 75 feet or greater preserved or established (habitat)
  - Number of riparian area crossings and/or impediments removed and/or retrofitted to improve or restore continuity of riparian buffers, including improvements to decrease resistance to animal movements (habitat)
  - Increase in suitable habitat patch size resulting from new connectivity (habitat)

C. Wildlife Habitat Goal: Protect high-quality areas or environmentally sensitive lands.

- **Potential Measures of Success**
  - Stream-miles inventoried and area of potential buffer identified. (habitat)
  - Stream-miles or area of land protected (habitat)

D. Terrestrial and Semi-aquatic Biodiversity Goal: Identify and restore or enhance terrestrial and semi-aquatic organism habitat in the AOC.

Objective 1: Identify terrestrial and semi-aquatic organism status through surveys and conservation assessments (i.e., birds, mammals. reptiles, amphibians, insects, crayfishes, etc.). (populations)

Objective 2: Restoration of terrestrial and semi-aquatic biodiversity (populations)

- Potential measures of success
  - Areas of existing critical habitat areas identified and protected, enhanced or mitigated (i.e., den sites, breeding sites, foraging sites, minimum viable habitat patch size areas, etc.) (habitat)
  - Number of SLCIs identified as potentially sustainable in the AOC. (populations)
  - Additional areas of new critical habitat restored or created in the AOC. (habitat)
  - Number of native species present or some equivalent biological indicator (populations)
  - Number of SLCIs restored or enhanced in the AOC (populations)
  - Increases in species richness or populations achieved in the AOC (populations)

E. Hydrology Goal: Moderate flow regimes to decrease flashiness.

- **Potential Measures of Success**
  - Numbers of detention and infiltration basins installed, drainage area controlled by regenerative stormwater practices that achieve quality and quantity control, area of permeable paving materials installed, acres of wetland and upland restored, area of low-impact development
  - Number of rain gardens or rain barrels installed and downspouts disconnected, green roofs installed
  - Drainage area controlled by regenerative stormwater practices that achieve quality and quantity control and numbers of basins inspected and maintained (%TSS reduction as indicated by WinSLAMM analysis after improvements implemented)
  - Miles of stream connected with the floodplain
  - Decreases in average flow magnitude, high flow magnitude, high flow event frequency, and/or high flow duration
  - Improvement in flashiness index

F. Hydrology Goal: Provide and preserve sufficient baseflow.

- **Potential Measures of Success**
  - Area of groundwater recharge protected
  - Improvement in flashiness index
  - Number of flow deflectors installed, pipes cut back from streambank, or land area treated by infiltration practices

Appendix C

Education, Information, and Outreach Campaign Tracking

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Milwaukee Estuary AOC

Education, Information & Outreach Campaign

To raise awareness of the projects, messages and actions/cooperation needed associated with the Milwaukee Area of Concern; keep the local community of partners, residents, businesses and tourists updated on and supportive of projects

2012-2013

	Campaign components shaded purple below are those in which the Delegation is currently involved.					
	Campaign components shaded green below are those in which Delegate involvement is possible.					
	Public Outreach Development Subcommittee Items					
Media	Target Audience	Messages	Implementer(s)	Collaborators	Funded by	BUI
HUB 3-D Exhibit [(1)]	Outreach Venue Audiences of conferences, meetings, festivals	Habitat Baskets provide food and shelter for migrating fish to and from Lake Michigan	GWM	Groundwork Milwaukee, Various Project Partners	GLRI	2, 3, 4
25 Interpretive Signs for *Gateway to Improved Long-term Spawning* project (2)	Boaters, residents, river walk users, tourists, businesses	Habitat Baskets provide food and shelter for migrating fish to and from Lake Michigan	UWEX	Groundwork Milwaukee, Various Project Partners	GWM – GLRI, FFLM, MMSD	2, 3, 4
Live View Telescope of Habitat Underwater Baskets	Harley Davidson Museum Visitor, Riverwalk users, community, tourists, etc.	HUB & River Critter viewing	Harley Davidson	Groundwork Milwaukee, GILS Outreach Advisory Team	GWM-GLRI	3, 4
GILS Presentations	Various meeting & event participants	Background info and status of evaluation of GILS Project	GWM	UWEX & GILS Outreach Advisory Team	GWM-GLRI	2, 3, 4
Adopt a HUB Program	Businesses along the River initially, other interested businesses, foundations,	Sponsor a GILS Interpretive Sign	Groundwork Milwaukee, UWEX	GILS Outreach Advisory Team	GWM-GLRI	3, 4

1- Degradation of Benthos; 2- Degradation of Phytoplankton and Zooplankton Populations; 3-Loss of Fish and Wildlife Habitat; 4- Degradation of Fish and Wildlife Populations; 5- Restrictions on Fish and Wildlife Consumption; 6-Restrictions on Dredging Activity; 7-Fish Tumors or Other Deformities; 8-Beach Closings; 9-Degradation of Aesthetics; 10- Eutrophication or Undesirable Algae; 11-Bird or Animal Deformities or Reproduction Problems

	funding agencies					
Interpretive Expeditions – canoe, kayak & hikes, snowshoe hikes, etc… 28 for 120 hrs. from May 2012 thru May 2013 UWEX – misc. opportunities	General Public & SIG	Awareness of issues on specific reaches of the rivers in the Area of Concern. Messages vary based on the location of the program. Chronicle the Milwaukee Estuary Area of Concern.	Urban Ecology Center, UWEX	UWEX, WDNR	WDNR/GLRI	All
Events exhibits (Gathering Waters/Urban Island Beach Party, Sturgeon Fest, UEC Fall Festival, etc.)	Event participants	Overview of the Milwaukee Estuary Sediment Cleanups and post-cleanup rehabilitation projects, How YOU can get involved.	UWEX	WDNR	UWEX-WDNR	All
Boat and Canoe Trips with Interpretation (one with historian John Gurda)	Stakeholder Delegation	Complexity of the AOC Program, History of the AOC, Current Projects and how they address the issues	Urban Ecology Center	UWEX, WDNR	WDNR/GLRI	All – focus on 3 & 9
Baseline Habitat Assessment Workshop	Stakeholder Delegation	How to perform a baseline assessment as part of habitat restoration projects	Urban Ecology Center, Partners	UWEX, WDNR, City of Milwaukee, UWM School of Freshwater Sciences	WDNR/GLRI	3, 4

1- Degradation of Benthos; 2- Degradation of Phytoplankton and Zooplankton Populations; 3-Loss of Fish and Wildlife Habitat; 4- Degradation of Fish and Wildlife Populations; 5- Restrictions on Fish and Wildlife Consumption; 6-Restrictions on Dredging Activity; 7-Fish Tumors or Other Deformities; 8-Beach Closings; 9-Degradation of Aesthetics; 10- Eutrophication or Undesirable Algae; 11-Bird or Animal Deformities or Reproduction Problems

Fish & Wildlife Webinars	Fish & Wildlife Habitat Technical Team	Status and Findings of various studies that have been identified by the Team relating to plan development	UWEX, WDNR, Project Leads	Technical Team, Various Project Teams	UWEX-GLRI	1, 3, 4, 11
Stakeholder Delegation Meetings – In Person/Webinar	Key Stakeholders Identified	Review and act as a sounding board for UWEX NRE as key outreach mechanisms & audiences are identified and developed	UWEX	WDNR, UEC	UWEX-GLRI	All
Quarterly newsletters (July, Oct, Jan, Apr)	SIG, Tech Team, Sweet Water Partners, general public, residents, river businesses, tourists, project partners	1 page (or more) of Project updates and news Education opportunities For more info, contact . . .	Sweet Water	UWEX	UWEX-WDNR	All
Milwaukee Estuary AOC web page & Facebook	SIG, Tech Team general public, residents, river businesses, tourists, project partners	Milwaukee Estuary AOC info, status and events	UWEX	EPA, WDNR	UWEX-GLRI	All
Milwaukee River Clean-ups	General Public, residents & SIG	Importance of stakeholders to river health and upkeep; Tie to aesthetics problem/public perceptions	UEC	UWEX	WDNR/GLRI	9
Stakeholder Delegation Business Cards	General Public, residents & SIG	Contact information for learning more or getting involved – for Delegates to have when acting as an outreach liaison to the public and other audiences.	UWEX	Stakeholder Delegation	UWEX-GLRI	All
Explore & Restore Milw Estuary AOC Fact Sheet(s)	General Public, Stakeholder Delegation	Basic Information on the AOC and the impact to the community.	UWEX, WDNR	Stakeholder Delegation	UWEX-GLRI	All

1- Degradation of Benthos; 2- Degradation of Phytoplankton and Zooplankton Populations; 3-Loss of Fish and Wildlife Habitat; 4- Degradation of Fish and Wildlife Populations; 5- Restrictions on Fish and Wildlife Consumption; 6-Restrictions on Dredging Activity; 7-Fish Tumors or Other Deformities; 8-Beach Closings; 9-Degradation of Aesthetics; 10- Eutrophication or Undesirable Algae; 11-Bird or Animal Deformities or Reproduction Problems

Milwaukee Estuary Area of Concern Video	All	Importance of restoration efforts in the Milwaukee Estuary AOC – History, effects of contaminants on recreation, history of recreation on the rivers,	WDNR	UWEX, UEC, Paul Davis Restoration	WDNR-GLRI	1, 3, 4, 5, 8
Data Information System Development & Integration	Various: EPA, WDNR, AOC Project Partners, Sweet Water, UWEX, Tech Team, Delegation, SIG, Community, General Public, etc.	Tracking & reporting progress of AOC projects and movement towards BUI removal and AOC delisting at various levels of detail and complexity	UWEX, WDNR-OGL, EPA , EPA Consultant	Sweet Water, AOC Coordinators in Milwaukee and Menominee	UWEX-GLRI, EPA, WDNR-GLRI	All
Paws Pledge Committee Outreach efforts (Dogipots installed in Milwaukee County Parks within the AOC, Logo Creation, Dogbone Bag Holders, Brochure, etc.)	Milwaukee County Park Users, Dog Owners in Milwaukee County Parks and other municipalities within the AoC, Pet Fair participants, Sweet Water Partners	Dog waste contributes to harmful bacteria in our rivers and Lake Michigan, Pet Owners have a responsibility to pick up after pets and can make a collective difference in water quality improvements; Municipalities, Parks, and other Partners can collectively assist in addressing bacteria issues in the rivers and the estuary	Sweet Waters Paws Pledge Committee	UWEX, County Parks, Municipalities in the Area of Concern (expanded area)	Sweet Water, Municipalities, UWEX Publications Unit	8, 9, 10

1- Degradation of Benthos; 2- Degradation of Phytoplankton and Zooplankton Populations; 3-Loss of Fish and Wildlife Habitat; 4- Degradation of Fish and Wildlife Populations; 5- Restrictions on Fish and Wildlife Consumption; 6-Restrictions on Dredging Activity; 7-Fish Tumors or Other Deformities; 8-Beach Closings; 9-Degradation of Aesthetics; 10- Eutrophication or Undesirable Algae; 11-Bird or Animal Deformities or Reproduction Problems

Miscellaneous Take-Aways (lanyards, magnets)	Event (Festivals, state fair, Pet Fairs, etc.) & Meeting participants, general stakeholders	Contact information about the Great Lakes Explore & Restore Areas of Concern Program	UWEX	WDNR, Tech Team, Delegation, Misc. Partners	UWEX-GLRI	All
Dredging benefits video	all	Benefits of contaminated sediment removal – quality of life, boost to the economy	II-SG, UW-SG	UWEX, Paul Davis Restoration, Pier Milwaukee, Horny Goat	IISG	1, 5, 9
Lincoln Park Contractor weekly updates on kiosk & Website [4]	Boaters, businesses, municipal officials, Park visitors	Project updates and logistics	Dredging and habitat contractors	City, County, WDNR, EPA, UWEX, IISG	Dredging and habitat contractors, GLLA	1, 5, 9
Lincoln Park Frequently Asked Questions brochure	General public	Dredging and habitat project info	IISG, UWEX	EPA, WDNR, UWEX, City, county	IISG	1, 5, 9
Tentative: *Roving Interpreters or Speakers Bureau*	Varies	Can support messages above for those projects this will support.	Delegation	Delegation	GLRI (UWEX)	(varies)

(1) HUB Exhibit at Gathering Waters

(2) Lincoln Park Kiosk

1- Degradation of Benthos; 2- Degradation of Phytoplankton and Zooplankton Populations; 3-Loss of Fish and Wildlife Habitat; 4- Degradation of Fish and Wildlife Populations; 5- Restrictions on Fish and Wildlife Consumption; 6-Restrictions on Dredging Activity; 7-Fish Tumors or Other Deformities; 8-Beach Closings; 9-Degradation of Aesthetics; 10- Eutrophication or Undesirable Algae; 11-Bird or Animal Deformities or Reproduction Problems

Appendix D

Milwaukee Estuary Wildlife Consumption Advisory Evaluation Proposal

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WDNR Office of the Great Lakes AOC Capacity Grants 2012

Project Title: Milwaukee Estuary Wildlife Consumption Advisory Evaluation

Project Applicant: Sean Strom

Organization name: Bureau of Wildlife Management,
Wisconsin Department of Natural Resources

Street/
Mailing address: 101 South Webster Street
Madison, WI 53707

Phone number: 608- 264-6121

Email address: sean.strom@wisconsin.gov

DUNS Number: NA

Project Manager's name and contact info: Andrew Fayram

Person responsible for reporting: Andrew Fayram

Project Location: The Milwaukee Estuary AOC includes: the lower 5 km of the Milwaukee River downstream of North Avenue Dam; the lower 4.8 km of the Menomonee River downstream of 35th Street; the lower 4 km of the Kinnickinnic River downstream of Chase Avenue; the inner and outer Harbor and the near shore waters of Lake Michigan, bounded by a line extending north from Sheridan Park to the city of Milwaukee's Linnwood water intake. The immediate area draining to the AOC encompasses 57.5 km2 or 2.6 % of the entire basin, including lands that drain directly to the AOC via storm sewers and combined sewer systems. This relatively small drainage area contributes disproportionately large amounts of pollutants associated with urban runoff. The AOC acts as both a source of pollution to Lake Michigan and as a sink for pollutants generated throughout the watershed. Consequently, water quality is affected by pollution sources associated with land use from the entire Milwaukee River drainage basin. Contaminants of concern within the Milwaukee Estuary AOC include PCBs, PAHs, Hg, Pb, dioxins, and furans. Waterfowl hunters in WI are advised not to consume mallards, black ducks, scaup, and ruddy ducks using these waters. Resident mallards and resident Canada geese will be collected at both the Milwaukee River and Milwaukee Harbor sites. In addition to resident mallards and Canada geese, black ducks, ruddy ducks, and scaup will be collected from the Milwaukee Harbor.

Problem Statement:

Relevance
Waterfowl consumption advisories have been in place for the Milwaukee Estuary Area of Concern (AOC), dating back to 1987 (Amundson 1987) (Figure 1). These advisories are the result of contamination from persistent, bioaccumulative, and toxic (PBT) chemicals, primarily polychlorinated biphenyls (PCBs). However, these consumption advisories have not been re-evaluated since their inception. Therefore, we propose to re-examine the state of the advisories and

determine if any of the existing advisories can be removed or if any additional advisories are warranted.

Objectives:

1. Evaluate concentrations of legacy contaminants in waterfowl within the Milwaukee Estuary AOC.
2. Determine if any existing waterfowl consumption advisories can be removed or whether any new advisories are necessary.

Rationale

The environmental contaminants program of WDNR's Bureau of Wildlife Management was initiated to serve two primary functions. First, to assure hunters that the wildlife they harvest and consume is free of chemical contamination. Secondly, there is an overwhelming amount of data showing that some species of wildlife can accumulate high levels of environmental contaminants that could pose a risk to both wildlife and human health. As a result of this program, consumption advisories for waterfowl are currently in effect within the Milwaukee Estuary Area of Concern. All of the advisories within the AOC are the result of bioaccumulation of PCBs by waterfowl.

Although levels of certain persistent toxic substances have declined in the Great Lakes Basin ecosystem over the past 30 years (GLRI Action Plan), they continue to be present at levels above those considered safe for humans and wildlife, warranting waterfowl consumption advisories in the WI Great Lakes basin. Although many point sources of contamination within the WI Great Lakes basin have been reduced, legacy contamination still persists. Legacy contaminants are pollutants largely left over from past practices, but continue to recirculate through the ecosystem (GLRI Action Plan). Examples of legacy contaminants include PCBs, DDT/DDE, organochlorine pesticides, mercury (Hg), and lead (Pb).

Persistent, bioaccumulative, and toxic chemicals are of concern because of evidence that they cause long-term harm to human health and the environment. Examples of PBT chemicals include PCBs, dioxins, organochlorine pesticides, and mercury). Although many chemicals can have toxic effects on humans and the environment, PBTs pose a special challenge primarily because of their unique properties. PBTs do not break down or become diluted in the environment as easily as some chemicals. PBTs also tend to bioaccumulate in the bodies of humans, fish, and other wildlife. As they slowly accumulate through the food chain, PBTs become increasingly concentrated, and may reach very high levels in both humans and wildlife that are at the top of the food chain. Although it may take months or years of regularly eating contaminated waterfowl or fish to build up amounts that are a health concern, the risk should not be ignored. Health problems that may result from the contaminants found in waterfowl range from small changes in health that are difficult to detect to birth defects and cancer. Mothers who eat highly contaminated fish for many years before becoming pregnant may have children who are slower to develop and learn.

Polychlorinated biphenyls are considered a PBT chemical ubiquitous in the Wisconsin Great Lakes, and have been shown to biomagnify up the food chain. PCBs are considered to be probable human carcinogens based on their association with liver tumors of laboratory rats (USEPA 1997). Recent EPA documents have termed the findings of some human studies as "suggestive" of an association between human cancer and PCB exposure (USEPA 1997). PCBs are also associated with immunological effects in animals and some developmental effects in humans. All of the current consumption advisories within the WI AOCs are the direct result of PCB contamination.

Proposed Work:
Based on historical data, we will sample species similar to those collected during the WDNR's original contaminants monitoring program conducted in the 1980s. Resident mallards and resident Canada geese will be collected at both the Milwaukee River and Milwaukee Harbor sites. Although Canada geese are not listed in any of the current consumption advisories within the WI AOCs, the fact they are resident and not migratory will make them a good indicator of the levels of contamination in a given area. In addition to resident mallards and Canada geese, black ducks, ruddy ducks, and scaup will be collected from the Milwaukee Harbor. Ten samples of each species from each location will be collected each year for three consecutive years.

Where possible, scaup will be collected in late winter or early spring. Scaup often overwinter on Lake Michigan and collecting them in the late winter/early spring will allow for the collection of ducks that have been in the area for several months, therefore better reflecting local contamination.

For existing consumption advisories, three years of data indicating waterfowl are free of harmful levels of contaminants are required to remove the advisory. This reasoning is based on the Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory (Anderson et al, 1993). Although this protocol does not explicitly state criteria for delisting a consumption advisory, it does discuss criteria for shifting sizes in consumption categories for a given fish species. For this to occur, 3 separate years of data is preferred in order for changes to an advisory to be considered. We believe these criteria are reasonable with regard to removing current waterfowl consumption advisories and related BUIs.

We realize the difficulty regarding the issuance of consumption advisories for waterfowl. Because they are mobile and migratory, it is difficult to pinpoint whether waterfowl have accumulated contaminants from outside WI or the United States or from a location in the state other than the area where they are harvested. To address this issue, we will focus on collecting adult mallards and Canada geese known to be members of a resident flock and/or juvenile birds known to have been hatched in Wisconsin. These collections will occur prior to fall migration to increase the likelihood of local birds being collected.

Wildlife biologists from the involved regions will collect the waterfowl and send the carcasses to the WDNR's Wildlife Health Laboratory in Madison, WI. Alternatively, hunters in the areas of interest may be asked to donate carcasses to the study. All carcasses will be processed in an identical manner. Briefly, an area (approximately 10 x 12 cm) will be plucked from each carcass and a 20 g sample of breast muscle with skin on will be dissected. Each sample will be divided between 2 sample bags. One bag will be submitted for organic contaminants (PCBs, DDT/DDE, etc.) testing and the other will be submitted for inorganic testing (mercury, lead, cadmium).

Samples for analysis will be submitted to the WI State Lab of Hygiene (SLOH). Samples will be analyzed for legacy contaminants (PCBs, Pb, Hg, DDT/DDE, organochlorine pesticides). Wildlife Health will evaluate and interpret sample results from the SLOH. Results for each contaminant will be compared with the associated critical advisory concentration in food to determine if consumption advisories can be repealed or are warranted. This process will include consultation with the Department of Health Services (DHS) on the interpretation of results.

Collaboration with partners: Wisconsin Bureau of Wildlife Management will collect samples and provide summary report. Wisconsin Department of Health will be consulted regarding the data and recommendations related to current consumption advisories.

Deliverables and Timetable: Goose and duck collection Year 1 Summer-Winter 2012. Summary report Year 1 Spring 2013. Goose and duck collection Year 2 Summer-Winter 2013. Summary report Year 1 Spring 2014. Goose and duck collection Year 3 Summer-Winter 2014. Final report Spring 2015.

Project Budget:

Project Duration: January 1, 2013 – June 30, 2016

		Annual Budget	Total 3-year Budget
Personnel			
FTE	Sean Strom-Wildlife Toxicologist (Project Manager)	$0	$0
	Wildlife Management Staff	$0	$0
LTE	40 Hours/year		
@16.570.hour		$663	$1,989
	SALARY TOTAL	$663	$1,989
Fringe			
FTE	at 46.46%	$0	$0
LTE	at 25.38%	$168	$504
	FRINGE TOTAL	$168	$504
Travel			
Sample Collection:	2 Sites/year		
@$400/site x 4 visits/year		$3,200	$9,600
Supplies			
Ammunition:	10 boxes/year		
@$15/box		$150	$450
Sample Bags:	1 box/year		
	@$40/box	$40	$ 40
	SUPPLY TOTAL	$190	$570
Contracts			
Laboratory Analyses	70 Samples/year		
	@$821/sample	$57,470	$172,410

TOTAL DIRECT CHARGES	$60,091	$180,273
Indirect @14.51%	$ 128	$ 381
TOTAL PROJECT COST	$61,812	$185,436
	Annual Budget	Total 3-year

References

Amundson TE. Environmental Contaminant Monitoring of Wisconsin Wild Game; 1985-1986. Prepared for the Wisconsin Department of Natural Resources. 1987.

Anderson HA, Amrhein JF, Shubat P, Hesse J. Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory. Prepared for the Great Lakes Sport Fish Advisory Task Force, September, 1993.

Great Lakes Restoration Initiative Action Plan. December 2009.

U. S. Environmental Protection Agency. 1997. EPA Integrated Risk Information System. Substance File for Polychlorinated Biphenyls (PCBs). June 1997.

Appendix E

Milwaukee Estuary Fish Tumor Evaluation Proposal

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Milwaukee Estuary Fish Tumor Evaluation

Causes of Habitat Impairment within AOC Addressed by Project

The International Joint Commission (IJC) lists "fish tumors or other deformities" as a beneficial use impairment (hereafter "fish tumor BUI") within areas of concern (AOC) in Annex 2 of the 1987 Protocol Amending the Great Lakes Water Use Impairment. The IJC subsequently stated that this BUI could be deemed to be not impaired when "the incidence of fish tumors or other deformities do not exceed rates at unimpacted control sites or when survey data confirm the absence of neoplastic or preneoplastic liver lesions in bullheads or suckers" (IJC 1991). The Milwaukee Estuary AOC BUI listing includes the fish tumor impairment.

Beneficial use impairment removal targets were established by Wisconsin Department of Natural Resources (WDNR) staff in collaboration with numerous partners in 2008 and 2009. The removal target in the Milwaukee Estuary AOC for the fish tumor BUI is as follows:

This BUI can be considered for delisting when:

- 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 reference sites.

OR, in cases where tumors have been reported:

- A comparison study of 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.

Toxic Sediments

The fish tumor BUI is inherently linked with the association between toxic sediments and fish tumor prevalence including chemical contaminants and polycyclic aromatic hydrocarbons (PAH) (Baumann et al. 1996). The fish tumor BUI is listed as "suspected" in the Milwaukee Estuary as no relevant historical data are available. As such, the fish tumor BUI will be considered for removal if tumor incidence rates are lower than a rate that is generally thought to be the background rate in the Great Lakes. If fish tumor incidence rates are above or not significantly below general background rates, a comparison to a suitable reference site can be made. If neither investigation suggests that the fish tumor BUI be considered for removal, further sediment remediation should be undertaken and the tumor sampling repeated.

Site Specific Population Target for Species

Understanding the extant tumor rate within the Milwaukee Estuary AOC is the first priority in determining whether the fish tumor BUI should be removed. Target rates of 5% of neoplastic tumor incidence were suggested for benthic species in the Great Lakes as indicative of "environmental degradation" (Baumann et al. 1996). Since that time, additional work has been completed to further refine the background tumor incidence rate. Baumann (2010) characterized a background tumor rate of 2% in Great Lakes areas considered as "urban or having a low/moderate pollution level without a major point source". We view a tumor incidence of 5% or lower with a 95% certainty as a threshold for fish tumor BUI removal. If sufficient sampling suggests that the fish tumor rate is below 5% we believe that the fish tumor BUI may be considered for removal.

Several of the fish tumor BUI targets developed in 2008 and 2009 by the WDNR and partners suggest that a sample size of 50 fish with a tumor incidence rate of no greater than 5% is a minimum to determine whether tumor incident rate targets have been met. However, there is uncertainty associated with any sample and in the case of tumor incidence. Tumor incidence can be described given the binomial distribution (i.e. a tumor is either present or it is not). For example, with a one sample proportion test the 95% confidence interval associated with an incident rate of 5% from a sample of 60 fish (i.e. 3 fish of the 60 have tumors) is approximately 1% to 14%, while an incidence rate of 5% from a sample of 200 fish is approximately 2% to 8% (R Core Development Team 2010). Similarly, a sample of 50 fish with an incidence rate of 0 has a 95% confidence interval of approximately 0% to 6%. Therefore, with a sample of 50 fish we would be less than 95% certain that the true tumor rate was less than 5%.

Our sampling target is 200 fish. If the 200 fish sample yields below 5% within the 95% CI (i.e. 5 or fewer tumors out of 200) we will consider the site for BUI removal. Similarly, if fewer fish are captured, we will consider the BUI for removal if the 95% confidence interval of the tumor incidence rate is less than or equal to 5%. Although a background tumor incidence rate of approximately 2% may be more appropriate (Baumann 2010), the most likely point estimate of 5 or fewer fish out of 200 is 2.5%. As such, given our conservative approach, we feel that a point estimate of 2.5% with a 95% confidence interval that does not include 5% is sufficient to consider BUI removal.

Comparison with Reference Site

If results from the intensive AOC sampling suggest that the upper 95% confidence limit of the tumor incidence rate is not below 5%, we will compare data obtained from the AOC with a suitable reference site which has available data (such as Jackfish Bay in Lake Superior) or data will be collected from a suitable reference site again with the target of 200 fish. We acknowledge that with a 200 fish sample, an $\alpha = 0.05$ (i.e. there is a 1 in 20 chance that we will incorrectly state that the reference is lower than the AOC), and a power of 0.80 (i.e. there is a 1 in 5 chance that we will incorrectly state that the reference and the AOC are the same) we can expect to detect the similarities or differences between about 10% in the reference and 18% in the AOC using a two-sample

proportions test (R Core Development Team 2010) for example. Actual detection probabilities will depend on the values obtained from sampling.

Project Goals

- Determine tumor incidence rate in the Milwaukee Estuary AOC for potential consideration of removal of the fish tumor BUI.

Project Coordination

One of the primary goals of remediation projects is to eliminate BUIs within AOCs. This project builds upon ongoing projects in this regard and will at the very least provide a basis for quantitative comparison to reference sites or may provide evidence for removal within the first year depending on the results.

Project Activities

We will collect up to 200 white suckers age-3 and older to and determine tumor incidence rates using methodology developed by Blazer et al. (2006). In addition, stable carbon and nitrogen isotopic data will be collected from fish within the AOC. Along with this data, isotopic signatures of diet items collected in the river, estuary, and lake environment will be analyzed in order to help determine the relative residence time of white suckers within the Milwaukee Estuary AOC. These data will supplement and benefit from previous similar efforts in the St. Louis River AOC and the Sheboygan River AOC.

Appropriate fish species

Although bullheads *Ameiurus spp*. and suckers *Catostomus spp*. were specifically mentioned in the IJC (1991) BUI definition, numerous species have demonstrated increased tumor rates in association with contaminants. These and other fish species may be appropriate indicators of the toxicity of contaminated sediments. However, while brown bullhead should be utilized when sample sizes are sufficient due to their limited home range and mobility (Sakaris et al. 2005) other species such as white suckers can be used as well. Other species with life history traits that lead to increased transience, such as white sucker and walleye (Becker 1983) can be utilized when it is deemed unlikely that collection of sufficient numbers of brown bullhead. However, the incidence of brown bullhead is likely high in the Milwaukee Estuary AOC and therefore will be targeted for sampling.

Covariates

Fish tumors do not develop instantaneously. As such there has been a demonstrated relationship with factors such as fish age and length (which themselves are obviously correlated) and tumor incidence, older and longer fish generally have a higher tumor

incidence rate (Rutter 2010). Similarly, resident fish species will have longer exposures to contaminated sediments than transient fish species. As such, all fish collected for tumor examination will be age-3 or older as this is the age of maturity for many species of fish present in AOC (Becker 1983). In addition, in the case of resident fish such as brown bullhead, covariates such as age and length may be considered. In the case of more transient fish species, covariates of age, length, and proportion of residence within the estuarine environment may be considered. As such, brown bullhead collected will be measured prior to sample collection, aged after sample collection to confirm the age of each fish, and stable isotope information collected in order help determine relative temporal presence within the AOC.

Tumor definition

The IJC (1991) BUI definition also included the presence of neoplastic and preneoplastic tumors as being evidence for impairment. We will only include neoplastic tumor rates for delisting purposes as defined by Blazer et al. (2006) since factors other than contamination such as viral infection and parasites (Hayes et al. 1990) have been shown to elicit external and preneoplastic tumor responses.

Sampling Strategy and Certainty

There are two nested approaches to statistically determine whether the fish tumor BUI should be removed. First, intensive sampling within the AOC to determine, with a known level of certainty (outlined above), whether the tumor incidence rate is below established target levels for the appropriate fish species (outlined above). Second, if the intensive sampling results suggest that tumor incidence rates may be above target rates, brown bullhead collection at an appropriate reference site will be conducted if data from an appropriate reference site does not currently exist.

Budget

Budget (Intensive): $86,900

External lesion and liver histopathology analyses, 200 white suckers $250/fish - $51,000.

-USGS Leetown Science Center

-13C analysis - $17/fish, 200 fish - $3,400

-University of California-Davis Isotope Laboratory

-Sucker collection – 5 days, $1,500/day - $7,500

-Contract or WDNR Fisheries

-Data management, interpretation (including ageing), and reporting - $25,000

-Contract or WDNR

Budget (Comparison with Reference): $83,500

External lesion and liver histopathology analyses, 200 white suckers $250/fish - $51,000.

-USGS Leetown Science Center

-Sucker collection – 5 days, $1,500/day - $7,500

-Contract or WDNR Fisheries

-Data management, interpretation (including ageing), and reporting – $25,000

-Contract or WDNR

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Appendix F

Benthos and Plankton BUIs Evaluation in Wisconsin's Lake Michigan Areas of Concern Proposal

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Benthos & Plankton BUIs Evaluation in Wisconsin's Lake Michigan Areas of Concern

Brief Project Description

Benthos (benthic invertebrate) and plankton (phytoplankton/zooplankton) communities in Wisconsin's four Lake Michigan Areas of Concern (AOCs; Menominee River, Lower Green Bay and Fox River, Sheboygan River, and Milwaukee Estuary) and six non-AOCs will be quantified. The inclusion of non-AOC sites will allow comparison of AOC sites to relatively un-impacted or less-impacted control sites with natural physical and chemical characteristics that are as close as possible to that of the AOCs. Comparison to less-impacted control sites as site pairs and as a group is consistent with the approaches used by other Great Lakes states, such as Michigan and Ohio (Michigan Department of Environmental Quality, 2008; Ohio EPA, 2008). The community data within and between the AOCs and non-AOCs will be analyzed and the differences and similarities will assist in determining the status of the communities and, when appropriate, support delisting of the "Degraded Benthos" and "Degradation of phytoplankton / zooplankton populations" beneficial use impairments in each AOC. This project is a cooperative agreement between the Wisconsin Department of Natural Resources (WDNR) and the US Geological Survey (USGS).

Project Location

Wisconsin Areas of Concern (AOCs) and non-AOCs for potential comparison along Lake Michigan's western shore.

Wisconsin's Lake Michigan Areas of Concern (AOCs)	**Approximate Decimal Lon-Lat** Harbor/River mouth
Menominee River	-87.592264, 45.093712
Lower Green Bay and Fox River	-88.004528, 44.539139
Sheboygan River	-87.703243, 43.748877
Milwaukee Estuary	-87.895958, 43.025215
Proposed non-AOCs (comparison sites)	
Manitowoc River/Harbor	-87.651565, 44.092347
Twin River/Harbor	-87.563848, 44.145584
Kewaunee River/Harbor	-87.499389, 44.459425
Little Bay de Noc	-87.023391, 45.718166
Root River/Racine Harbor	-87.779949, 42.732715
Oconto River Harbor	-87.830544, 44.894127
Algoma River/Harbor	-87.433056, 44.608866

Seven non-AOC harbors have been identified as possible comparison sites; however, six of these will be sampled; the feasibility of each site will be determined from local input, site visits, data collection, and professional judgment. One non-AOC will be used as an alternate site, in case reconnaissance shows that a proposed non-AOC is unsuitable. A map of each location is available at: http://maps.google.com/maps/ms?ie=UTF8&hl=en&oe=UTF8&msa=0&msid=102008844605005406045.0004790db30557e1a6328

Full Project Description

Purpose

This project will answer the following questions:

1. What is the current state of benthic invertebrate and plankton communities in Wisconsin's Lake Michigan AOCs?
2. How do the benthos and plankton communities in these AOCs differ from rivers and harbors that are not considered AOCs?
3. What community measures (richness, abundance, diversity, and tolerance) can be used as guides for determining benthos and plankton impairment in the AOCs?

To do so, the Wisconsin Department of Natural Resources (WDNR) will enter into a cooperative agreement with the USGS to quantify benthic invertebrate (benthos, hereafter) and phytoplankton / zooplankton (plankton, hereafter) communities of Wisconsin's four Lake Michigan AOCs. These will be compared with non-AOC rivers and harbors along the Lake Michigan shoreline to be used as comparison or reference sites for data analysis; use of the term "reference" in this case does not imply "pristine." The community data within and between both the AOCs and non-AOCs will be analyzed and differences and similarities will assist in determining whether or not the "Degraded Benthos" and "Degraded Plankton Populations" beneficial use impairments (BUIs) are still valid for each AOC. By developing community-based metrics that can quantify subtle differences between sampled communities we will be able to determine if the benthos and plankton in the AOCs are significantly different from those in the non-AOCs. If there is no statistically significant difference between the sampled communities from an AOC and a comparable non-AOC site, the data may be used to support delisting of that BUI once all other components of the delisting target have been met. If statistically significant differences exist between AOC and non-AOC sites, future examination of the potential causes of the impairment will be required. <u>Characterization of current benthos and plankton populations is a critical first step that must occur before these BUIs can be considered for delisting.</u>

Timeline

<u>Year 1 – Data Mining Base-line</u>
The first year will include a data mining effort to determine the base of information available on benthos and plankton communities in the AOCs, non-AOCs, and other rivers or harbors along the western shore of Lake Michigan with similar characteristics. Available data will be entered into a central database housed at the USGS office in Middleton, WI. A detailed literature search will be performed for peer-reviewed journals and other agency papers containing information on the AOCs and non-AOCs and rivers that flow into those areas. These papers will be entered into an EndNote Library with applicable links to the documents. Historic data will be used to inform the researchers of appropriate sample locations for this study and to provide context for the data

collected. Decisions about delisting a BUI however, will not be made based on a comparison of current and historic conditions within an AOC unless expressly identified within that AOC's delisting targets.

Year 1 (2) – Data Collection

Sample collection and data analysis will begin in the first year. Sampling will be conducted three times during the growing season per sampling year: the spring sample will be collected in May/June; the summer sample will be collected in July/August; and the fall sample would be collected in September/October. The sampling events will be separated by at least 4 weeks, but preferably 6 weeks to ensure adequate recolonization of the sampling devices. Due to the time required for site reconnaissance, and equipment requisition and preparation, if the award is not received by March 11, 2011, the first sampling would not occur during the spring season, instead the summer sample would be the first sample collected and the spring sample would be postponed until the next calendar year. Only non-wadeable portions of the sites will be sampled to simplify comparisons between AOCs and non-AOCs, and to minimize the variability associated with benthos in complex river/stream systems. Data collected will include parameters to characterize the sites, and the benthos and plankton communities. Details of all data to be collected and associated methods follow below under Methods.

Year 2 – Analysis and Report

The second year will consist of finalizing the data analysis and report writing. A USGS Digital Data Series report will be prepared and an article detailing the methods, data, and results of this project will be submitted to a peer-reviewed journal publication. Progress reports will be prepared and submitted to WDNR and USEPA in January and July for each of the years that the project is continuing. All reporting required by USEPA will be completed by the USGS and WDNR.

Date	**Milestone**
Spring 2011	GLRI grant award
	Sample sites finalized (review available data, meet with AOC groups)
	Plankton and benthos collections begin (dependant on timing of GLRI award)
	Literature review and EndNote Library prepared
Fall 2011	Plankton and benthos collections complete
Winter 2011	Data received from laboratories reviewed and data analysis begins
Summer 2012	Data analysis completed and report/journal article compiled and submitted for publication
Winter 2012	Final report submitted to WDNR and USEPA

Methods

All sample collections will be performed by boat, so that towing and retrieval speed can be calculated. Coordinates of each sampling location will be recorded on a GPS unit. Flow measurements in the rivers will be conducted in coordination with the benthos sampling using a boat-mounted Doppler. Additional field measurements to be taken at each sampling event include dissolved oxygen, pH, specific conductance, and

temperature using a water-quality sonde. Sediment samples will be collected from each of 5 Ponar dredges to be composited for particle-size analysis and loss-on-ignition, to determine substrate size, type, and organic matter content at each location. Artificial substrate samplers will be deployed at each site. Two types of plankton samples will be collected, one using a tow net and the other using a water filter-assembly.

The Milwaukee Estuary and Lower Green Bay/Fox River AOCs each have unique characteristics that must be researched carefully, and the data collected for those AOCs will be used as baseline data for future analysis. Because three separate and unique river systems converge to create the Milwaukee Inner Harbor, one sample will be collected within each of those three river systems and an additional sample will be collected in the Inner Harbor. These separate samples will be used to determine if the benthos and plankton communities in each of those systems are degraded or if a particular system is more degraded and requires more remediation for these BUIs than the other systems. The Lower Green Bay/Fox River AOC is unique because there is extensive remediation occurring in the river, and the bay is so different from any other system in the Great Lakes. For this AOC, two separate samples will be taken, one from the Fox River and one from the inner bay. The sample from the Fox River will be similar to the other AOCs, whereas both benthos and plankton communities will be sampled. The sample from the Lower Green Bay will be limited to the plankton community only.

All methods for sample collection are based on reports published or used by the USEPA for large rivers and lakes, or are detailed in peer-reviewed papers publically available. Every laboratory has standard operating procedures in place for sample analysis and quality assurance practices.
Details of each of the collection methods follow:

Sample structure summary

A total of 45 plankton samples and 42 benthos samples will be collected, as follows:

- Plankton:
  - Sheboygan AOC: 3 samples
  - Menominee AOC: 3 samples
  - Fox River/Green Bay AOC: 6 samples
  - Milwaukee AOC: 12 samples (3 for each river and 3 for the harbor)
  - Non-AOCs: 18 samples
  - Replicates: 3 samples (one each sampling event)

- Benthos:
  - Sheboygan AOC: 3 samples
  - Menominee AOC: 3 samples
  - Fox River/Green Bay AOC: 3 samples
  - Milwaukee AOC: 12 samples (3 for each river and 3 for the harbor)
  - Non-AOCs: 18 samples
  - Replicates: 3 samples (one each sampling event)

For each location, the following information will be collected:

- Water quality data (temperature, dissolved oxygen, specific conductance, pH)
- GIS location
- Flow of river (discharge using Doppler)

For each sample, the following analyses will be performed:

- 63µm plankton tow
    - Large-cell zooplankton community assessment
- 20 µm plankton sample
    - Small-cell zooplankton community assessment
    - Soft algae phytoplankton community assessment
    - Diatom phytoplankton community assessment
    - Chlorophyll a concentration
    - Ash free dry mass
- Ponar grab sample
    - Benthos community assessment
    - Sediment particle size
    - Loss-on-ignition (organic matter content)
- Artificial substrate benthos sample
    - Benthos community assessment

<u>Phytoplankton / Zooplankton Collection</u>
The methods for zooplankton collection are based on the United States Environmental Protection Agency's (USEPA's) Standard Operating Procedures (SOPs) for zooplankton sample collection and preservation for Great Lakes National Program Office's (GLNPO) Water Quality Survey (WQS) (LG402, Revision 10, March 2005); however, because the samples will be performed in the harbors, bays and rivers, the deeper water sample will not be collected:

> One sampling tow is performed at each station from 20 meters below the water surface to the surface using a 63µm net. If the station depth is less than the specified depth, the tow is taken from about 0.5 meters above the bottom to the surface. The tow net, with a screened sample bucket attached at the bottom, is lowered to the desired depth, and raised at 0.5 meters/second to collect zooplankton from the water column. After lifting the net from the water it is sprayed with a garden hose to wash the organisms down into the bucket. The sample is concentrated into the sample bucket and is transferred to a sample storage bottle. The organisms are narcotized with soda water and preserved with formalin solution before sending to the analysis laboratory.

In addition to the 63µm sample, 1 liter of water from each meter of depth will be collected using an integrator sampling device for a maximum of 20 liters of water. Aliquots of this whole water sample will be subsampled and filtered for chlorophyll a and ash-free dry mass analysis and sent to the Wisconsin State Laboratory of Hygiene (WSLOH). Two one-liter aliquots will then be preserved with formalin and one will be

sent to Dawn Perkins at WSLOH for soft algae phytoplankton identification and enumeration, and one will be sent to Paul Garrison at the WDNR for diatom phytoplankton identification and enumeration. This water will then be filtered through a 20 µm filter to insure collection of smaller rotifer zooplankton that cannot be captured with the larger mesh. This mesh size is not applicable for standard plankton tows due to the clogging that occurs, but is necessary for an accurate assessment of plankton communities. The 63µm sample and 20 µm filtered sample will be sent to Paul Garrison at the WDNR for zooplankton identification and enumeration in accordance with GLNPO SOP LG 403, Zooplankton Analysis. Taxonomic identification of plankton will be down to the lowest practical level.

Mesh size	Disposition	Information gained
63µm	WDNR	Community assessment of zooplankton
20µm	WSLOH	Chlorophyll a concentration
	WSLOH	Ash free dry mass
	WSLOH	Community assessment of soft algae phytoplankton
	WDNR	Community assessment of zooplankton
	WDNR	Community assessment of diatom phytoplankton

Benthos Collection

The two methods for benthos collection are based on the USEPA's Assessment and Remediation of Contaminated Sediments (ARCS) Program Assessment Guidance Document, Chapter 7: Assessment of Benthos Community Structure (EPA 905-B94-002).

The first method includes grab samples of the bottom sediment using a sampler such as a Ponar dredge. This grab sampler will be used to collect samples from 5 locations at each site. To minimize costs of analyzing multiple benthos samples for each location, multiple times per year, compositing the five samples into a single sample will produce a more comprehensive taxa list for the locations and will then be more comparable between sites. Although USEPA's ARCS does not require more than one sample per location, the investigators feel that a composite sample will more accurately reflect the communities within the AOCs and non-AOCS (see http://www.epa.gov/reg3hscd/risk/eco/faqs/composite.htm for more information). A small amount of sediment from each grab sample will be collected and composited into one sediment sample for particle-size analysis and loss-on-ignition, to determine substrate size and organic matter content. Each grab sample will then be elutriated to remove debris, larger sand and inorganic particles and rinsed to remove finer sediment through a 500 µm wash frame. The 5 individual Ponar samples will then be composited into one benthos sample, transferred into a collection bottle, and preserved with formalin solution before sending to the analysis laboratory. The sediment particle size samples will be sent to WSLOH and loss-on-ignition will be conducted by Amanda Bell. The benthos samples will be sent to Dr. Schmude at the University of Wisconsin–Superior for identification and enumeration.

The second benthos sample is collected using an artificial sampler constructed using the design shown in figure 7-1 of the ARCS document:

Artificial substrate samplers were constructed from 3M ® synthetic mesh and stainless-steel wire rotisserie chicken baskets (Stauffer et al. 1976). Each substrate consisted of five pieces of mesh (20 x 20 cm) folded in half and placed beside each other in a basket. The baskets were 26 cm in length, 17 cm in diameter, and 53 cm in circumference (Figure 7-1). The baskets were wired shut, and three baskets were wired to a cinder block at each sampling station. The baskets were connected to the cinder block with 2-m wires and were placed horizontally on the bottom near the cinder blocks. One end of the wire was attached to the cinder block and the other end was connected to a recognizable landmark on shore to facilitate retrieval of the artificial substrate samplers.

These artificial samplers will be deployed at one location at each site, GPS locations captured, allowed to colonize for 30 days, retrieved, rinsed through a 500µm wash frame, transferred into a collection bottle, and preserved with formalin solution before sending to Dr. Schmude at the University of Wisconsin-Superior for identification and enumeration.

Sample type	**Disposition**	**Information gained**
Ponar grab	University of Wisconsin–Superior	Community assessment of benthos
	USGS	Loss on ignition/organic matter content
	WSLOH	Sediment particle size distribution
Artificial substrate	University of Wisconsin–Superior	Community assessment of benthos

Quality Assurance

A Quality Assurance Project Plan will be prepared by the WDNR and USGS to document quality assurance methods for this project. Triplicate zooplankton tows and benthos samples will be collected at one location for each sampling event for a total of 20% sampling replicate. These co-located replicate samples will be collected within a 100-m^2 area at each station. The data collected from the replicate samples will be compared to original samples to determine sampling and laboratory efficiency. If it is determined that the replicate samples are within 7% of the original sample data for each data type collected, the original sample will be used for further data analysis. If the replicate samples are greater than 7% of the original sample data for each data type collected, then values of the three replicate samples will be averaged and that value will be used for further data analysis.

To minimize disturbance of the different sampling substrates, samples will be collected in the following order: water quality data, plankton tows, Ponar grab samples and deployment or retrieval of artificial samplers. Because no other water or sediment samples are included in this proposal, the samples for this proposal will be collected without regard to other samples.

Data Analysis

Multivariate, multimetric, and correlation methods will be used to analyze the data. Software designed to incorporate the non-normality of ecological data will be used to analyze variability in the biological community data from the sampled AOCs and non-AOCs. Using non-parametric multivariate statistical analyses in the Primer statistical program (Clarke and Gorley, 2006) and observed over expected methods developed by Meador et al. (2008), the community data will be compared amongst the sites and differences between taxa richness, composition, and abundance will be determined for benthos and plankton communities. Routines to be used in PRIMER will likely include nMDS (non-metric MultiDimensional Scaling) to derive plankton and benthos community site scores; PCA (Principal Components Analysis) to derive environmental site scores; and ANOSIM (ANalysis Of SIMilarity) to determine the extent plankton and benthos communities vary across sites. Probability values are based on 1,000 random permutations that are used to develop a nonparametric probability distribution. Site-specific scores based on similarities between communities will be used to determine whether a given site is statistically different from the others. Location specific differences such as drainage area, substrate, soil type, latitude/longitude, land cover, and climate will be incorporated as well. This information will be used to determine if the BUIs in the AOCs are impaired when compared with the non-AOC site pairs and group, and if there are no differences to support delisting of beneficial use impairments for delisting the AOCs.

Relevance to the Great Lakes, Existing Comprehensive Plans & Great Lakes Restoration Efforts

Great Lakes Areas of Concern (AOCs) are severely degraded areas within the Great Lakes Basin where beneficial uses have been identified as impaired. This proposal seeks the funds necessary to evaluate the status of two use impairments (Degraded Benthos and Degraded Phytoplankton / Zooplankton Populations) in Wisconsin's four Lake Michigan AOCs. Delisting beneficial use impairments is a high priority referenced by the following programs and documents:

- Great Lakes Restoration Initiative Action Plan (http://greatlakesrestoration.us/action/wp-content/uploads/glri_actionplan12032009.pdf):

The Great Lakes Restoration Initiative Action Plan (USEPA 12/3/09) lists "comprehensive monitoring and assessment" as a principle action for Focus Area 1 (Toxic Substances and Areas of Concern). This project will assess the status of seven beneficial use impairments: degraded benthos in four AOCs and degraded plankton populations in three (Menominee not impaired). If the uses are not impaired (compared to non-AOC sites), the data will provide the supporting documentation for delisting and contribute to achieving measure of Progress 2, number of "AOC BUIs removed" (p. 19, USEPA 2009).

- USEPA's Strategic Plan (http://www.epa.gov/ocfo/plan/plan.htm):

Subobjective 4.3.3 (Improve the Health of Great Lakes Ecosystems) strategic targets include "By 2010, restore and delist a cumulative total of at least 8 Areas of Concern" (p 98, USEPA 2006). This proposed evaluation of seven use impairments will be a critical

step in identifying whether or not the benthos and plankton communities in four Wisconsin AOCs are impaired compared with non-AOCs sites. This step was identified in the AOC delisting targets and must be completed before the use impairments can be considered for delisting.

- Lake Michigan Lakewide Management Plan 2008 (http://epa.gov/greatlakes/lamp/lm_2008/index.html)

Results of this project will help answer the question posed by Subgoal 4 of the Lake Michigan LaMP: "Are all habitats healthy, naturally diverse, and sufficient to sustain viable biological communities?" (USEPA 2008) for the four AOCs.

- Great Lakes Regional Collaboration Strategy to Protect and Restore the Great Lakes (http://www.glrc.us/strategy.html):

A recommended action to address obstacles to restoring the AOCs is "providing for the program capacity needed to develop measurable endpoints, design and implement remedial actions, and measure results" (p 37 GLRC 2005). The strategy further states that the "research, remediation and monitoring needed to achieve these restoration targets must be identified, funded, and implemented" (p 37 GLRC 2005). This proposal seeks the funds necessary to conduct the research and monitoring needed to assess and possibly demonstrate the ability to delist these use impairments.

- Wisconsin's Great Lakes Strategy (http://dnr.wi.gov/org/water/greatlakes/wistrategy/GLStrategy2009_final_wcover.pdf)

This proposal addresses a key point in Wisconsin's strategy by requesting the funds needed to "Evaluate and delist BUIs when monitoring demonstrates that targets have been met" for Wisconsin's four Lake Michigan AOCs (p 28, WDNR 2009).

- Area of Concern Beneficial Use Impairment Delisting Targets (all four AOC delisting targets available at http://dnr.wi.gov/org/water/greatlakes/priorities/aocs.html):

WDNR developed delisting targets for the four Lake Michigan AOCs in 2008-2009. Evaluation of the status of the benthos and plankton communities relative to reference conditions is a critical step in determining whether or not the beneficial uses are currently impaired and is mentioned in the delisting targets documents for the Milwaukee Estuary (p 38 and 46, SEH & ECT 2008), Sheboygan (p 19 and 20, SEH & ECT 2008), and the Lower Green Bay and Fox River (p 7 and 9, WDNR 2009).

- Area of Concern Stage 2 Remedial Action Plans (RAP):

Milwaukee Estuary (http://www.epa.gov/greatlakes/aoc/milwaukee/Milwaukee-Estuary-RAP1994.pdf)
Sheboygan River (http://dnr.wi.gov/org/gmu/sheboygan/SHEB_RAP.pdf)
Lower Green Bay and Fox River (http://dnr.wi.gov/org/gmu/lowerfox/1993%20RAP%20Complete.pdf)
Menominee River (http://www.epa.gov/greatlakes/aoc/lowmeno/1996_Lower-Menominee-RAP.pdf)

AOC Stage 2 RAPs outline the need for baseline and periodic updated monitoring for the "Degraded Benthos" and/or "Degraded Phyto/Zooplankton" beneficial use impairments. For example, the Milwaukee Estuary RAP states "long term trend analysis, a quantitative benthos baseline survey and periodic surveys are needed in order to determine the extent of this impairment, and to gauge the effectiveness of any clean-up actions over the long term" (p 2-18, WDNR 1994). The Sheboygan River RAP states "Collect phytoplankton and zooplankton samples for identification and data

analysis. This work will reveal the degree to which phytoplankton and zooplankton populations are degraded, signifying an impaired beneficial use of the waterway" (p 6-26, WDNR 1995).

Facilitation of USEPA oversight & administration
The level of USEPA oversight and administration necessary to successfully implement this project is minimal. Assessment of two use impairments at four AOCs have been combined in a single proposal to minimize the reporting requirements associated with this grant proposal.

WDNR and USGS have over 40 years of cooperative history collecting and analyzing data and publishing their findings in USGS and WDNR reports and peer-reviewed journals.

Education/outreach plan to disseminate results
USGS and WDNR will present the results to each AOC Citizen Advisory Committee (other citizens and local volunteer monitoring groups may be invited to attend). These committees were consulted during the initial planning phase of this proposal and they approved of potential plans. USGS will coordinate with WDNR to ensure a sampling event is captured by photo and/or video for inclusion in AOC education and outreach materials. Final results of the data and analysis will be published as a USGS Digital Data Series report, and an interpretive report will be submitted to a peer-reviewed scientific journal for publication.

Potential for transferability
The results of this project will assist other AOCs with Degraded Benthos and Degraded Phytoplankton/Zooplankton populations determine appropriate levels of monitoring to characterize AOCs. Non-AOC reference site data may be useful for comparison with other AOCs, if they have similar physical, chemical, and biological characteristics. For example, the St. Louis River Estuary is Wisconsin's only other AOC and is located on Lake Superior. The results of this project will be useful when determining the study design necessary to evaluate that AOC's "Degraded Benthos" beneficial use impairment.

Outcomes, Outputs, and Expected Results

This project will definitively determine the status of and result in measurable progress towards delisting up to 7 beneficial use impairments. Data will be collected and analyzed to re-evaluate these existing beneficial use impairments to determine if they are still applicable, an expected result from projects in this program (EPA GLRI RFP p I-2). The results will also help identify further actions needed to restore the beneficial uses.

The expected outcomes of this study are to determine the baseline conditions of two beneficial use impairments in four AOCs along Wisconsin's Lake Michigan shoreline.

Species/taxa lists for each of the sample types (Ponar, plankton, and artificial substrate) will be provided from the analytical laboratories. These community data will be summarized based on metrics such as nutrient, oxygen, and pollution tolerance, functional feeding groups, substrate preference, and family/taxonomic groupings from Barbour et al. (1999), and Porter et al. (2008), among others. By determining the taxonomic differences between the AOCs and non-AOC sites, the beneficial use impairments can be quantified for the sites in question. Data from the non-AOC sites will be used to determine a preferred taxonomic composition for each AOC which then may be re-evaluated for the zooplankton and benthos Beneficial Use Impairments.

Description of Project Result	**Output**	**Outcome**
Compilation of historic benthos and plankton community data for AOC and non-AOC locations	Endnote Library created and available literature brought to common location.	Compiling the abundant relevant agency reports and publications on benthos and plankton communities in one location will allow for new interpretation of historic results. Authors of future RAP updates will be able to easily access relevant data.
	Listing and/or map of historic sample sites at each location.	List may be used to inform decisions about where to sample at each location.
Quantification of Benthos communities	Baseline: unknown BUI status in 4 AOCs Output: definitive determination of BUI status in 4 AOCs. Metrics such as taxonomic richness, pollution tolerance, and functional feeding group generated for 4 AOCs and 6 non-AOCs.	Data will be used to characterize current benthos populations and determine appropriate metric for evaluating impairment.
Quantification of Phytoplankton / Zooplankton communities	Baseline: unknown BUI status in 3 AOCs Output: definitive determination of BUI status in 3 AOCs. Metrics such as taxonomic richness, diversity, and pollution tolerance generated for 4 AOCs and 6 non-AOCs.	Data will be used to characterize current phytoplankton / zooplankton populations and determine appropriate metric for evaluating impairment.
Comparison of AOC and non-AOC benthos and plankton communities	Baseline: • 4 Degraded Benthos BUIs • 3 Degraded Phyto/Zooplankton BUIs Output: • Potential delisting of up to 7 BUIs	Evaluation is a necessary step to re-evaluate if the BUIs are still applicable. All other relevant criteria in delisting target documents for these BUIs will have to be met.
Final Report and Peer-reviewed journal article	Publication of results in a widely accessible format.	Scientific peer review will lend additional credibility to decisions made based on data.

Description of Project Result	Output	Outcome
Coordination with AOC citizen committees (e.g. CAC, PAC, or STAC)	• Consultation with AOC groups prior to sampling • Presentation of results to AOC groups	Inclusion of AOC groups as project is developed and executed will increase public understanding and support for decisions about delisting based on the results of this project.
WDNR photographs and/or video of sampling event	Photos and/or video of sampling equipment and methods.	AOC community outreach and education materials will make the results accessible to the public in an understandable manner.

Collaboration, Partnerships, and Overarching Plans

The WDNR will collaborate with the USGS in Middleton, WI to perform necessary data collection, sampling, data analysis and reporting. All phases of the project will be coordinated with AOC site managers and LaMP coordinators. Where feasible, effort will be made to coordinate with other ongoing studies at these sites by the WDNR, USGS (J Larson and others), other agencies, and universities with regard to sampling timing, specific location within each AOC or non-AOC, and data sharing. Additional collaboration with analytical laboratories to perform taxonomic identification of the samples includes:

- Paul Garrison from the WDNR will identify zooplankton and diatom phytoplankton
- Dawn Perkins from the WSLOH will identify the soft-bodied phytoplankton
- Dr. Schmude at UW Superior will be doing the benthos analysis (http://www.uwsuper.edu/acaddept/naturalsciences/employees/kurt-schmude_employee77608)
- WSLOH will also be analyzing the sediment particle size distribution, chlorophyll a, and ash free dry mass of the samples

AOC public stakeholder groups will be consulted prior to initiation of sampling, and results of the sampling will also be presented to them. Inclusion of AOC groups as the project is developed and executed will increase public understanding and support for decisions about delisting based on the results of this project.

Relevant overarching plans to this project include the AOC delisting targets, RAPs, Wisconsin's Great Lakes Strategy, and the Great Lakes Regional Collaboration Strategy (project relevance to each previously described in Section 8 of this proposal, see p 7 and 8).

Programmatic Capability and Past Performance

The WDNR has had the opportunity to be an USEPA grant recipient for the past three decades and has been able to consistently demonstrate grant performance accountability. WDNR grant management is a joint effort that consists of multiple

mechanisms to ensure expected outcomes and deliverables have been satisfactorily met.

Internal GPO's (Grant Project Officer's) are dedicated to each project to provide oversight and coordination. WDNR project officers have been able to satisfactorily meet reporting requirements as outlined in the grants programmatic and administrative conditions (annual, and/or semiannual, and final) for all grants received to date. Project Officers are responsible for meeting technical reporting and periodic project status requirements conveyed though reporting updates or communication/correspondence with USEPA.

Financial accountability has been demonstrated through systematic tracking by our staff grant accountants and financial accountants. State budgetary information systems track project activity and project related expenditures in order to provide accurate fiscal reporting. State procurement policies and processes provide guidelines to ensure funds are managed appropriately. Financial reporting is completed on a quarterly basis as required in programmatic terms and conditions to include a Final Federal Financial Reports (SF-425). Our financial representation has also established credibility for providing additional final reporting requirements; MBE/WBE reporting, Property Reports, Disclosure of Inventions, etc.

Historically, the WDNR has been successful in meeting grant recipient requirements and expectations. We appreciate the opportunity to continue to demonstrate our high performance standards and anticipate these to strengthen in the near future.

Listed below are four grant awards the WDNR has received annually for the past three years. These grants highlight a wide array of programmatic areas and demonstrate our achievement history as a recipient for significantly funded grant awards. Additional WDNR past grant performance detail available upon request.

<u>PPG – Performance Partnership Grant</u>

The Department and USEPA in partnership and through the Environmental Partnership Performance Agreement (EnPPA) will work together toward five shared environmental goals to enhance efforts to protect and restore our water resources and to measure our accomplishments. The five goals are: 1. support healthy aquatic biological communities; 2. support fish populations with safe levels of contaminants; 3. designated swimming waters in will be swimmable; 4. public water supplies will have water that is consistently safe to drink, and; 5. the quantity and quality of critical aquatic habitat, including wetlands, will be maintained or improved. The PPG is the primary federal funding mechanism to work toward these goals.

The EnPPA between the State of Wisconsin and USEPA serves as the overall work plan for federal grant moneys awarded under sections 106, 319, 604(b) and 104(g) of the Clean Water Act. As part of the EnPPA process, the State of Wisconsin prepares a self-assessment annual report at the end of each federal fiscal year identifying work

plan accomplishments. In addition, the state also prepares a more in-depth report for expenditure of s. 319 grant funds.

FY09 Grant # BG97550709 ($8,497,700) FY08 Grant # BG97550708 ($8,640,600)
FY07 Grant # BG97550707 ($8,561,600)

319 Incremental

Section 319 Incremental Grant funds are used by the WDNR to implement the Wisconsin Nonpoint Source Pollution Abatement Program. Funds are targeted to areas and efforts backed by watershed-based nonpoint source control plans or Total Maximum Daily Loads (TMDLs). Incremental funds support implementation of best management practices, water quality monitoring, TMDL development, and TMDL implementation in areas of the state with nonpoint source impaired waterbodies.

WDNR provides regular reports to USEPA on progress made in projects funded with Section 319 incremental monies. Progress is measured through annual reports from counties implementing best management practices, analysis of pollutant load reduction data and water quality monitoring results, TMDL reports submitted to USEPA, and development of an effective TMDL implementation program.

FY06 Grant # C900591706 ($2,701,600) FY05 Grant # C900591705 ($2,634,600)
FY04 Grant # C900591704 ($2,591,600)

GLNPO – Lake Superior/ Lake Michigan LaMP and RAP
The work plans submitted as part of this grant funding are for staff time dedicated to participation and the continued implementation of the RAP and LaMP activities in Lake Michigan and Lake Superior basins. There is also funding for additional staff to work on LaMP and RAP activities that include: developing and promoting implementation projects, coordination with other jurisdictions; participation in workgroups, and public involvement with stakeholders to recreate the local presence of the RAP process; develop and review quality management plans and quality assurance project plans; and coordinate department efforts to compile and distribute information.

The LaMP and RAP efforts move the WDNR towards the goal of de-listing the AOCs or are demonstration projects for implementing new techniques for addressing beneficial use impairments. These projects are collaborative efforts with partner and community groups.

The outputs were qualitative in nature for this grant. Public outreach and education plays a critical role in the implementation of the goals of the LaMP and RAP. Through interaction with the basin partner teams, the Forum and other interested parties, information exchanges resulted in the development and use of educational materials for basin residents. Additionally, through the basin educator, materials and educational sessions were provided for basin residents. Wisconsin prepared informational reports

to document the status of remedial efforts for the public using various media or opportunities.

WDNR worked with USEPA to provide updates and information for the RAP websites, LaMP AOC matrix, LaMP documents and reporting activities required by GLWQA.

WDNR reported on progress in semiannual narratives and will use goals documents which were created as part of the Water Division's realignment that occurred over the last two years. Department managers reported to the Division Administrator and the Department Leadership Team on strategic issues that affect the entire program. There are goals and objectives regarding the Great Lakes included in the realignment document that must be reported on quarterly basis.

FY07 Grant # GL00E06601 ($375,371) FY06 Grant # GL96574401 ($450,000)
FY05 Grant # GL96561901 ($130,000)

<u>Water Quality Planning 205(j)</u>
The purpose of this funding is to conduct planning using the concepts of the federal Unified Watershed. Based on the need to revise portions of the plans as data is obtained particularly in regard to watershed tables for 303d listing and 305b reporting, the biennial activities focused on redesigning the Watershed Program to match new data systems for monitoring and assessments and migrating historical watershed and basin plan data into those systems.

Waters. The Watershed Program designed a plan to update the equivalent of 3 watersheds per Water Management Unit.

Watershed Planning Workshops are held throughout the state and new webpages were developed to support this effort.

A major effort to migrate and quality control the impaired waters data has been undertaken so that the state is preparing to submit an integrated report for the 2008 Clean Water Act Reporting Cycle.
EPA

- Coordinated the State/Federal watershed work group to facilitate exchange of information.
- Provided technical assistance on planning issues.
- Review and award Sect 205(j) grants to local agencies.
- Review and, when appropriate, approve revisions to the Continuing Planning Process and WQM plans. (See attached watershed planning checklist and screen shots).

Review watershed plans against NPS guidance, provide input to the State and work with the State to upgrade the plans.

Pass Through Grants to Water Quality Planning Agencies for at least 40 percent of the total amount of the 604b grant award.

Annual work program contracts with the agencies, which include scope of work, budget, and funding source breakdowns and submit the contracts to Region V USEPA.

A semiannual summary of each local agency's progress in meeting commitments contained in the scope of work for the contracts including a copy of each signed agreement.

FY09 Grant # C600E71701 ($185,823) FY08 Grant # C600E50501 ($185,824)
FY07 Grant # C600E09701 ($292,271)

Budget

The following table outlines the total cost of the proposed project, which is a cooperative agreement between WDNR and the USGS. WDNR will use the grant funds to purchase equipment and supplies, and pay for analytical costs to minimize costs. Contractual category includes salary, fringe, supply, and travel costs for USGS, WSLOH, WDNR, and UW Superior. The contractual costs are mostly associated with laboratory costs. One of the laboratories is run by WDNR so no competitive sourcing is necessary. WSLOH is a state-owned lab that has contractual services with the WDNR and USGS for discounted prices. The other laboratory is a university that specializes in the types of samples being collected (benthos). No other laboratories in the Midwest were able to process the samples with the expertise of the selected labs with regard to the Great Lakes benthos fauna.

Summary	
Personnel/Salaries	$0
Fringe Benefits	$0
Travel	$0
Equipment	$4,800
Supplies	$2,200
Contract Costs	
UW Superior	$30,500
WDNR	$17,500
WSLOH	$10,000
USGS	$382,000
Construction Costs	$0
Other Costs	$3,000
Total Direct Charges	$450,000
Indirect Charges	$0
Total Cost	**$450,000**

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Appendix G

Identification and Quantification of Sanitary Sewage Contamination in the Milwaukee Estuary Area of Concern

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WDNR Office of the Great Lakes AOC Capacity Grants 2013

Project Title: **Identification and quantification of sanitary sewage contamination in the Milwaukee Estuary Area of Concern (AOC)**

Project Applicant:
Sandra McLellan, Great Lakes WATER Institute, School of Freshwater Sciences, University of Wisconsin-Milwaukee

Fiscal Agent (if different from Applicant):
Same as applicant

Project Implementation Leader (if different from Applicant):
Same as applicant

Person responsible for quarterly reporting:
TBD

Project Location:
Milwaukee Estuary AOC

Problem Statement:
Beach closings and recreational restrictions is an impaired use in the Milwaukee Estuary AOC. Early RAP documents (DNR 1991, DNR 1994) stated that the use was impaired because of high bacteria counts and sewer overflows in the AOC that caused beach closings and recreational hazards. While sewer overflows closed beaches in the AOC, high bacteria counts from urban nonpoint pollution throughout the AOC waterways often exceeded water quality standards for recreation. Since the early 1990s, however, sewer overflows have decreased substantially, largely as a consequence of the Milwaukee Metropolitan Sewerage District's Deep Tunnel system. Before the wastewater storage tunnel became available, rain storms caused more than 50 combined sanitary and storm sewer overflows each year to local rivers and Lake Michigan. Construction of the 19.4-mile-long original tunnel was completed in 1993 and its first full year of operation was 1994. Since the Deep Tunnel system came online, there has been an average of 2.5 overflows a year from 1994 through 2011.

Despite this substantial improvement in sewage treatment in the AOC, water quality standards for recreation are still regularly exceeded in the AOC, and pose a significant challenge to removing the beach closings and recreational restrictions impairment. The cause of these exceedances is largely attributed to contamination by urban stormwater. High levels of fecal indicator bacteria have been found in urban stormwater discharges (O'Shea and Field, 1992; Field, 1996; Haile et al., 1999; Schiff and Kinney, 2001) and are the largest contributor to water quality impairments for bacteria in Milwaukee's urban rivers (SEWPRC 2008). Complicating matters is that water quality models have shown that 60-75% of the fecal coliform loads cannot be explained by nonpoint source runoff from rooftops, parking lots, streets, and other impervious surfaces (SEWRPC, 2008), especially for the Menomonee and KK Rivers (Figure 1). The Great Lakes Water Institute's preliminary data (detailed below)

demonstrates that exfiltration (leaking) from failing sanitary sewer infrastructure is a major source of fecal indicator bacteria and pathogens in urban stormwater that impacts the AOC. This means that stormwater systems are acting as conduits for conveying sewage from failing infrastructure into surface waters used for drinking water and recreation. This sanitary waste poses a more direct threat to human health, since it is more likely to contain pathogens than urban stormwater runoff. This problem is particularly difficult to address because thousands of localized breeches within the sanitary sewage system are much more difficult to address than combined and sanitary sewage overflows, where sources and system capacities are better understood. Therefore, completing this project to identify and quantify sanitary sewage contamination of stormwater in the AOC provides a crucial, and currently missing, link in efficiently and effectively addressing the beach closings and recreational restrictions impairment.

Relevance and Rationale

The Milwaukee Estuary AOC and its constituent waterways are listed on Wisconsin's 303(d) list as impaired because they frequently do not meet the variance standard (1000 fecal coliforms/100 ml), much less the water quality standard (200 FC/100 ml), for recreation. Total Maximum Daily Load (TMDL) studies to address bacteria are underway for the three AOC tributaries and the estuary. The TMDL, however, focuses on using *E. coli* and fecal coliform bacteria indicators, which can come from a variety of sources. Some sources, namely sewage, pose a greater human health risk than other sources of fecal contamination because of extremely high concentrations of viruses, protozoa, and pathogenic bacteria associated with human waste. ***Identifying the source of contamination is integral to TMDL development because it allows for the prioritization of implementation strategies to target pathogens, which pose the greatest risk to human health.*** The risk to human health is the actual water quality impairment, and is the reason that recreation in the AOC is restricted. The lack of source information (e.g. human vs. nonhuman), therefore, hampers implementation plans that are intended to ultimately reduce pathogens and remove the recreational restrictions beneficial use impairment in the AOC.

Fortunately, the Great Lakes WATER Institute (GLWI) has been developing methods for tracking sources of fecal pollution in urban rivers, the Milwaukee Estuary, and Lake Michigan over the past several years. GLWI's previous research using source-specific indicators of fecal pollution demonstrates that sewage contamination of stormwater is common and widespread in the urban environment (Salmore 2006, McLellan 2007, Sauer 2011, Newton et al. 2011). Recent studies in their lab demonstrate that the Menomonee and Kinnickinnic (KK) Rivers are the major source of sewage (and human pathogens) to the AOC. These approaches are now being applied to studies, in partnership with Milwaukee Riverkeeper and the Milwaukee Metropolitan Sewerage District (MMSD), to map the extent of stormwater contaminated by sewage. Additionally, Dr. McLellan is already working with the TMDL effort in the three watersheds and the estuary to interface existing source identification data into the TMDL. The requested funding for this proposed project would fill critical data gaps by identifying human versus nonhuman sources, and estimating loads of sewage-derived pathogens for the two watersheds that contribute high loadings of human waste and pathogens into the AOC. The challenge is to identify, prioritize, and remediate failing sewer infrastructure systematically so that limited fiscal resources can be directed to the largest problem areas; a challenge this project would address. Specifically, the proposed project corrects the impediments to TMDL implementation by identifying the most critical infrastructure failures, and assisting decision-makers in determining their priorities for stormwater management and infrastructure investment. Based on source testing results, we will map and disseminate the locations of stormwater outfalls that are discharging sewage to the municipalities, so they can effectively direct their limited budgets toward projects that would make the greatest impact on

improving water quality in the Milwaukee Estuary AOC, thus helping to bring the AOC into compliance with water quality standards.

In order to achieve this, Dr. McLellan's lab has partnered with Milwaukee Riverkeeper, who is funding a full time water quality specialist (Joe Rath) who will assist with sample collection support, GIS expertise, mapping and visualization of data for this project. This partnership increases our capabilities to extensively cover the lower Menomonee and KK watersheds that contribute significant pollutant loads to the Milwaukee Estuary AOC and to disseminate this information in a form usable to municipalities and water resource planners.

Objectives

The overall goal of our research is to delineate fecal pollution sources entering the AOC. A major part of this research is to identify unrecognized sanitary sewage contamination and determine the contribution of sewage to pathogen and fecal indicator loads to the Milwaukee Estuary. This information is necessary to direct mitigation efforts towards reducing pathogens in the AOC. The specific objectives in this proposal are critical elements in our overall research efforts and they address data needs that are not currently funded, or are only partially funded. Below are specific objectives and a brief description of each. Appendix A provides a detailed description of the overall research plan and current funding sources.

Objective 1. ***Map and sample stormwater outfalls along the lower Menomonee and Kinnickinnic and perform up the pipe investigations to identify illicit discharges.***

This objective will provide a comprehensive map of illicit discharges in two urbanized watersheds, which can be used as a resource by municipalities. Levels of human-specific indicators will be quantified and results mapped using GIS. We will determine if levels and loads are correlated to drainage area, elevations, and sewer configuration. We will specifically determine if certain variables correlate to a "high likelihood of failing infrastructure". Outfalls will be prioritized based on the concentration and load of human-specific indicators and up-the-pipe investigations conducted in collaboration with municipalities and MMSD.

Objective 2. ***Quantify amount of sewage contamination loads at two locations in the Menomonee and Kinnickinnic Rivers and at the estuary.***

Our ongoing sampling program with USGS will allow us to collect integrated water samples across the hydrograph at downstream locations in the Menomonee and Kinnickinnic Rivers. Our preliminary data (see proposed work) demonstrates there is a clear human signal from the Kinnickinnic and Menomonee watersheds in the absence of combined or sanitary sewage overflows. We will analyze baseflow and storm event samples collected in 2012 and 2014 to determine the relative contribution of sewage sources to the overall fecal coliform levels. We will use the same analytical procedures (microbiology and the sewage-indicating quantitative real time polymerase chain reaction, or qPCR, analytical method) used in Objective 1 for the outfall mapping. Importantly, this monitoring will help evaluate the effectiveness of mitigation and source reduction.

Objective 3. ***Fill data gaps and interface with TMDL efforts to prioritize implementation strategies.***

Current Great Lakes Restoration Initiative funding is supporting TMDL development for the three watersheds within the Milwaukee River Basin and estuary. This project is designed to meet a

major need for TMDL implementation, i.e. identification of sources. Load calculations will be based upon fecal coliforms for the watersheds and *E. coli* for the estuary, but these general indicators DO NOT correlate to pathogens (some sources have few pathogens, but sources such as sewage have lots of pathogens). Comprehensive mapping and river sampling will allow priority ranking of sites suspected as major contributors to sewage derived fecal coliform loads and result in more effective remediation of both local and downstream loads. For example, the area of highest fecal coliform loading in the Kinnickinnic River watershed, Holmes Avenue Creek, has few stormwater outfalls that have come back positive for human-specific indicators. These areas, however, would be identified as high priority areas for TMDL implementation activities, even though their risk to human health is relatively low. By doing this work, we ensure that the stormwater outfalls that pose the greatest risk to human health can be targeted, which increases overall effectiveness and efficiency of the TMDL. To do this, we will interface with the Center for Water Policy to disseminate research information into the policy arena. The research results will be disseminated to policy-makers, stakeholders, municipalities, and water resource managers in the form of research briefs, policy briefs, and science-based policy solutions. For example, findings from this project could improve stormwater permitting, TMDL development and implementation, as well as provide evidence for the need for municipalities to fix areas of failing infrastructure. The policy briefs will focus on identifying the most significant problem areas, and can be used for prioritizing investment in infrastructure to remediate failing sewer lines that present the most critical concerns for public health.

Proposed Work:

This project will identify unrecognized sanitary sewage contamination and determine the contribution of these sources to pathogen and fecal indicator loads in the Milwaukee Estuary. We will map sections of two urban watersheds (the lower Menomonee and Kinnickinnic River watersheds) to identify the prevalence of sewage entry into stormwater systems (e.g., local outfall scale). We will also measure overall contributions of sewage to impaired water quality in urban rivers following storm events (e.g., watershed scale). We will transfer our findings to local municipalities responsible for mitigating sanitary sewage discharges, to water resource managers working on TMDLs, and to the DNR to support their watershed-based permitting efforts.

Objective 1. *Map and sample stormwater outfalls along the lower Menomonee and Kinnickinnic and perform up the pipe investigations to identify illicit discharges.*

This objective will provide a comprehensive map of illicit discharges in the lower Menomonee and Kinnickinnic River watersheds, which can be used as a resource by municipalities. Human-specific fecal indicators will be quantified in terminal outfalls and results mapped using GIS and will include drainage areas, elevations, and sewer configuration. We will also map age of development and use these different variables to determine correlations to "high likelihood of failing infrastructure" (Figure 2). Outfalls will be prioritized based on the concentration and load of human-specific indicators and up the pipe investigations conducted in collaboration with municipalities and the Milwaukee Metropolitan Sewerage District (MMSD).

The analytical methods for the human-specific indicators Bacteroides and Lachno2 have been previously described by our laboratory (Newton et al., 2011). We are also developing methods for new assays that target non-human sources of fecal pollution and will incorporate this testing as appropriate. These new markers will continue to improve our resolution in confirming, and positively identifying other sources of fecal pollution in stormwater (e.g., urban wildlife).

Concentrations determined by the analytical quantitative polymerase chain reaction (qPCR) method help to determine the extent of human sewage contamination, and can be used in conjunction with storm sewer drainage areas as a proxy for pathogen loads.

We have mapped 185 different terminal outfalls to date, which represents 70% coverage of the terminal outfalls in the lower Menomonee River (between Burleigh Ave and Hawley Ave) and 10% coverage of the Kinnickinnic watersheds. We found 80 of these terminal outfalls (>40%) have low to moderate levels of sewage contamination and 28 have very high levels of sewage contamination (15%). In this project, we would complete the mapping of the lower Menomonee and KK watersheds and conduct a minimum of 15 up-the-pipe-investigations each year, targeting areas of the highest priority, e.g. sites with the highest human fecal pollution signal and/or load. In all, we anticipate analyzing 150 terminal outfalls and 150 up-the-pipe samples using traditional microbiology and qPCR for source-specific indicators over 2013-2014. Up-the-pipe sampling is important in helping to better define the location of infrastructure failure within the storm sewer drainage area that leads to each terminal stormwater outfall at the river discharge location, and MMSD has been conducting this sampling as an in-kind contribution to this project. This effort would provide comprehensive coverage for the two most urbanized watersheds impacting the AOC.

Objective 2. *Quantify amount of sewage contamination loads at two locations in the Menomonee and Kinnickinnic Rivers and at the estuary.*

Our ongoing sampling program with USGS will allow us to collect integrated water samples across the hydrograph at downstream locations in the Menomonee and Kinnickinnic Rivers. We have been quantifying human-specific markers and general indicators at the channel leading to Lake Michigan (Figure 3). There is a clear human signal from the Kinnickinnic and Menomonee watersheds in the absence of combined or sanitary sewage overflows.

In collaboration with USGS, we will deploy ISCO sequential samplers at an estuary site (Jones Island), the Kinnickinnic River (11th and Harrison) and the Menomonee River (16th Street). The downstream river locations will provide a critical dataset for the evaluation of fecal bacteria loads just prior to the estuary and the estuary site will provide a critical dataset for calculation of bacterial loads just prior to Milwaukee's inner harbor.

As sewage-contaminated waters are closely associated with human pathogens, the cause of the beach closings and recreational restrictions impairment, we will analyze baseflow and storm event samples collected from 2012 through 2014 to determine the relative contribution of sewage sources to the overall fecal coliform levels. We will use the same analytical procedures (microbiology and qPCR) used for outfall sampling to differentiate the two forms of pollution.

Objective 3. *Fill data gaps and interface with TMDL efforts to prioritize implementation strategies.*

Current Great Lakes Restoration Initiative funding is supporting TMDL development for the three watersheds within the Milwaukee River Basin and estuary. This project is designed to meet a major need for TMDLs, i.e. identification of sources.

For the TMDLs, load calculations will be based upon fecal coliforms for the watersheds and *E. coli* for the estuary. However, unrecognized sanitary inputs contribute additional fecal coliforms and *E. coli* beyond what is estimated from land use and runoff calculations. Comprehensive mapping and river sampling will allow priority ranking of sites suspected as major contributors to sewage derived TMDLs and result in more effective remediation of both local and downstream loads, ultimately targeting the pathogens that give rise to one of the estuary's beneficial use impairments.

Historically, concentrations of fecal coliform bacteria in the estuary portions of the Kinnickinnic, Menomonee, and Milwaukee Rivers regularly exceeded the estuary variance standard of 1,000 CFU/100 ml. According to MMSD datasets, between 1975 and 2004 the median concentration of fecal coliform bacteria in the Milwaukee Harbor estuary was about 930 CFU/100 ml. Fecal coliform counts in the estuary varied over seven orders of magnitude during this period (from 1 CFU/100 ml to 2,400,000 CFU/ 100 ml), regularly exceeding the variance standard and almost always exceeding the standard for full recreational use (200 CFU/100 ml). From 2000-2002, MMSD levels of *E. coli* in the estuary varied over six orders of magnitude, ranging from 0.5 CFU/100 ml to 240,000CFU/100 ml.

Current MMSD data illustrates the substantial and ongoing contamination problems in the AOC. In 2012 during June, July, and August, 53% of MMSD samples collected in the estuary (n=30) had fecal coliform levels greater than 200 CFU/100 ml and 10% had levels greater than 1000 CFU/100 ml. The *E. coli* levels were greater than 235 CFU/100 ml in 20% of the samples and 7% were greater than 1000 CFU/100 ml, USEPA standards for water quality advisories and beach closings respectively. Importantly, 2012 was during an extreme drought, thereby representing a "best case" scenario for storm-driven pollution levels.

MMSDs comprehensive sampling program provides ongoing data for the AOC and the upstream rivers that impact the AOC. This sampling program is the primary data source for developing the TMDLs and sites correspond to assessment points used in the TMDL. As the McLellan lab became engaged in the TMDL project, they requested split samples from MMSD's monitoring program in the Kinnickinnic and lower Menomonee rivers, whereby MMSD took 2 sets of samples—one for their lab and one for the McLellan lab. This has enabled the McLellan lab to archive an entire sampling season with minimal budget investment so that these samples would be immediately available for analysis during winter of 2012/2013. As a result, more than 200 samples have been analyzed for *E. coli* and enterococci by culture methods and archived by freezing samples for later qPCR testing. We will obtain river samples from MMSD in 2013 and each year analyze the most relevant samples by qPCR. We estimate that we will use qPCR to analyze a max of 200 in-stream samples over the three year time frame.

Center for Water Policy

The second part of this objective is to interface with the Center for Water Policy to disseminate our findings to inform policy. We will dedicate one Master's student to these efforts, who can help translate our research findings into information useful in other efforts in our region. The research results will be translated into research briefs and policy briefs designed to be useful for decision makers, stakeholders, municipalities, and water resource managers. The articulation and communication needs will be assessed for targeted groups. The results will be disseminated through stakeholder meetings, links to research briefs, and direct access to policy briefs, providing for feedback loops.

Collaboration with partners:
This project builds upon an existing and longstanding collaboration between the Great Lakes WATER Institute (GLWI), School of Freshwater Sciences, Riverkeeper, and MMSD. This group meets monthly to implement an overall strategy to map stormwater outfalls. "On the ground" interaction is ongoing and includes GIS information sharing between MMSD and Riverkeeper. Riverkeeper has an extensive collection of stormwater samples, which are analyzed by GLWI, and results mapped by Riverkeeper. Up the pipe investigations are jointly formulated by the group and then sampled by MMSD, analyzed by GLWI, and mapped by Riverkeeper. At the GLWI, there is a research specialist and one Master's student dedicated to our stormwater and AOC work. These are just a few examples of the ongoing and longstanding collaboration of this group.

In addition, Dr. McLellan and Cheryl Nenn, MS, work closely with the Southeastern Wisconsin Watersheds Trust (Sweet Water) and municipalities to disseminate mapping of sewage contamination in outfalls for further investigation and remediation and cooperate with the Southeastern Wisconsin Regional Planning Commission (SEWRPC) in their efforts to facilitate watershed-based stormwater permits. The draft watershed-based stormwater permit for Menomonee River municipalities incorporates improved monitoring requirements (e.g., to test all size outfalls and test outfalls suspected of human sewage contamination multiple times during dry and wet weather) and requires the municipalities to develop a watershed-wide strategy to identify and eliminate human-specific bacteria sources in response to our joint monitoring efforts by spring 2013.

Deliverables and Timetable:
See Appendix A for comprehensive timetable and activities.

Deliverables include:
Analysis of 150 terminal outfall samples by culture and qPCR
Analysis of 150 up the pipe samples by culture and qPCR
Analysis of 200 watershed samples collected with ISCO samplers
Analysis of 200 river samples (collected by MMSD) by culture and qPCR
Update comprehensive stormwater reports and maps for 2013 and 2014
Develop research briefs and policy briefs to disseminate to stakeholders and target groups

Project Budget:
Project Duration: January 1, 2014 to December 31, 2015

<u>Year one:</u>

Personnel costs:	$103,941
Graduate student tuition costs:	$8,984
Supplies and equipment:	$46,000
Travel:	$500
Subcontract to Riverkeeper for sampling/mapping collaboration:	$25,000
Subcontract to USGS for sample support and expertise:	$20,000
University overhead:	$30,663
Total:	$235,089

<u>Year two:</u>

Personnel costs:	$110,865

Graduate student tuition costs:	$17,948
Supplies:	$32,080
Travel (include scientific meetings):	$3400
Publication costs (peer reviewed journals):	$3000
Center for Water Policy dissemination materials and meetings	$5000
Subcontract to Riverkeeper for sampling/mapping collaboration:	$50,000
Subcontract to USGS for sample support and expertise:	$10,000
University overhead:	$34,844
Total:	$267,137

References:

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Haile, R.W., Witte, J.S., Gold, M., Cressey, R., McGee, C., Millikan, R.C. et al. (1999) The health effects of swimming in ocean water contaminated by storm drain runoff. *Epidemiology* **10**: 355-363.

McLellan, S. L., Hollis, E. J., Depas, M. M., Van Dyke, M., Harris, J., & Scopel, C. O. (2007) Distribution and fate of Escherichia coli in Lake Michigan following contamination with urban stormwater and combined sewer overflows. *Journal of Great Lakes Research* **33**: 566-580.

Newton, R. J., VandeWalle, J. L., Borchardt, M. A., Gorelick, M. H., & McLellan, S. L. (2011) Lachnospiraceae and Bacteroidales alternative fecal indicators reveal chronic human sewage contamination in an urban harbor. *Applied and Environmental Microbiology* **77**: 6972-6981.

O'Shea, M.L., and Field, R. (1992) Detection and disinfection of pathogens in storm-generated flows. *Can J Microbiol* **38**: 267-276.

Salmore, A. K., Hollis, E. J., & McLellan, S. L. (2006) Delineation of a chemical and biological signature for stormwater pollution in an urban river. *Journal of Water and Health* **4**: 247-262.

Sauer, E. P., Bower, P. A., Bootsma, M. J., & McLellan, S. L. (2011) Detection of the human specific Bacteroides genetic marker provides evidence of widespread sewage contamination of stormwater in the urban environment. *Water Research* **45**: 4081-4091

Schiff, K., and Kinney, P. (2001) Tracking sources of bacterial contamination in stormwater discharges to Mission Bay, California. *Water Environ Res* **73**: 534-542.

SEWRPC (2008) Regional Water Quality Plan Update, Technical Report 39.

USEPA (2009) National Water Quality Inventory: Report to Congress, 2004 Reporting Cycle.

Figure 1. Predicted fecal coliform levels from water quality modeling of nonpoint source runoff (orange lines) compared with observed values (open circles; ±1SD is represented by the blue dashed line). The lower Menomonee River had observed fecal coliform values one order of magnitude greater than model predictions suggesting major contributions of fecal coliforms from unrecognized sources.

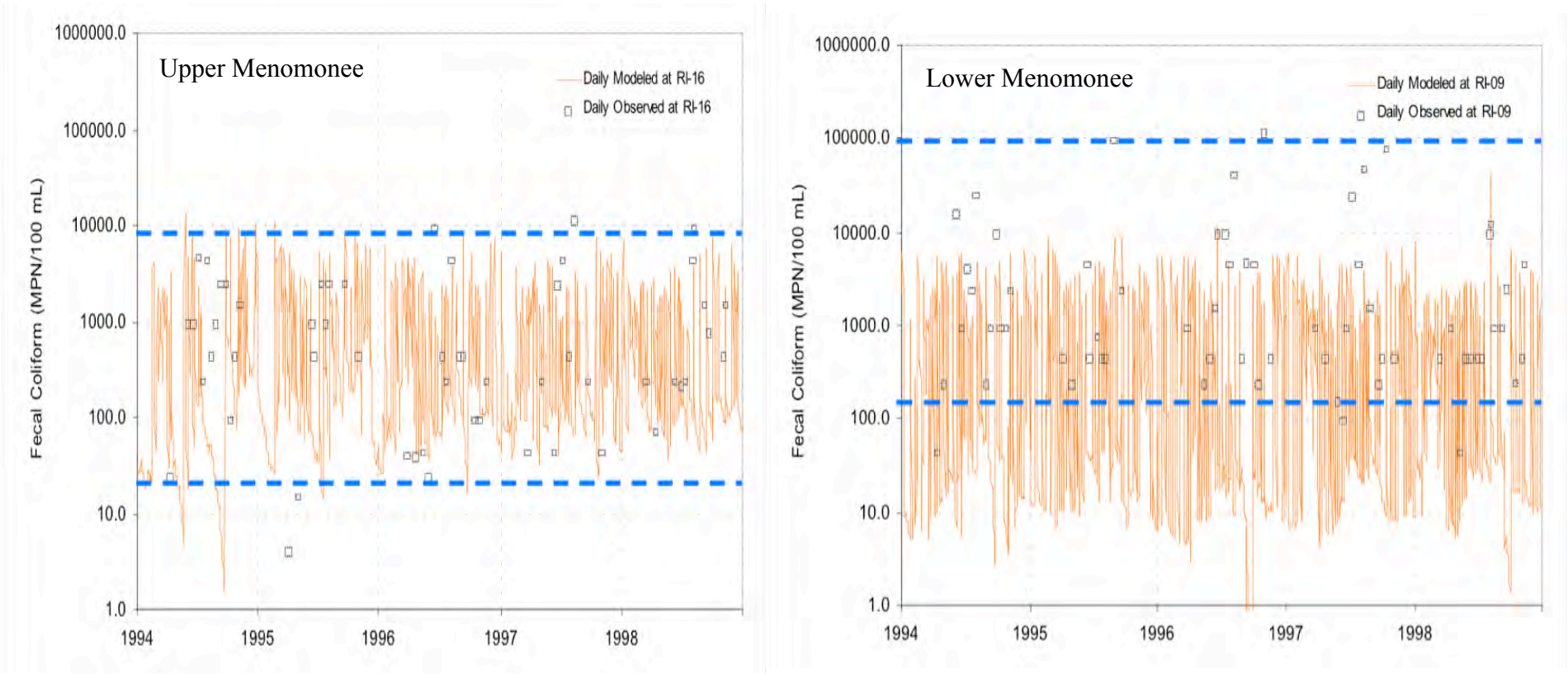


Figure 2: The Menomonee and Kinnickinnic watersheds. The stormwater outfall results for sewage contamination will be correlated to age of development, pipe elevations, ground elevations and other available data to develop a risk index to help target actual investigations.

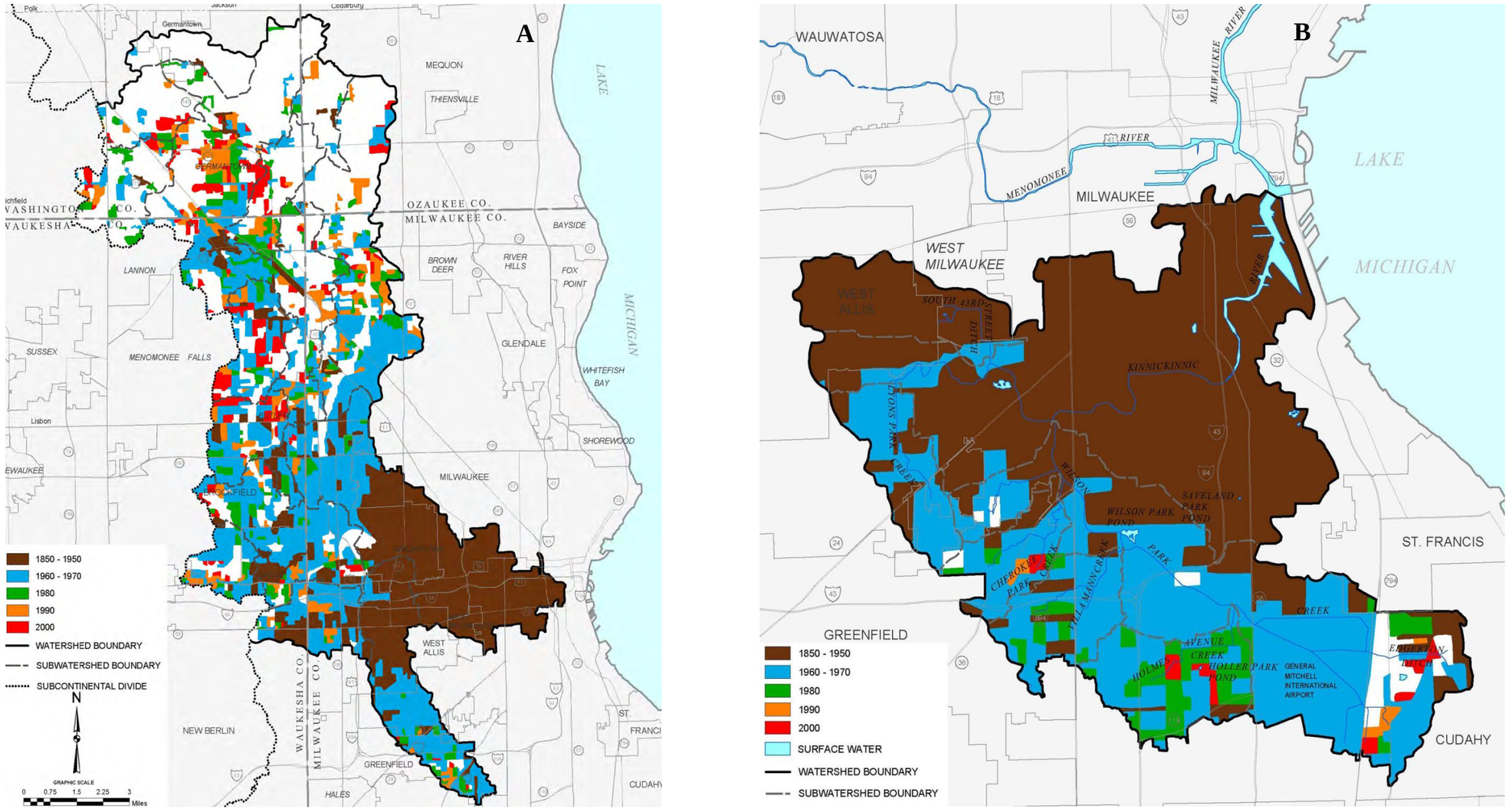
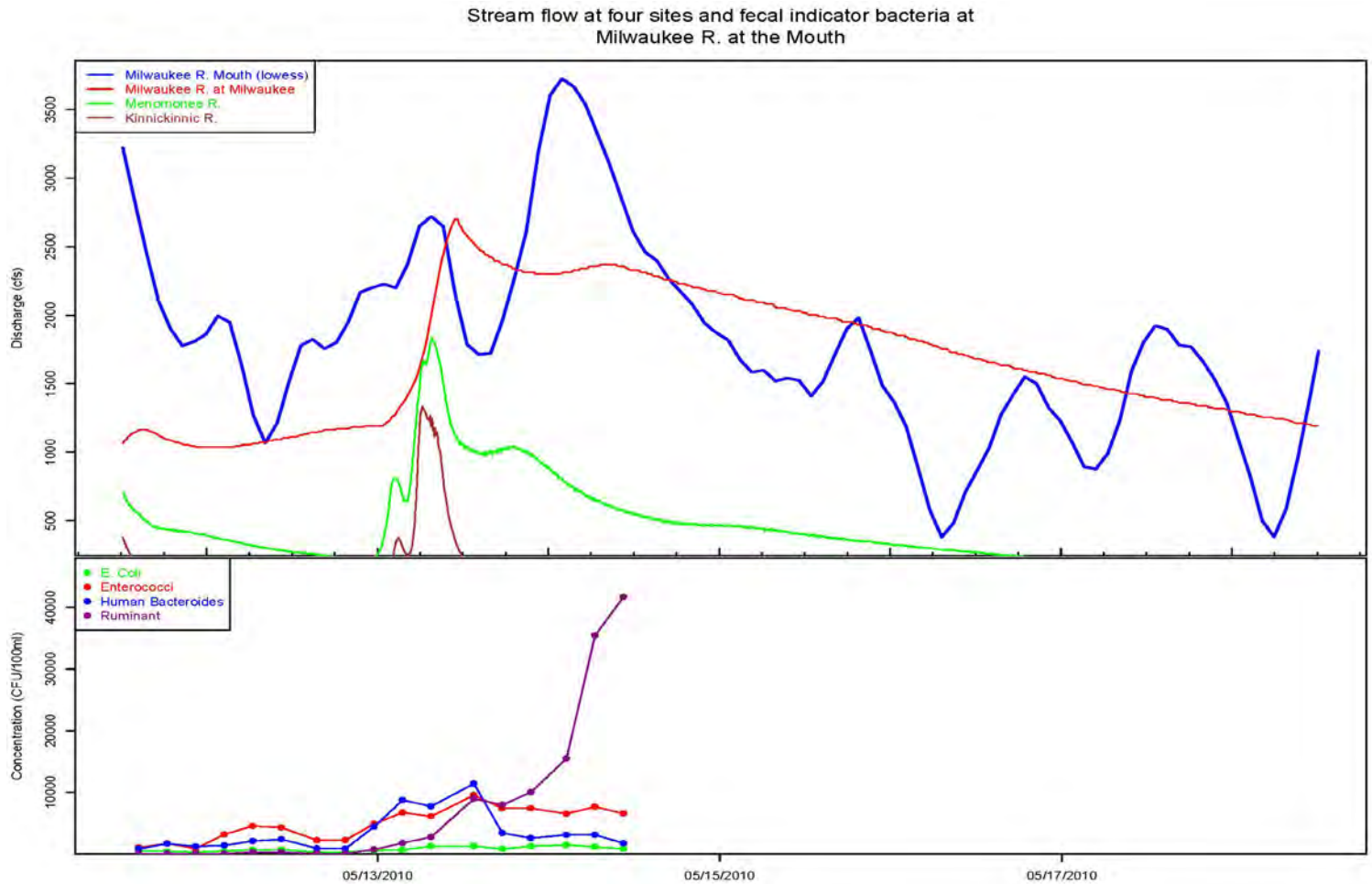


Figure 3. *Top panel,* hydrograph of three AOC rivers; blue line indicates the discharge to Lake Michigan from the estuary. Bottom panel, **human-specific indicators** and **ruminant-specific indicators** measured at the estuary across the hydrograph during rain events **5/13/10.** Human fecal indicators, *Bacteroides* and *Lachnospiraceae* (i.e., Lachno2), are detected at high concentrations at the peak of the discharge for the two urban rivers, while the flow peak later in the hydrograph for the estuary is correlated with higher contributions of bacteria from ruminants.



Appendix H

Results from 2011 Bacteria Source Tracking

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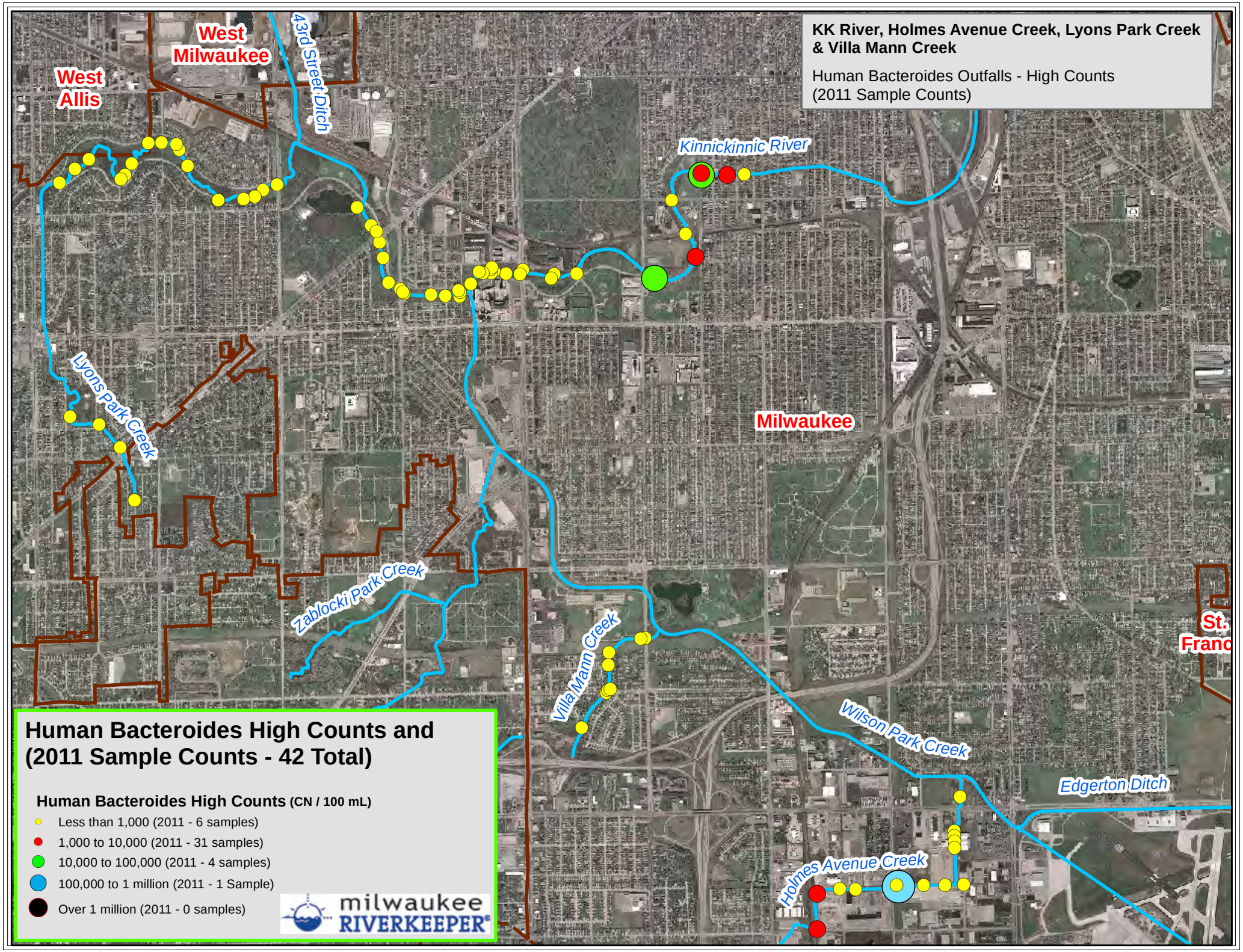
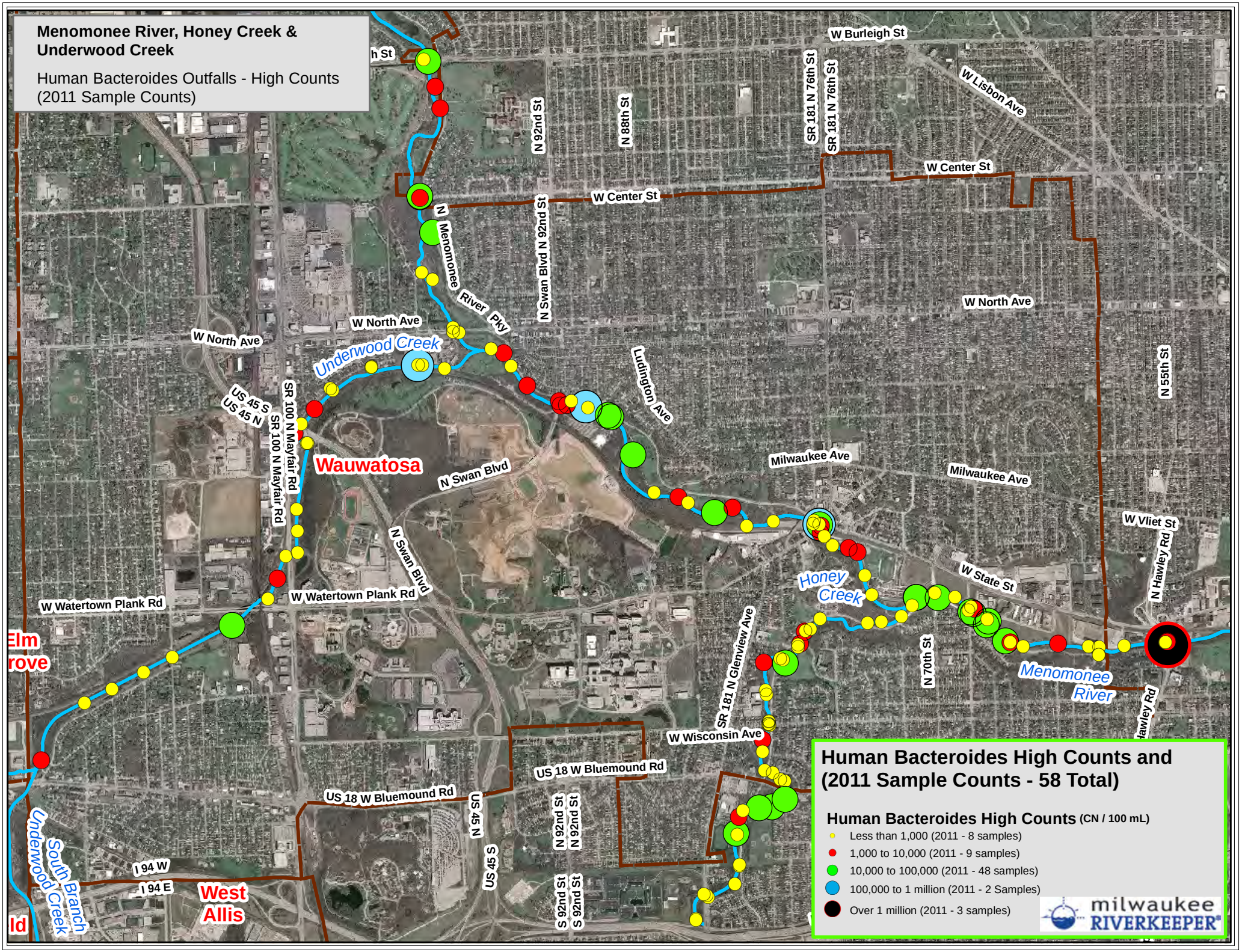

KK River, Holmes Avenue Creek, Lyons Park Creek & Villa Mann Creek
Human Bacteroides Outfalls - High Counts (2011 Sample Counts)
West Milwaukee
West Allis
43rd Street Ditch
Kinnickinnic River
Lyons Park Creek
Milwaukee
Zablocki Park Creek
Villa Mann Creek
Wilson Park Creek
Edgerton Ditch
Holmes Avenue Creek
St. Franc
Human Bacteroides High Counts and (2011 Sample Counts - 42 Total)
Human Bacteroides High Counts (CN / 100 mL)
Less than 1,000 (2011 - 6 samples)
1,000 to 10,000 (2011 - 31 samples)
10,000 to 100,000 (2011 - 4 samples)
100,000 to 1 million (2011 - 1 Sample)
Over 1 million (2011 - 0 samples)
milwaukee RIVERKEEPER


Menomonee River, Honey Creek & Underwood Creek
Human Bacteroides Outfalls - High Counts (2011 Sample Counts)
Human Bacteroides High Counts and (2011 Sample Counts - 58 Total)
Human Bacteroides High Counts (CN / 100 mL)
Less than 1,000 (2011 - 8 samples)
1,000 to 10,000 (2011 - 9 samples)
10,000 to 100,000 (2011 - 48 samples)
100,000 to 1 million (2011 - 2 Samples)
Over 1 million (2011 - 3 samples)
milwaukee RIVERKEEPER
Wauwatosa
West Allis
Elm Grove
Underwood Creek
Honey Creek
Menomonee River
South Branch Underwood Creek
W Burleigh St
W Lisbon Ave
W Center St
N 92nd St
N 88th St
SR 181 N 76th St
N Menomonee River Pky
N Swan Blvd N 92nd St
W North Ave
Ludington Ave
N 55th St
US 45 S
US 45 N
SR 100 N Mayfair Rd
N Swan Blvd
Milwaukee Ave
W Vliet St
N Hawley Rd
W State St
W Watertown Plank Rd
N 70th St
SR 181 N Glenview Ave
W Wisconsin Ave
US 18 W Bluemound Rd
N 92nd St
S 92nd St
I 94 W
I 94 E

Appendix I

BUI Tracking Matrix

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.

Milwaukee AOC BUI Tracking Matrix

December 2012

Beneficial Use Impairment Name	Assessment needed? If yes, is it scheduled? When?	Actions/Tasks Needed	Funding Source; estimated cost if known	Action status: In progress, Completed, Not started	Project type*	Project Lead	Timeframe for Project Completion	Comments
Restrictions on Dredging Activities - Kinnickinnic	Yes, area across from Solvay in line for Legacy Funding year TBD	Solvay Superfund Alternative site Sed. cleanup in area across from Solvay	RP Legacy Act	In progress Not started	3 3	USEPA USEPA	Unknown Unknown	USEPA negotiating scope of project with RP. Submitted by WDNR as a priority Legacy Act project in 2011.
Restrictions on Dredging Activities – Menomonee	Yes, not scheduled	Assess river downstream of its confluence with the Little Menomonee River. Clean up of Burnham Canal also needed.	Legacy Act	Not started	1	USEPA	Unknown	One of several sites where sediment characterization is needed.
Restrictions on Dredging Activities - Milwaukee	Yes, see comments	Assess areas downstream of confluence with Cedar Creek and upstream from the Lincoln Park sites. Phase 2 of the Lincoln Park project also needs to be completed.	Legacy Act	In progress, not started	1	USEPA	Unknown	Some areas downstream of Cedar Creek are being assessed, but additional characterization is needed. Phase 2 of Lincoln Park project is in queue for feasibility study in 2013.
Restrictions on Dredging Activities - Estuary	Yes, 2012	Assess areas adjacent to Solvay Coke site that are not dredged for navigation	Legacy Act	Not started	1	USEPA	Unknown	Sediment characterization is scheduled to take place in 2012.
Restrictions on Fish and Wildlife Consumption	Wildlife – needed and scheduled for late 2012 & early 2013 through 2015 Fish – assessments occur on a 5-year statewide schedule.	Wildlife consumption study modeled after the one designed for the Sheboygan AOC. Fish consumption outreach and education for subsistence anglers.	Grant to WDNR "FY12 AOC Next Steps"$270,000 TBD	Not started. In progress	1, 5 4	WDNR – Sean Strom WDNR/Milwaukee City/County Health Depts.	2014 2012	Wildlife consumption study funded as part of the GLRI block grant from USEPA's Great Lakes National Program Office to WDNR (referred to as the "FY12 AOC Next Steps" grant). AOC waterbodies are included in the state's fish consumption advisory program, which revisits waterbodies every 5 years. AOC Stakeholder Input Group identified fish consumption outreach project as a priority for the AOC.

Degradation of Benthos	Yes, occurred 2012	Develop outreach and education related to the 2012 assessment.	GLRI funding – part of Sheboygan project	In progress	1, 4	WDNR, USGS, UW-Extension – Andy Fayram, Amanda Bell, Gail Epping Overholt	2012	Sampling delayed in 2011 due to delay in arrival of federal funds. Study findings will be used to assess the need to revisit the 2008 target and to conduct additional characterization. Data expected to be available early in 2013.
Degradation of Fish and Wildlife Populations	Yes, seeking 2013 funding	See proposals in Appendix A.	Unknown	Not started	2, 4	WDNR	2012-2013	Little Menomonee study contributed to assessment methods, and understanding of population status.
Loss of Fish and Wildlife Habitat	Yes, through population assessment	Implement interim habitat projects on pp. 45-46.	Unknown	Not started	2, 4	WDNR	2012-2013	In 2012, list of interim habitat projects identified. Further review of additional projects will occur through 2013.
Bird/animal deformities or reproduction problems	Yes, currently not scheduled	Compile existing data and work with stakeholders/tech teams to determine if which other indicators might be needed, and if current monitoring (tree swallow and mussels) should be expanded.	Unknown	In progress	1, 2, 4	WDNR, NOAA, USGS	2013?	NOAA and USGS collect data which may be useful, especially if expanded to other sites in the AOC.
Fish Tumors or other Deformities	Yes, scheduled for early 2013	Fish tumor study similar to St. Louis River fish tumor study.	GLRI	In progress	1	WDNR, USFWS	2014	In addition to assessment, other sites must still be cleaned up for BUI removal to occur.
Beach Closings/Recreational Restrictions	Yes, seeking 2013 funding	Source identification of bacteria necessary to determine human health risk for recreational restrictions.	Unknown	In progress	1	GLWI, MKE Riverkeeper	Unknown	See Appendices F and G.
Degraded Phytoplankton and Zooplankton populations	Yes, occurred 2012	Develop outreach and education related to the 2012 assessment.	GLRI funding – part of Sheboygan project	In progress	1	WDNR, USGS, UW-Extension – Andy Fayram, Amanda Bell, Gail Epping Overholt		Sampling delayed in 2011 due to delay in arrival of federal funds. Study findings will be used to assess the need to revisit the 2008 target and to conduct additional characterization. Data expected to be available early in 2013.

Eutrophication or Undesirable Algae	Unknown, pending results of TMDL	Implementation of TMDL.	GLRI	In progress	2, 3	MMSD	2013	
Degraded Aesthetics	Yes, began in 2012	Continue volunteer aesthetics monitoring in the AOC in 2013.	GLRI	In progress	4, 5	WDNR	2012-2016	Target says that we must have at least five years' worth of data.

*Project types:

1 Baseline assessment through data gathering
2 Compile & analyze existing data
3 On-the-ground remediation or restoration project
4 Stakeholder engagement and/or community education & outreach
5 Verification of target achievement through monitoring or other documentation
6 BUI status change process