DELISTING TARGETS FOR THE MILWAUKEE ESTUARY AREA OF CONCERN: FINAL REPORT

Submitted to Wisconsin Department of Natural Resources

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1.0 EXECUTIVE SUMMARY

This report summarizes the development of delisting targets for the Milwaukee Estuary Area of Concern (AOC). The goal of this project was to establish endpoints that define a rehabilitated watershed and allow the delisting of the Milwaukee Estuary as an AOC under the Great Lakes Water Quality Agreement. Delisting targets also support and reinforce the planning and implementation of watershed rehabilitation efforts, thus providing positive social and economic impact for the region. The process of delisting AOCs is defined by policies and guidance established by The International Joint Commission (IJC), U.S. Environmental Protection Agency (U.S. EPA), and Environment Canada. These policies are, in turn, carried out by the states and provinces wherein the AOCs reside. For the Milwaukee AOC, the Wisconsin Department of Natural Resources (WDNR) has collaborated with various local and regional governments, universities, and citizens in addressing the impairments to the watershed, including the development of these targets.

Since European settlement of the region, changes in land use within the river basins feeding the Milwaukee Estuary have redefined the watershed and resulted in degradation to natural features and functions. More than a century of such degradation resulted in the estuary's listing as a Great Lakes AOC. The Milwaukee AOC was listed in the mid 1980s based on the identification of eleven of the fourteen Beneficial Use Impairments (BUIs) the IJC had identified as potentially applying to the Great Lakes region. The eleven Beneficial Use Impairments for the Milwaukee Estuary AOC are as follows:

- Restrictions on fish and wildlife consumption
- Degradation of fish and wildlife populations
- Fish tumors and deformities
- Bird or animal deformities or reproduction problems
- Degradation of benthos
- Restrictions on dredging activities
- Eutrophication or undesirable algae
- Beach closings and body contact
- Degradation of aesthetics
- Degradation of phytoplankton and zooplankton populations
- Loss of fish and wildlife habitat

The WDNR and its local collaborators have already made progress toward addressing many of these impairments. Significant milestones include the completion of a Remedial Action Plan in 1994, reductions in combined sewer overflows and stormwater discharges, and the investigation and remediation of contaminated sediments at several locations in the watershed.

This project to develop delisting targets has drawn from previous efforts within the Milwaukee Estuary and its tributaries, as well as from efforts at other Great Lakes AOCs. The project team reviewed Wisconsin Water Quality Criteria and the delisting/restoration targets developed in other states to

determine the applicability of these targets to the Milwaukee Estuary AOC. Included in this review were the targets under development for the St. Louis River AOC, the only other Wisconsin AOC to have begun the delisting target development process. During this review, it became apparent that although targets developed in other AOCs and generic state-wide criteria were good starting points, the final targets for an AOC had to be site-specific and adapted to the specific circumstances associated with the watershed under consideration. This philosophy was utilized in tailoring the Milwaukee Estuary watershed delisting targets that were reviewed and adopted by members of the steering committee for this project.

Draft delisting targets for the eleven BUIs were initially developed by the project consultants Short Elliott Hendrickson Inc. (SEH®) and Environmental Consulting & Technology, Inc. (ECT). The project consultants reviewed the current state of the AOC based on existing data and available reports. No additional data were collected as a part of this project. These targets were then reviewed by designated technical experts and refined for presentation to the project steering committee before incorporation into this document.

The delisting targets presented in this report are measurable and definable endpoints established specifically for the Milwaukee Estuary AOC. In some cases, the targets are conditional, offering alternative methods of evaluation to achieve restoration goals. The discussion of the targets also identifies specific actions necessary to apply the target and determine when the criteria have been met. An updated Remedial Action Plan (RAP) report will be completed for the Milwaukee Estuary AOC in the near future. This next generation RAP, and subsequent iterations, will help identify and prioritize BUIs that can be most easily delisted using these targets, and will identify the steps necessary to work towards implementing the restoration for all BUIs. This updated RAP will constitute a restoration work plan that will address restoration alternatives, reference sites, schedule, estimated costs, funding sources, and monitoring networks.

It is also important to note what a delisting target is not. Delisting targets are not promulgated standards, nor are they meant to be incorporated into promulgated standards. Rather, delisting targets are to be considered along with other guidelines and lines of evidence to determine when it is appropriate to delist a BUI. Delisting targets are meant to be consistent with state guidelines and administrative codes, but they are not meant to supersede or in any way modify the application of such guidelines and codes.

Once it has been established that delisting targets have been met or that progress is moving extensively towards delisting goals, the BUI or sub-watershed can be recommended for delisting or placement in the “recovery” stage. An RAP implementation committee, working in consultation with the public and stakeholders, would then submit a recommendation to delist the AOC, or portions thereof, and complete a Draft Final RAP Stage 3 Report to U.S. EPA and WDNR. The recommendation spells out the roles and responsibilities for implementation of the RAP.

2.0 PROJECT INTRODUCTION AND RATIONALE

There is renewed interest in determining goals and targets for "de-listing" Areas of Concern (AOCs) (i.e. determining at what point impaired beneficial uses can be considered restored) throughout the Great Lakes. The process of listing and delisting AOCs is largely defined by the International Joint Commission (IJC) and U.S. Environmental Protection Agency (U.S. EPA), although the guidance provided by these agencies is necessarily general, leaving individual AOCs with the task of tailoring delisting targets to local needs. For the Milwaukee Estuary AOC, the complexity of the watershed requires a combination of delisting targets that are either: 1) specific to site conditions; or 2) flexible enough to assimilate new data and address changing watershed conditions.

The renewed interest in delisting is especially relevant for the Milwaukee Estuary AOC, where active involvement by the Wisconsin Department of Natural Resources (WDNR), various local and regional governments, universities, and citizens groups has resulted in significant progress. This collaborative effort has resulted in several reports and initiatives that have established the foundation upon which this current delisting effort is based. Specifically, the 1994 Remedial Action Plan, the 1999 Milwaukee River Basin Environmental Indicators Pilot Project, the Milwaukee Metropolitan Sewerage District's Corridor Study database, and the Southeastern Wisconsin Regional Planning Commission's Regional Water Quality Management Plan Update (SEWRPC, 2008) have, among others, provided valuable site-specific information to support the development of meaningful restoration endpoints.

It is important to note the development of delisting targets is a culmination of efforts at the international, federal, state, and community levels. Thus, the development of delisting targets relevant to the Milwaukee Estuary AOC, accepted by Wisconsin, the U.S. Environmental Protection Agency, other agencies, regional and local governments, and the public, was the major goal of this project.

It is equally important to note what a delisting target is not. Delisting targets are not promulgated standards, nor are they meant to be incorporated into promulgated standards. Rather, delisting targets are to be considered along with other guidelines and lines of evidence to determine when it is appropriate to delist a BUI. Delisting targets are meant to be consistent with state guidelines and administrative codes, but they are not meant to supersede or in any way modify the application of such guidelines and codes.

The process of delisting AOCs is defined by policies and guidance established by IJC, U.S. EPA, and Environment Canada. These policies are, in turn, carried out by the states and provinces wherein the AOCs reside. The original listing of Great Lakes AOCs was based on the presence of beneficial use impairments (BUIs) within each candidate area. The IJC lists fourteen BUIs that may apply to Great Lakes AOCs, eleven of which were identified as impaired in the Milwaukee Estuary AOC Remedial Action Plan (RAP). Annex 2 of the Great Lakes Water Quality Agreement (GLWQA) provided no guidance for listing or delisting BUIs. The first set of guidance for delisting targets was put forth in 1991 by the IJC. These criteria were fairly general, and led to a more specific set of guidance published by the U.S. EPA in 2001. In addition to the generalized guidance published by U.S. EPA, the states of Michigan (April 2006) and Ohio (2005) have developed generic statewide criteria that can be applied to AOCs within these jurisdictions. These and other AOC-specific criteria were considered in the development of delisting targets for the Milwaukee Estuary AOC.

Because early IJC guidance for listing BUIs was general, many Great Lakes AOCs included listings for BUIs where relatively little data existed to justify an impairment. For the Milwaukee Estuary AOC, BUIs listed without substantial data, and thus considered "suspected impairments," include: 1) fish tumors and deformities; 2) bird or animal deformities or reproduction problems; and 3) degradation of benthos. The fact that these BUIs were originally listed based on minimal standards has been considered in the development of delisting targets within this document.

The eleven Beneficial Use Impairments for the Milwaukee Estuary AOC are as follows:

- Restrictions on fish and wildlife consumption
- Degradation of fish and wildlife populations
- Fish tumors and deformities*
- Bird or animal deformities or reproduction problems*
- Degradation of benthos*
- Restrictions on dredging activities
- Eutrophication or undesirable algae
- Beach closings and body contact
- Degradation of aesthetics
- Degradation of phytoplankton and zooplankton populations
- Loss of fish and wildlife habitat

Note: BUIs noted with an asterisk (*) above were originally listed based on insufficient data and should be considered "suspected impairments."

The goal of developing delisting targets is to create a plan for the improvement of the watershed. Rehabilitation and improvement of the Milwaukee Estuary AOC which will result in benefits that can be described both qualitatively (e.g. aesthetics) and quantitatively (e.g. economic benefits). Rehabilitation is expected to enhance the beneficial uses of the watershed, perhaps even those not listed as impaired. Beneficial uses include swimming, boating, transportation, tourism, fish for recreational and commercial catch and consumption, wildlife viewing, clean and healthy drinking water, biodiversity and genetic preservation, agriculture, and natural products for food and medicines. In addition, the quality of life is improved with enhanced aesthetics from the natural beauty of the watershed. Many people experience the environment in positive ways, such as a relief from the stresses and pressures of urban life or by having a spiritual experience or a connection with nature. In general, we can attribute many social and psychological benefits to preserving and enhancing the natural beauty of our environment.

There are measurable and immeasurable benefits to improving water quality in terms of human health effects. At beaches with degraded water quality associated with storm water runoff or sewage discharges, bacterial and parasitic infections can result in direct medical costs or in sick days off of work for afflicted adults or adults caring for sick children. Such effects are very difficult to tie directly to degraded surface water quality, however, as water-borne diseases may be attributed to many different means of exposure. Restrictions on fish consumption lead to losses in market revenues from fisheries,

and consumption of contaminated fish can cause health effects. Water quality improvements should lead to improvements in human health that cannot easily be quantified due to a lack of our understanding or ability to establish cause-and-effect from exposure to biological and chemical agents from contaminated sites. For example, gastroenteritis can result from swallowing contaminated water while swimming or from eating contaminated food. The relative contribution of cumulative exposures to chemicals in the environment to major disease processes is very difficult to assess. PCBs, one of the major contaminants in sediments, water, and fish tissues of the Milwaukee Estuary, contributes to several health effects, including thyroid problems, reproductive and immune system impairments, decreased IQ in children of mothers with PCBs stored in their bodies, diabetes, and cancer. Mercury, another contaminant in sediments that accumulates in fish tissues, is known to cause neurological and developmental effects.

It is equally important to reduce or eliminate chemical discharges into our waterways. Chemicals released to the environment cycle between air, soil, water, sediments, and biota and are transported globally through the atmosphere. Thus, we cannot eliminate our exposure to toxic chemicals by merely avoiding direct contact with known contaminated sites. Routes of exposure to toxic chemicals include dermal, oral, and respiratory/inhalation from swimming and other outdoor activities. An additional route of exposure results from ingestion contact to chemicals in our drinking water, since the Milwaukee Estuary drains into Lake Michigan which is a source of drinking water for many communities.

Nutrient loading from improper use of fertilizers, storm water runoff, and erosion can lead to undesirable algal blooms which can affect water quality and other biota. Algae can increase the natural organic matter content of drinking water source water, which upon disinfection with chlorine, may form toxic disinfection byproducts. Algae can also add an undesirable taste-and-odor to the water. Although drinking water was not a basis for the listing of the AOC, restoration of the nutrient-related BUIs would likely improve drinking water quality.

Ecosystem health is important to humans as well as to fish and wildlife. Maintaining genetic diversity and healthy populations of fish and wildlife will result in immediate as well as long term beneficial uses.

Restrictions on dredging impact navigational uses of the AOC related to recreational uses and commercial transportation. Most of the BUIs documented in the AOC have direct or indirect links to contaminated sediment and excessive sedimentation, including fish populations, fish consumption, habitat, and benthic environments. Expected economic impacts from AOC delisting include increases in property values, business, and tourism revenues. Cost-benefit analysis in terms of remediation can easily be justified. Remediation for PCB and other contaminant removal is a short-term investment that leads to long-term benefits. Long-term projects to sustain the environment, such as storm-water management plans, lead to continuous economic benefits, but require operation and management costs in addition to capital investments in infrastructure improvements and technological Best Management Practices (BMPs).

There are social and economic consequences of the current BUIs of the Milwaukee Estuary. In addition, the designation of AOC may also have economic impacts to a region. For example, a 2003 study by the Northeast-Midwest Institute estimated that remediation of contaminated sediment in Waukegan Harbor, Illinois could increase individual property values by a range of $21,000 to $53,000.

A similar analysis was completed for the Sheboygan River AOC, indicating a potential increase in single-family residential property values of 3.9 to 5.4 percent. In Thunder Bay, Sustainable Futures et al. (1996) estimated that $50 million in investments in economic development would ensue from cleanup of contaminated sediments in this AOC (cited from the Sediment Priority Action Committee 2000).

The development of delisting/restoration targets for the BUIs within the AOC is an essential part of updating RAP status. These targets will be used as guidelines to provide measurable endpoints that will enable stakeholders to know when the remediation in the AOC has accomplished the specified RAP goals. Each BUI will be evaluated with respect to the applicability of that BUI to each of the AOC watersheds as part of this project. This information will be utilized in the RAP status report to determine which targets should be applied where within the AOC.

3.0 MILWAUKEE ESTUARY – HISTORICAL OVERVIEW

The Milwaukee Estuary Area of Concern (AOC) includes: the lower 3.1 miles of the Milwaukee River downstream of North Avenue Dam; the lower 3 miles of the Menomonee River downstream of 35th Street; the lower 2.5 miles of the Kinnickinnic River downstream of Chase Avenue; and the inner and outer Harbor and nearshore waters of Lake Michigan, bounded by a line extending north from Sheridan Park in the city of Cudahy to the city of Milwaukee's Linnwood water treatment plant. The immediate area draining to the AOC encompasses about 22 mi^2 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 has been affected by pollution sources associated with land use from the entire drainage basins of the Milwaukee, Menomonee, and Kinnickinnic Rivers.

Since European settlement of the area, changes in land use within the river basins feeding the Milwaukee Estuary have redefined the watershed and resulted in severe manipulation and degradation to natural features and functions. More than a century of such degradation resulted in the estuary's listing as a Great Lakes AOC. Delisting the AOC is not a simple matter of reversing these historical trends, however. Reversion to pre-European settlement conditions is not a reasonable expectation – nor would many consider that an acceptable goal. Rather, the challenge of de-listing the Milwaukee Estuary AOC involves rehabilitating degraded resources and reforming high-impact practices. In meeting this challenge, a successful effort will establish a modern and sustainable relationship between the community and its watersheds.

3.1 SIGNIFICANT HISTORICAL TRENDS

The watersheds feeding the Milwaukee Estuary (including the Milwaukee, Menomonee, and Kinnickinnic Rivers) have undergone significant transformation since European settlement. These changes have affected the landforms, water quality and quantity, fisheries, wildlife habitats, and sediments of the area. These trends are summarized in the following paragraphs.

3.1.1 Landform Transformation

It is clear that land use plays an important role in water quality, water quantity, presence of fish and wildlife habitat, and sediment contamination. The Milwaukee Estuary and its watersheds have undergone significant man-made transformations that define the backdrop for our current de-listing efforts. Among the significant trends that have transformed the landscape of the Milwaukee Estuary and its tributaries are:

- Urbanization – The Milwaukee area is Wisconsin's largest city and metropolitan area. Urbanization results in increases of impervious surfaces, runoff, water temperature, pollutants, sewage, and industrial discharges. Fortunately, recent trends reflect federal, state, and local efforts to better manage storm water and sewage, as well as to address the legacy of industrial pollutants remaining in sediments.
- Loss of Wetlands – Much of the area that is now in the Milwaukee Estuary AOC was once wetlands. Due to urbanization, harbor development and channelization, few wetland areas

remain in the area. As an indication, the Kinnickinnic River basin is currently less than one percent wetlands by land area (WDNR, 2001). Current efforts to restore and protect wetlands are primarily focused where opportunities exist upstream of the defined AOC, although benefits from such efforts will also accrue to the estuary.

- Channelization and Shoreline Modification – Along with the loss of wetlands and urbanization, the landform of the Milwaukee Estuary has been greatly altered by the channelization of the water course and the armoring of the shoreline. These activities significantly affect aesthetics and fish and wildlife habitat. The Southeastern Wisconsin Regional Planning Commission (SEWRPC) performed an extensive analysis of shoreline buffers and channel modifications that provides valuable baseline information for target setting (SEWRPC, 2008).

3.1.2 Water Quality and Quantity

Water quality and quantity have been greatly affected by urbanization, through changes to landform, as described above, and sewage and industrial discharges. Sanitary sewage overflows (SSOs) (from a variety of municipalities), and combined sewage overflows (CSOs) (from within the Milwaukee Metropolitan Sewerage District (MMSD) footprint), have degraded water quality, especially following heavy rains. Pollutants like excess solids, nutrients, and toxic substances are found in untreated sewage and can have a direct effect on water quality, habitat, fish, and wildlife. The pathogens found in sewage, such as certain types of bacteria, viruses, and protozoa, can put humans that ingest these organisms at risk. Some skin rashes can also occur from contact with certain water-borne pathogens. Beach closings from the presence of pathogens have been a particular concern, especially due to an apparent increase in the frequency of beach closings earlier this decade. Although CSOs and SSOs have commonly been identified as a source of bacteria, some information suggests that urban wildlife and illicit stormwater connections may also be significant contributors to the issue (McLellan, et al, 2007). The WDNR and MMSD have identified measures and taken steps to reduce the frequency of SSOs and CSOs, including MMSD's highly visible "deep tunnel" project, which was completed in 1996 and has been shown to reduce the frequency of CSO events from 50+ per year to an average of 2-3 per year.

3.1.3 Fisheries and Habitat

As could be expected, changes in land form, river channel modifications, and the degradation of water quality have greatly impacted fisheries and habitat in the Milwaukee Estuary AOC. Despite the long-term degradation of the watershed from its natural state, recent efforts to rehabilitate the fishery and improve habitat have shown positive results. For example, the partial removal of the North Avenue dam in 1997 and subsequent structural improvements have benefited native species such as smallmouth bass, as well as salmon and trout. As evidence of these improvements, the fish community within the impoundment in 1990 was dominated by a few species considered tolerant to degraded conditions. In 1997, the number of native fish species had increased five-fold, and is characterized by species that are less tolerant of degraded conditions. Smallmouth bass have become the dominant species and Greater Redhorse, a state listed Threatened Species, is common. Despite such successes, more work is needed basin-wide to enhance spawning and nursery habitat for native species. The *Milwaukee River Estuary Fish Spawning Habitat Rehabilitation Project* installed fish spawning habitat for native

resident and potadromous (migratory) fish and other aquatic life in the Milwaukee River Estuary. The construction was completed in 2006; evaluations are being conducted to determine the use by species such as walleye for spawning.

3.1.4 Sediment

The growth of the Milwaukee area as a leading industrial center brought with it the legacy of pollution, much of which was discharged into area rivers where it settled in sediments. With the onset of environmental legislation in the 1970s (most notably the Clean Water Act), direct discharges of typical sediment pollutants have been largely eliminated. Progress has been made on cleaning up several contaminated sediment areas, including removal of PCBs from the Ruck Pond site in Cedarburg, remedial design for the Estabrook Impoundment on the Milwaukee River, and the Kinnickinnic River Contaminated Sediment Remediation Project (which is within the AOC).

Since the Milwaukee Estuary AOC Boundary was first drawn in the late 1980s, research has shown that there are significant contributions of toxic substances to the Milwaukee Estuary AOC from upstream sources. The upstream areas contributing contaminated sediments include:

- *Cedar Creek downstream from Bridge Road to confluence with Milwaukee River*. This area encompasses the entire Cedar Creek Superfund site, which contributes sediments contaminated with PCBs to the Milwaukee River.
- *Milwaukee River and tributaries from confluence with Cedar Creek to former North Avenue Dam*. This area includes the Milwaukee River area that is influenced by contaminated sediments from Cedar Creek and Lincoln Creek. This also includes a large deposit of contaminated sediments located upstream from the Estabrook Park Dam.
- *Little Menomonee River from Brown Deer Road to confluence with Menomonee River, and Menomonee River downstream from confluence with Little Menomonee River to 35th Street*. The Little Menomonee River contains the Moss American Superfund Site, which potentially contributes contaminated sediments to the Menomonee River.

The WDNR is notifying the IJC and U.S. EPA of its intention to expand the AOC to encompass these contaminated sediment sources. The Milwaukee RAP Technical Advisory Committee recognized that sources of contaminated sediments upstream from the AOC must be controlled prior to initiating large-scale sediment removals within the AOC.

3.2 BENEFICIAL USE IMPAIRMENTS

The Milwaukee Estuary was designated an Area of Concern (AOC) in the mid-1980s because of historical modifications and pollutant loads that contributed toxic contaminants to the AOC and Lake Michigan. Sediments contaminated with PCBs, PAHs, and heavy metals contribute to most of the beneficial use impairments (BUIs) within the AOC. The rivers within the AOC were also historically modified (straightened and dredged) to accommodate large vessel commercial shipping.

While Milwaukee still maintains a viable commercial port, some of the river reaches within the estuary are no longer maintained through dredging. Through the RAP process, the WDNR, along with the help of citizens groups, has identified eleven of the fourteen beneficial uses as impaired. Although the WDNR listed eleven impairments, the RAP Technical Advisory Committee (TAC) considered the data

adequate for only eight of the listed BUIs. Three of the impairments (designated with an asterisk below) were considered "suspected impairments" based on limited data. The 1994 RAP recommended monitoring of these suspected impairments to better determine the extent of the impairment. The eleven BUIs in the AOC are:

- Restrictions on fish and wildlife consumption
- Degradation of fish and wildlife populations
- Fish tumors and deformities*
- Bird or animal deformities or reproduction problems*
- Degradation of benthos*
- Restrictions on dredging activities
- Eutrophication or undesirable algae
- Beach closings and body contact
- Degradation of aesthetics
- Degradation of phytoplankton and zooplankton populations
- Loss of fish and wildlife habitat

Note: BUIs noted with an asterisk (*) above were originally listed based on insufficient data and should be considered "suspected impairments."

Once delisting targets are identified for these eleven BUIs, the next step will be to develop a guide for meeting recommended benchmarks to restore beneficial uses through consultations with experts and public participation.

3.3 DEVELOPMENTS TOWARDS DELISTING

Stage One of the Milwaukee Estuary Remedial Action Plan (RAP) was initiated in 1988. The WDNR was primarily responsible for RAP development. A Technical Advisory Committee, a Citizen's Advisory Committee (CAC) and a Citizen's Education and Participation Subcommittee advised WDNR during RAP development. The CAC has been instrumental in building consensus from divergent views, striving for community-wide unity and enthusiasm for the RAP.

The development of a Stage Two RAP began in 1991 using technical work groups to develop recommendations. The RAP fosters the philosophy of continuous improvement. The 1994 Milwaukee Estuary RAP document describes progress made on RAP work and outlines a five-year work plan for RAP implementation. The Stage Two RAP is at least 80 percent complete.

Significant RAP Milestones:

- In 2005, the WDNR completed the Estabrook Impoundment Sediment Remediation Pre-Design Study. This study found that the Estabrook Impoundment contributes the greatest mass loading of PCBs to the Milwaukee River and Milwaukee Harbor. Anticipated remediation costs for the project area range from $18 to $36 million depending upon the quantity of contamination addressed and the selected management approach.
- In August 2005, the WDNR completed the Changing Habitat and Biodiversity report for the Lower Milwaukee River and Estuary (Hirethota, et al, 2005). The report documents changes to the river environment following the removal of the North Avenue Dam in 1997. The WDNR conducted a detailed survey of the riverine habitat in the area that indicated substantial improvement to fish populations and habitat. The removal of the dam not only provided an opportunity for migratory fish species to move further upstream, it also opened up opportunities for rehabilitation of some of the native species that had been reduced to remnant populations. Improvements in the riverine habitat following dam removal increased biological diversity several-fold in the formerly impounded area, including a five-fold increase in the number of native species. The overall environmental quality measured as the Index of Biotic Integrity (IBI) in the formerly impounded area increased from 20 (poor) in 1996 to 80 (excellent) in 2001.
- In 2004, the WDNR with the assistance from the U.S. Army Corps of Engineers (USACE) completed a pre-engineering design for the Deepening/Restoration of the Kinnickinnic River within the Milwaukee Estuary AOC. Eleven project alternatives, including no action and five dredging alternatives combined with two disposal options, were evaluated. The details of the evaluation can be found in the Concept Design Documentation Report. The selected alternative calls for dredging up to 170,000 cubic yards of contaminated sediments, approximately 90% of PCB mass in the project area, creating an 80-ft navigational channel of 20-24 feet deep with side sloped to 11 feet. The dredged sediment is planned to be disposed on the USACE-operated Jones Island Confined Disposal Facility (CDF). Updates related to the Kinnickinnic River Project can be found at: http://dnr.wi.gov/org/water/wm/sms/kkriver/index.html.
- In 2003, the WDNR, in cooperation and collaboration with local, state, and federal authorities, began implementation of the federal Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000. Under the Wisconsin BEACH Program, the WDNR gives grants to communities along Lake Michigan and Lake Superior to monitor beach water for elevated bacteria levels. This information is made available to the public so beach visitors can make informed choices about how to use beach water resources.
- In 2002, the WDNR completed a sediment assessment effort for the Kinnickinnic River, funded by a U.S. EPA-Great Lakes National Program Office (GLNPO) grant. The purpose of this study was to define the extent of contaminated sediments in the project area. Maximum concentrations of 36 ppm and 244 ppm were detected for PCBs and PAHs, respectively. The results are documented in the Sediment Assessment Report, 2003. This report supported the pre-engineering design for deepening/restoration of the Kinnickinnic River completed in 2004 (described above).
- Cedar Creek Remediation Projects (1993 - present): Ruck Pond, the most upstream contaminated site in Cedar Creek, was remediated in 1993 by Mercury Marine under supervision of the WDNR Remediation and Redevelopment program. In 1996, the Hamilton

Dam failed, causing flooding of streambanks and deposition of contaminated sediments onto the floodplains. In 2000 and 2001, Mercury Marine removed approximately 14,000 tons of contaminated sediment from the banks of the floodplains, although contaminated sediments remaining in the stream were not removed. Another source of contamination, the Amcast Company, declared bankruptcy in 2004, complicating investigation and cleanup efforts. A remedial investigation and feasibility study are in progress. A cleanup decision is expected in Fall 2008. (http://www.epa.gov/Region5/sites/cedarcreek/index.htm)

- Milwaukee River and Cedar Creek PCB Mass Balance Studies: This project focused on tracking PCB transport in seven contaminated impoundments on Cedar Creek and the Milwaukee River in order to target sites for future remediation projects. Based on this analysis it was determined that the Estabrook Impoundment contributes the greatest mass loading (4x the mass) of PCBs to the Milwaukee River and Harbor than all the other Cedar Creek and Milwaukee River impoundments combined (Baird and Associates, 1997; Westenbroek, 1993).
- Milwaukee Estuary RAP progress update was completed in 1999.
- RAP Progress Report was completed in 1994.
- Milwaukee Estuary Stage I RAP document was completed in 1991.

The main priorities for the Milwaukee Estuary AOC include: remediation of contaminated sediments in tributaries and nearshore waters of Lake Michigan, prevention of eutrophication, nonpoint source pollution control, improvement of beach water quality, enhancement of fish and wildlife populations, and habitat restoration.

4.0 DELISTING TARGETS – WHERE WE WANT TO BE

4.1 APPLICABILITY OF STATE PROGRAMS AND WATER QUALITY STANDARDS TO DELISTING TARGETS

The State of Wisconsin has adopted Water Quality Standards (WQSs) that are applicable to all surface water bodies in the state. Although the BUIs are technically based on the IJC criteria established in Annex 2 of the 1987 Amendment to the Great Lakes Water Quality Agreement that established the Area of Concern program, many are also related to the Wisconsin WQSs/Designated Uses and/or fish contaminant advisories.

The Milwaukee Estuary AOC shall be delisted when there are no significant controllable impairments to the beneficial uses of the area which have been caused by human activities. The relationship of Milwaukee Estuary BUIs and Wisconsin designated uses and water quality criteria (Chapters NR 104 and 102, Wisconsin Administrative Code) is presented in Table 4-1.

Table 4-1: Milwaukee Estuary Watershed BUIs and Wisconsin Designated Uses

USE IMPAIRMENT	WISCONSIN DESIGNATED USE
Restrictions on fish and wildlife consumption	• Fish and Other Aquatic Life Waters • Waters protected for Public Health and Welfare
Degradation of fish and wildlife populations	• Fish and Other Aquatic Life Waters • Wildlife Use Waters
Fish tumors and deformities	• Fish and Other Aquatic Life Waters • Waters Protected for Public Health and Welfare
Bird or animal deformities or reproductive problems	• NA
Degradation of benthos	• Fish and Other Aquatic Life Waters
Restrictions on dredging activities	• NA
Eutrophication or undesirable algae	• Recreational Use Waters • Waters Protected for Public Health and Welfare
Beach closings and body contact	• Recreational Use Waters
Degradation of aesthetics	• Recreational Use Waters
Degradation of phytoplankton and zooplankton populations	• Fish and Other Aquatic Life Waters
Loss of fish and wildlife habitat	• Fish and Other Aquatic Life Waters • Wildlife Use Waters

The WDNR Water Division Monitoring Strategy (WDNR, 2006a) clarifies which monitoring efforts are used to meet federal Clean Water Act, Fisheries, and Public Trust Doctrine Objectives and prioritizes where future efforts will be focused. The strategy covers all monitoring done under the three WDNR Water Division Bureaus: Fisheries Management, Watershed Management, and Drinking Water and Groundwater.

The Wisconsin Water Quality Report to Congress (2006) is prepared every two years to summarize water quality conditions in the state. The state must also provide electronic data reporting of water body assessments on an annual basis. Additionally, every two years the state is required to submit a list of "impaired waters" to the U.S. EPA. The entire Milwaukee Estuary AOC is currently listed as impaired for bacteria and fish consumption advisories.

Targets for unacceptable contaminant levels in fish and wildlife are established by the Wisconsin Department of Health and Family Services, Division of Public Health, in conjunction with the WDNR. These contaminant levels are used in conjunction with measured contaminant levels from the Wisconsin fish monitoring program to establish fish consumption advisories that result in the Restrictions on Fish and Wildlife Consumption BUI. Fish Consumption Advisories are presented in Choose Wisely - A Health Guide for Eating Fish in Wisconsin (WDNR, 2006b). Elevated contaminant levels can be caused by "food chain biomagnification" through exposure to contaminants in the water column and sediments.

Although there are goals and management programs available from the WDNR that can be used to determine how various factors impact the fish and wildlife populations, there are no promulgated standards directly related to Degraded Fish and Wildlife Populations. Wisconsin's Comprehensive Management Plan to Prevent Further Introductions and Control Existing Populations of Aquatic Invasive Species (WDNR, 2003) presents an example of programs in place and references various State regulations that are indirectly related to this BUI.

The incidence of Fish Tumors and Deformities is indirectly related to the Wisconsin Water Quality Standard (WQS) under Chapter NR 105, Wisconsin Administrative Code (NR 105). Although NR 105 refers to acute and chronic toxicity effects as an endpoint indicator, many of the chemicals listed under the rule also could contribute to the incidence of fish tumors and other deformities. This BUI is generally impacted by contaminated sediments and industrial/municipal wastewater discharges. For the Milwaukee Estuary AOC, this BUI was originally listed based on sediment contaminant concentrations that have been observed to correlate to tumors or deformities, rather than on actual observation of tumors and deformities.

Similarly, Bird or Animal Deformities or Reproductive Problems were not directly observed within the AOC; this BUI was listed based upon indirect data. This BUI is generally impacted by contaminated sediments through biomagnification, but may also be affected by terrestrial factors. No Wisconsin WQS directly relates to this impairment.

Degradation of Benthos is another BUI that is measured by guidance used by the WDNR but is not directly related to established WQSs. The BUI is normally a result of excessive and/or contaminated sediment within the watershed and/or deteriorated water quality which can be evaluated through the

use of WQSs but is more a correlative relationship than a direct standards comparison. The Consensus Based Sediment Quality Guidelines - Interim Guidance (WDNR, 2003) includes probable effects concentrations (PECs) for several chemicals.

Specific determinations on handling of navigation channel maintenance dredge spoils are made by the USACE and the WDNR at the time of dredging. Restrictions on Dredging Activities is considered to be a BUI when dredge spoils must be handled in a special manner or disposed of at a confined disposal facility due to the level of contaminants in the sediment. The WDNR has published the approval process for dredging of commercial ports, which outlines the sampling and disposal protocols for dredged materials. These protocols reflect state regulations found in Chapter NR 347, Wisconsin Administrative Code and Chapter NR 00-520, Wisconsin Administrative Code. The WDNR administrative codes also apply to dredging to remediate contaminated sediments.

It is important to note that the Restrictions on Dredging Activities BUI has been interpreted more broadly for the Milwaukee Estuary AOC than for many other AOCs. The RAP Technical Advisory Committee considered that this BUI applies to all contaminated sediment areas, and is not limited only to areas of navigational dredging. This position is appropriate because handling and disposal issues are identical for navigational and environmental dredging.

While the Eutrophication or Undesirable Algae BUI is not directly evaluated by application of a Wisconsin WQS, interference with "designated uses" established under Chapter NR 102, Wisconsin Administrative Code and unacceptably depressed dissolved oxygen concentrations compared to Chapter NR 102.04, Wisconsin Administrative Code can be used to determine if undesirable algae growths are evident in the watershed. The presence of specific algal species is also indicative of a BUI. This BUI results from excessive nutrient discharges associated with storm water runoff (both point and non point sources), point source discharges from wastewater treatment plants, nutrient release from contaminated sediments, and low base flows resulting in extended detention times in the watershed.

The Wisconsin Beach Monitoring Program was established to implement the U.S. EPA's criteria under the Clean Water Act Section 406(a). These criteria establish the maximum concentration of *E. coli* bacteria that are acceptable for waters of the state to meet total and partial body contact recreational uses. These standards are used to evaluate the Beach Closings and Other "Full Body Contact" Restrictions impairment.

NR 102.04 establishes narrative criteria to evaluate the BUI Degradation of Aesthetics coupled with the watershed designated uses established in Chapter NR 104, Wisconsin Administrative Code. The criterion used in the evaluation is if any of the "unnatural physical properties" associated with aesthetics interferes with the designated use of the watershed. Degraded aesthetics can be caused by point and non-point source storm water runoff, littering, and poorly operated wastewater treatment systems.

Degradation of Phytoplankton and Zooplankton populations is not directly evaluated by application of a Wisconsin WQS. This BUI may result from changes in the food chain caused by other impairments, including temperature changes or excessive nutrient discharges associated with storm water runoff (both point and non point sources), point source discharges from WWTPs, nutrient release

from contaminated sediments, and low base flows resulting in extended detention times in the watershed.

Loss of Fish and Wildlife Habitat is not measured by a Wisconsin WQS. However, it can be evaluated and comparatively ranked by goals and management programs developed by the WDNR. Poor land use planning, failure to protect wetland areas, erosion, high stream flows, and low base flows all contribute to the degradation of this BUI.

4.2 SUMMARY OF DELISTING TARGETS ADOPTED IN OTHER AREAS OF CONCERNS AND THEIR RELEVANCE TO MILWAUKEE ESTUARY AOC

Delisting targets developed and/or proposed in other AOCs were reviewed for relevance to the Milwaukee Estuary AOC during development of the recommended restoration/delisting targets for the watershed. These targets from other AOCs are summarized in this section of the report. Progress toward delisting has been made in the following AOCs:

- In the United States:
    - Oswego AOC on Lake Ontario in New York has recently been delisted; it is the first US AOC to be delisted.
    - Presque Isle Bay AOC in Pennsylvania is in recovery stage.
    - AOCs Clinton River, White Lake, and Saginaw in Michigan have developed delisting criteria/targets and/or milestones.
    - Torch Lake AOC, Michigan, has a well-defined restoration design with appropriate goals, indicators, and a long-term monitoring strategy.
    - Kalamazoo AOC in Michigan is close to finalizing its delisting targets and has established baseline inventories of habitat and wildlife, but needs to develop a long-term monitoring plan.
    - The U.S. side of the Detroit River AOC is progressing toward finalization of delisting targets.
    - The Degradation of Benthos BUI for the Manistique River has been recommended for delisting by the Michigan Department of Environmental Quality (MDEQ).
- In Canada:
    - Collingwood Harbour AOC and Severn Sound AOC have been delisted.
    - Waukegon Harbour AOC may be close to being delisted and fish advisories have been removed.
    - Spanish Harbour AOC is in recovery.

Detroit River AOC on the Canadian side has developed delisting targets that have been approved by the Canadian side Public Advisory Committee (PAC).

The Canadian side of the Detroit River AOC developed delisting targets that have been reviewed and approved by their PAC (May 2005). The targets report has been endorsed by the Canadian PAC as the Canadian delisting targets for the Detroit River until bi-national delisting targets can be developed. This is a multiple BUI and multiple-parameter AOC and may be useful in evaluating and developing Milwaukee AOC delisting targets.

Torch Lake AOC is a Superfund Site and somewhat irrelevant to the Milwaukee Estuary AOC because it is a single issue AOC focusing specifically on mine tailing waste. Most other AOCs have similar issues that relate to the Milwaukee AOC.

Kalamazoo River in the Kalamazoo AOC (Michigan) is also a superfund site similar to portions of the Milwaukee AOC and focusing primarily on PCB-contaminated sediment remediation. Temporary measures to contain leaching of PCBs from landfill sites include installing sheet steel piling to slow erosion of PCB-contaminated soil into the river. A record of decision (ROD) for remediation has not yet been issued. One ”lesson learned” from Kalamazoo to be avoided if possible in the Milwaukee AOC is that delays can be costly and that stakeholders need to get involved in order to achieve progress.

The Presque Isle Bay AOC in Pennsylvania is another location that includes BUIs directly affected by contaminated sediments. This AOC is notable for its consideration of natural attenuation/monitoring as an implementation strategy in the areas that are not significantly contaminated with PCBs. Presque Isle Bay, the only US AOC in recovery stage, was listed as an AOC on the basis of fourteen BUIs, with the most severely impacted being fish tumors and restrictions on dredging. A review of the current sediment data indicates that the sediments were not as contaminated as initially believed in 1991 when the AOC was established, and natural attenuation appears to be working as a recovery process for contaminated sediments. There is currently no indication that natural attenuation is a viable remediation strategy within the Milwaukee Estuary AOC.

Although the St. Clair River AOC developed and adopted “yardstick” measurements of success early in the RAP process, they have not as yet developed approved delisting targets for the nine BUIs in the AOC. The AOC has made significant remediation progress with respect to contaminated sediments utilizing these “yardsticks,” which may be relevant to the Milwaukee Estuary AOC with respect to the dredging restrictions BUI targets. Of specific interest also are the contaminated sediment-related studies that have been conducted to assist in developing sediment-related delisting guidelines. These studies have been conducted to evaluate surficial sediments that may impair benthos and that may help determine the feasibility of remediation.

Further details of information gathered from other AOCs and their relevance to specific BUIs are discussed below:

4.2.1 Restrictions on Fish and Wildlife Consumption

IJC recommends that this BUI is restored “When contaminant levels in fish and wildlife populations do not exceed current standards, objectives or guidelines and no public health advisories are in effect for human consumption of fish and wildlife. Contaminant levels in fish and wildlife must not be due to contaminant input from the watershed.” The limitation to using this criterion is that contaminants in

other sites can be transported to the AOC by atmospheric deposition, and thus will stay in the food chain. A potentially more rational approach is reflected in the Delisting Targets for Ohio Areas of Concern document (2005) that bases this delisting target on "no fish and wildlife consumption advisories attributed to sources within the AOC." Additionally, the proposed milestones include not only tracking changes in fish tissues and advisories, but also setting fish tissue contaminant maximums for PCBs (50 ppb), mercury (50 ppb) and lead (86 ppb).

The Four Agency Framework (U.S. EPA, et al 2000), developed to address the Detroit River, St. Clair River, and St. Mary's River AOCs, recommends basing delisting targets for this BUI on appropriate assessment programs and reporting for a suite of most at-risk chemicals and consumption guidelines (on the most current and restrictive guidelines).

The Great Lakes Fish Consumption Advisory Task Force limit for "no consumption" is for PCB levels above 2000 ng/g, which only applies to lake trout in Lake Michigan. Coho salmon sometimes fall into lesser categories such as "1 meal per month" up to "no more than 6 meals per year."

The St. Louis River AOC delisting target addressed fish consumption through a multi-faceted approach that considers control of contaminant sources, contaminant concentrations in fish tissue, and the status of fish consumption advisories. The delisting target includes a "fallback" provision that applies if the primary targets are not reached within 10 years. The fallback provision is based on control of man-made contaminant sources and no statistically significant difference in fish tissue levels between the AOC and Lake Superior. The St. Louis River AOC does not consider wildlife consumption impairments.

Michigan guidance (2006) is silent with respect to wildlife because there are no AOCs in Michigan with advisories for wildlife. The fish advisories are set by the Michigan Department of Community Health (MDCH). The Michigan guidance states that the BUI is considered restored when:

> "the fish consumption advisories in the AOC are the same or less restrictive than the associated Great Lake or appropriate control site" OR,
>
> if the advisory is more stringent than its associated Great Lake or control site, "a comparison study of fish tissue contaminant levels demonstrates that there is no statistically significant difference in fish tissue concentrations of contaminants causing fish consumption advisories in the AOC compared to a control site" OR,
>
> if a comparison study is not feasible because of the lack of a suitable control site, "analysis of trend data (if available) for fish with consumption advisories shows similar trends to other appropriate Great Lakes trend sites."

In addition, more details are given as to how to conduct the comparison, including choosing of the same species as in control site, controlling for variables that affect contaminant concentrations in tissues, comparing data between the AOC and control site collected within a year of each other, and how to test statistically significant differences between AOC and control site. Michigan AOCs impacted by this BUI include Detroit River, Rouge River, River Raisin, St. Clair River, Torch Lake, Deer Lake and Carp Creek, St. Mary's River, Saginaw River, Kalamazoo River, Muskegon Lake, White Lake, and Manistique River.

In the Saginaw River AOC (Michigan), fish contaminant delisting targets are based on a comparison of contaminant (PCBs and dioxin) levels in other areas of Great Lakes that are not listed as AOCs and on indications from caged fish studies that PCBs sources have been controlled. Comparison to a reference site should be considered in the Milwaukee River Estuary AOC. However, reference sites have to be carefully chosen and agreed upon by the WDNR, U.S. EPA, and stakeholders.

There are currently no specific wildlife consumption advisories for the Milwaukee Estuary AOC. The Sheboygan River also has a waterfowl advisory, but no specific delisting targets related to birds. Most of the delisting targets of AOCs focus on fish, not wildlife generally. The highest PCB levels known in waterfowl were discovered in ducks in the Housatonic River, Massachusetts, where sediments contain an average of 21 ppm PCBs and hot spots were found up to percent levels. The average breast tissue concentration of PCBs in ducks from this study, conducted in 1999, was 7.1 ppm. For comparison, ducks from the Fox River, Wisconsin contained an average breast concentration of PCBs of 0.4 ppm. Although these studies may provide a basis for estimating tissue levels in Milwaukee estuary waterfowl based on sediment concentrations, direct measurement of PCB concentrations in waterfowl are desirable, where available. There has also been some sampling of urban geese for PCBs throughout the state that can be helpful in evaluating this impairment. No sampling was conducted within the AOC, but elevated levels of PCBs were detected in geese tissues sampled in the Cedarburg, Wisconsin area.

4.2.2 Degradation of Fish and Wildlife Populations

The MDEQ guidance (2006) requires the development of a site-specific restoration plan focusing on the individual AOC rather than a statewide universal criterion to address the habitat-related BUIs. The requirements of the plan are applied throughout the state but the content will focus on the individual AOC. The MDEQ guidance recommends that the first step in addressing any of the BUIs is to assure that sources of water quality contamination are controlled. Once the control programs have been established, then a restoration plan must be developed and implemented as described in MDEQ (2006). Since the restoration goals may take a long time to achieve, the guidance states that fish and wildlife populations need not be fully restored before delisting.

The proposed Rouge River, Michigan delisting criteria (2004 Rouge River RAP Revision) are based on: "…fish data are acceptable or better at all stations for 3 consecutive surveys, and Sustainable populations of fish species predicted by Willey/Seelbach models (especially sensitive species), based on stream size and flows."

For St. Mary's River, Michigan, the delisting targets (2002 Stage 2 RAP) are: "concentrations of persistent toxic substances in fish and wildlife will be below no observable adverse effect concentration (NOAEC) for reproductive, population, and teratogenic effects. Effects will be the same as control populations from unaffected areas." The criterion also recommends development of localized restoration plans for fish and wildlife populations.

Ohio guidance (2005) sets delisting targets for fish on biological indices for lakes and nearshore areas, and for wildlife, healthy reproducing populations of sentinel species. In addition, restoration goals and management objectives must be met. The process, which could be applied in the Milwaukee Estuary AOC, would include selecting sentinel species and tracking changes in populations of wildlife and

tracking fish community surveys, achieving water quality standards, and meeting ecoregional biocriteria.

In the Grand Calumet AOC in Indiana, the current proposed delisting target is an "Index of Biotic Integrity (IBI) score that represents the best attainable fish community in the AOC… monitored for ten consecutive years. The IBI Score is determined by U.S. Fish and Wildlife Service and Indiana Department of Environmental Management's (IDEM's) Ecological Potential Study." Note that the Grand Calumet River delisting targets are currently under review for update/modification.

The Canadian side of the Detroit River AOC has set delisting targets based on the following:

- Environmental conditions should support self-sustaining, healthy, and genetically diverse communities of most sensitive indicator species at levels of abundance and biodiversity that would be expected from the amount and quality of suitable physical, chemical, and biological habitat present. The objective should be consistent with the Great Lakes ecosystem objectives, the Great Lakes Fishery Commission's fish community goals for adjoining waters, and the conservation vision for the Detroit River.
- There should be no significant toxicity from water column or sediment contaminants.
- Programs should be in place to discourage further proliferation of existing non-native species and prevent future introductions.

In the Detroit AOC, the number of bald eagles is low, but lake sturgeon and river otters are returning and therefore are being considered as indicator species for the Detroit River.

In the Oswego AOC, the fish habitat and population impairments were partially addressed by the new United States Federal Energy Regulatory Commission's (FERC) Oswego River power dam license that commits to providing enhanced run-of-river flow throughout the year, thereby increasing the amount of suitable habitat for spawning and rearing within the AOC.

The St. Louis River AOC based its delisting targets on population metrics within its own area-specific habitat plan and on the absence of aquatic toxicity impairments in Wisconsin's reporting to Congress under the Clean Water Act sections 303(d) and 305(b).

Channelization/alteration of natural stream flow patterns is a source of impairments to beneficial uses associated with both populations and habitat. Channelization and concrete lining in the Menomonee and Kinnickinnic Rivers of the Milwaukee Estuary AOC has lead to impaired habitat quantity and quality in addition to limiting sediment deposition and increasing flashiness of flow. Several AOCs are addressing this issue in their restoration goals and targets. For example, in the St. Louis River AOC, a restoration goal has been established to restore the natural flow regime to the extent feasible and to achieve a channel morphology that reflects the natural hydrological regime to the extent that it can be replicated. In the Rouge River, an oxbow was reconnected to allow fish migration and a program has been proposed to eliminate the concrete edges down to the low water line in the area of the Rouge that has been concrete lined. The Ohio delisting document recommends altering stream morphology to a more natural state when possible.

At Collingwood AOC, sediment monitoring in 1995 by Environment Canada found that benthic species were different from those in reference sites due to the assemblage of organisms present which were reflective of nutrient conditions and not due to the presence of contaminants. Recommendations for further actions included repeating sediment toxicity tests and resampling of sites to determine if the benthic community was returning to reference conditions. This may be relevant to the Milwaukee Estuary AOC due to the nutrient enrichment problems within the AOC.

4.2.3 Fish Tumors and Deformities

About half the AOCs (including the fourteen US/binational) have fish tumors/deformities as a BUI. For the Milwaukee AOC, this BUI was listed with little evidence to substantiate that an impairment actually exists. This BUI was listed for the Milwaukee Estuary because sediment PAH concentrations were similar to areas with documented tumors and deformities. No studies have been conducted on fish within the AOC to document or describe this impairment.

For AOCs where this impairment has been documented, most can point to declines in the incidence of tumors due to natural attenuation of contaminated sediments and by addressing source reduction. For example, Presque Isle Bay in Pennsylvania, a U.S. AOC in the recovery stage, addressed contaminants with a $100 million sewage treatment expansion and a pollution prevention plan. The class of chemicals thought to contribute the most to tumors and deformities are polyaromatic hydrocarbons (PAHs) and related compounds such as nitro-PAHs and nitrosamines that are found in urban runoff from the combustion of fossil fuels. PCBs and dioxins can also be a cause for this BUI.

The major limitations to delisting this BUI in AOCs are lack of data to substantiate tumor rates and lack of comparison to an appropriate background rate in a reference site. As previously mentioned, the Milwaukee Estuary AOC did not base its listing on fish data, but rather inferred the potential for fish tumors based on concentrations of PAHs in sediments that are known to be associated with effects. Niagara River AOC did the same with PAHs, but had more data on fish tumors. The approach of evaluating sediments for contaminants related to fish tumor and deformities incidence is a good first round screening tool until funds become available to do a more extensive survey, if appropriate. Fish tissue data are better indicators of potential effects than developing relationships based on sediment concentrations of PAHs, but are one step from the complete fish survey recommended by the Pennsylvania Sea Grant study described below. If sediments are found or known to be contaminated above most sediment quality guidelines for PAHs, it may not be worth spending the money on a fish tumor/deformity study until the contaminated sediment issue is resolved and sources are controlled. A standardized approach for evaluating and monitoring fish tumors and other deformities was developed by Penn State and others under a Pennsylvania Sea Grant. The standard approach takes into account the species of fish to be considered, the age of the fish, and how to identify tumors, including histology and other criteria. A final document has not been published, but a manual has been recently released for identification of tumors. A drawback to this approach is that this method requires a lot of expertise and a statistically meaningful study could be extremely costly.

The IJC Delisting Criteria reads, “When the incidence rates of fish tumors or other deformities do not exceed rates at unimpacted control sites and when survey data confirm the absence of neoplastic or preneoplastic liver tumors in bullheads or suckers.”

The Ohio Delisting Target is "DELT (deformities, eroded fins, lesions and tumors) levels in fish do not exceed 0.5%." An optional criterion noted in the delisting document is that "low tumor prevalence is documented in brown bullhead age three years and older over a series of years. Current guidelines suggest that a 5% incidence of liver tumors and a 12% incidence of external tumors are acceptable to consider the area to be in recovery. Great Lakes regional final targets are under development but will be less than 5% liver tumors and 12% overall external tumors."

The MDEQ guidance considers the BUI restored when "no reports of fish tumors or deformities due to chemical contaminants have been verified through observation and analysis by the MDNR or MDEQ for a period of 5 years" OR, in the cases where any tumors have been reported, "a comparison study of resident benthic fish (e.g., brown bullheads) of comparable age and at maturity (3 years), or of fish species which have historically been associated with this BUI, in this AOC and a non-impacted control site, indicates that there is no statistically significant difference (with a 95% confident interval) in the incidence of liver tumors or deformities."

The Detroit River's delisting target is that the incidence rates of fish tumors or other deformities do not exceed rates at non-impacted control sites for a minimum of three sampling periods spaced two to three years apart, and should demonstrate a downward trend. At a minimum, no more than five percent of three-year-old Detroit River brown bullhead fish should have liver tumors, and less than twelve percent should have external tumors or lesions.

The St. Mary's River AOC delisting target is that concentrations of persistent toxic substances in fish will be below no observable adverse effect concentration (NOAEC) for reproductive, population, and teratogenic effects. Any noted effects will be the same as control populations from unaffected areas that may include Lakes Superior and Huron.

The St. Louis River AOC delisting target is based on the control or elimination of all known sources of PAHs and on the absence of reports of DELTs. The target also includes a provision for a comparison study of DELTs within the AOC and a non-impacted control site.

A recent workshop in Ohio hosted by the U.S. EPA Great Lakes National Program Office was convened for the purpose of discussing the fish tumor targets. Two important recommendations coming out of the workshop were that a Great Lake-wide reference condition for fish tumors in brown bullheads should be developed and that DELT should not be used as part of the Fish Tumor and Deformities BUI delisting. The DELT was felt to be more appropriate for evaluation of the Degradation of Fish and Wildlife Populations.

4.2.4 Bird or Animal Deformities or Reproduction Problems

This impairment has not been documented to exist within the Milwaukee Estuary AOC. Rather, the BUI was listed based on the presence of contaminated sediments. Other AOCs have faced similar uncertainties related to this BUI. River Raisin, St. Clair River, Detroit River, Saginaw River, St. Mary's River, Deer Lake, and Kalamazoo River in Michigan list this BUI as being either impaired or "unknown status." Some of these AOC listings are based on historic data and observations of crossed bills and eggshell thinning. In most cases, recent studies of bird/animal deformities or reproductive problems

have not been done. Michigan is using two approaches for determining when this BUI can be considered to be restored/delisted based primarily on availability of data specific to the AOC. In general, the first approach evaluates restoration based on existing MDEQ or other State-approved bird and wildlife data while the second approach, when direct bird and animal data are not available, is to compare tissue residue data with known concentrations of effects. If fish tissue residues in the AOC are not statistically significantly different from their associated Great Lake residues (at the 95% CI), the AOC is considered restored according to MDEQ (2006).

In Kalamazoo, the delisting target is to "remediate contaminated sediments so that there are no reproductive or other negative health effects on wildlife or benthos." In River Raisin, the proposed delisting criterion (2002 RAP Update) is "reduce bird deformities due to causes within the Area of Concern." In the Saginaw AOC, the delisting target is "for Bald eagles –The reproductive success of bald eagles in the Saginaw Bay area is equivalent to that found in other Lake Huron coastal areas in Michigan and, for herring gulls, PCB levels in eggs taken from Saginaw Bay area nest sites are not significantly higher than those found in other Lake Huron sampling locations." According to a 1999 survey, PCBs in the affected site are about five times higher than the reference site. This survey is cited in a report by Public Sector Consultants Inc. (2000).

In New York, the Rochester Embayment set the delisting targets as "1. Representative samples of water do not exceed NYSDEC ambient water quality standards for the protection of aquatic life and/or for protection of wildlife, and 2. Mink are present and are reproducing, or levels of PCBs, dioxin/furans, mirex and mercury measured in the tissue of resident prey are below those known to be associated with mink reproductive failure."

The Ohio AOCs do not have any AOCs with this BUI.

4.2.5 Degradation of Benthos

The degradation of benthos in the Milwaukee Estuary AOC is demonstrated by a lack of biodiversity, where oligochaetes dominate. The degradation is suspected to be caused by metal toxicity and anoxic conditions in some cases, as well as sediments contaminated with PAHs. Thus, addressing contaminated sediments and nutrients will aid in the restoration. However, addressing contaminants and nutrient loadings is not likely to improve benthos in all areas. There are some locations, such as low-energy depositional areas that are routinely dredged, where a healthy population of benthic invertebrates may not be possible regardless of contaminant or nutrient levels. This observation points to the need to assess the impairment on an area-specific basis and on the need to carefully select control sites.

The IJC delisting target is when the benthic macroinvertebrate community structure does not significantly diverge from unimpacted control sites of comparable physical and chemical characteristics. Further, in the absence of community structure data, this use will be considered restored when toxicity of sediment-associated contaminants is not significantly higher than controls.

The MDEQ guidance (2006) states that this BUI will be considered restored when "an assessment of benthic community, using either MDEQ's SWAS Procedure #51 for wadeable streams or MDEQ's

pending rapid assessment procedure for non-wadeable rivers yields a score for the benthic metrics which meets the standards for aquatic life in any 2 successive monitoring cycles (as defined in the two procedures)" OR, in cases where MDEQ procedures are not applicable and benthic degradation is caused by contaminated sediments, the BUI will be considered restored when "all remedial actions for known contaminated sediment sites with degraded benthos are completed (except minor repairs during operation and maintenance) and monitored according to the approved plan for the site."

The guidance in MDEQ (2006) indicates that the BUI only applies to surficial sediments where organisms live.

The Four Agency Framework recommends delisting based on no more benthos than observed in unimpaired areas elsewhere in the Great Lakes basin, or upon comparison with upstream/downstream populations.

On the Canadian side of the Detroit River, delisting targets reflect that the benthic community must contain none of the attributes that characterize a degraded community for four years, and toxicity of sediments from test sites should not be significantly higher than controls. The Canadian RAP specifies the criteria for evaluating if the benthic community is degraded.

In the Saginaw AOC, the delisting targets required that samples of mayfly nymphs collected in the open areas of Saginaw Bay exceed 30/square meter for two consecutive years based on established sampling methods. Mayfly nymphs were used as an indicator organism because they are important to fisheries and because their populations have been severely impacted since early 1950s.

Severn Sound also has as a partial delisting target "to maintain and enhance presence of the mayfly Hexagenia as an indicator of ecosystem health." The delisting target approach utilized for Hamilton Harbour, Ontario AOC could be considered relevant to Milwaukee, especially to the outer harbor and near-shore Lake Michigan areas. Specifically, the Hamilton Harbour targets are: biomass estimates for mesotrophic conditions to range from 25 to 50 g/m2 wet weight of benthos; shift in oligochaete assemblages from indicators of eutrophic environments to mesotrophic indicators; an increase in the contribution of other species such as midges, fingernail clams, mayflies, and the amphipod Pontoporeia hoyi; reduction in oligochaete density from an average 10,000 animals per m2 found in 1984 to between 2,000 and 3,000 per m2 in profundal sediments; appearance of crustaceans, such as freshwater shrimp in the deep water basin and the amphipod Pontoporeia hoyi in the surficial sediments throughout the hypolimnion; and absence of acute and chronic toxic effects attributable to trace metals or organics in benthic macroinvertebrates throughout the harbor.

The Manistique River in the Upper Peninsula of Michigan, which feeds into Lake Michigan, has received concurrence from the U.S. EPA for removing the BUI for Degradation of Benthos. The prinicipal reason for removing this BUI is that sediments contaminated with PCBs and other chemicals have been remediated.

The St. Louis River AOC delisting target states that the "anticipated benthic community quality must be established on a site-specific basis considering conditions that impact the benthic community that cannot be modified." The target includes completion of remedial/restoration actions, control of

contaminant sources, a Benthic Index of Biotic Integrity (B-IBI) of at least "good," and several specific toxicity indicators.

Since the Milwaukee River Estuary AOC has several BUIs related to contaminated sediments, the first priority is to move forward with the remediation of the known contaminated sites. Since most of the PCBs are confined to known sites, after these sites are remediated the PAHs and metals will be the next most important priorities. In many cases, PCBs are buried deeper in the sediments than metals and PAHs, so removing PCBs in depositional areas helps achieve remediation for other contaminants. Remedial actions are conducted with these co-located contaminants in mind. Historic contaminant sources are significant, but ongoing sources will also have to be monitored. Reference sites for setting specific delisting targets such as was done for Hamilton Harbour should be identified and studied.

4.2.6 Restrictions on Dredging Activities

The Milwaukee RAP Technical Advisory Committee considered that this BUI applied to all contaminated sediment areas and not only to navigational dredging. In this way, the application of this BUI to the Milwaukee Estuary AOC may deviate from other AOCs. For example, in Michigan, the BUI is interpreted as applying to navigational dredging. The MDEQ guidance (2006) states that the BUI is considered to be restored when "there have been no restrictions on routine commercial or recreational navigational channel dredging by the US Army Corps of Engineers, based on the most recent dredging cycle, such that special handling or use of a confined disposal facility required for dredge spoils due to chemical contamination" OR, in cases where dredging restrictions exist, "a comparison of sediment contaminant data from the commercial or recreational navigational channel (at the time of proposed dredging) in the AOC indicates that contaminant levels are not statistically different from other comparable, non AOC commercial or recreational navigation channels."

The St. Louis River AOC considered this BUI to apply only to navigational dredging and based its target on the requirements for handling and disposal of dredged spoils.

The Canadian Detroit River AOC delisting targets are based on contaminants in sediments not exceeding applicable standards, criteria, or guidelines. As such, there would be no restrictions on dredging or disposal activities.

The Presque Isle Bay AOC is depending on natural attenuation rather than formal remedial action to alleviate contaminated sediment and be delisted.

4.2.7 Eutrophication or Undesirable Algae

The Ohio delisting target for this BUI is "when waters meet the minimum dissolved oxygen criteria listed in the Ohio Water Quality Standards (WQS) AND no nuisance growths of algae, such as filamentous *Cladophora*, or blooms of blue-green algae exist. There are no nuisance growths of aquatic weeds that may be hindering recreational use or contact with the water body."

The MDEQ (2006) guidance states that this BUI will be considered restored when "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 *Clean Water Act Water Quality and Pollution Control in Michigan: Section 303(d) and*

305(b) Integrated Report, which is submitted to U.S. EPA every two years." In addition, MDEQ is in the process of developing nutrient criteria for surface waters that will be adopted by Michigan's Water Quality Standards.

Targets used for delisting the Oswego AOC are based on survey results indicating phosphorus concentrations and loadings, chlorophyll, ammonia, water clarity, dissolved oxygen and other ambient water quality levels that are consistently better than standards, criteria, and guidelines. The observation of algal blooms in the AOC or downstream needs to be evaluated as to the cause, the undesirable nature, and any proposed remedial action. Suggested thresholds for ambient water quality comparisons in the AOC include lake parameters and values: phosphorus concentration < 20 ug/l (lake), Secchi disc transparency > 1.2 meters, dissolved oxygen > 6 mg/l, unionized NH3 < 0.02 mg/l.

The relevant delisting targets for the Muskegon Lake AOC (MI) are that:

Average annual concentrations/values are achieved for Muskegon Lake and Bear Lake:

Indicator	Target	Reasoning
Surface Total Phosphorus Concentration	30 ug/l	MDEQ guidance
Chlorophyll *a*	10 ug/l	U.S. EPA
Secchi Disk depth	~ 2.0 m	Pentwater Lake as reference
Trophic Status Index	50-55	Pentwater Lake as reference

The following AOCs also have specific measures for delisting this BUI. Collingwood Harbour used the specific delisting targets of: all harbour waters have persistent phosphorus concentrations of less than 20 micrograms per liter (0.02 mg/L), a Secchi disc transparency of greater than 1.2 meters, dissolved oxygen at saturation, chlorophyll concentrations of less than 10 micrograms per liter, unionized ammonia of less than 0.02 milligrams per liter, and phosphorus load from the sewage treatment plant of less than 2760 kilograms per year. Saginaw River/Bay used the delisting targets of: the average concentration of total phosphorus is 15 micrograms per liter or less, in accordance with the supplement to Annex 3 of the 1978 Great Lakes Water Quality Agreement (as amended). The Rochester Embayment targets were: total phosphorus concentrations for near (11 to 12 meters) and near-nearshore (1 meter) are less than or equal to 15 parts per billion and 20 parts per billion, respectively; and chlorophyll a concentrations for the near (11 to 12 meters) and near-nearshore (1 meter) are less than or equal to 3.8 parts per billion and 5 parts per billion, respectively; and Secchi disk measurements in the nearshore (12 meters) are greater than or equal to 4 meters.

4.2.8 Beach Closings and Body Contact

The IJC Criteria states that the BUI can be delisted "when waters, commonly used for total-body contact or partial body-contact recreation, do not exceed standards, objectives, or guidelines for such use."

The MDEQ guidance (2006) states that this BUI will be considered restored when "no water bodies within the AOC are included on the list of impaired waters due to contamination with pathogens in the most recent *Clean Water Act Water Quality and Pollution Control in Michigan: Section 303(d) and 305(b) Integrated Report*, which is submitted to U.S. EPA every two years." The limits for E. coli are set by Michigan's Water Quality Standards for bacterial contamination Rule 323.1062 for partial and total body contact at 130 E.coli per 100 ml for total body contact recreation and 1000/100 ml for partial body contact based on a specified monitoring protocol.

The Ohio (2005) guidance document has delisting targets as follows:

Total Body Contact:

For Bathing Waters - Geometric mean *E. coli* content, based on not less than five samples within a 30-day period, exceeds 126 per 100 ml.; or *E. coli* content exceeds 235 per 100 ml. in more than 10% of the samples taken during any 30-day period.

For Primary Contact - Geometric mean *E. coli* content, based on not less than five samples within a 30-day period, exceeds 126 per 100 ml.; or *E. coli* content exceeds 298 per 100 ml. in more than 10% of the samples taken during any 30-day period; or geometric mean fecal coliform content, based on not less than five samples in a 30-day period exceeds 1000 per 100 ml; or fecal coliform content exceeds 2000 per 100 ml in more than 10% of the samples taken in any 30-day period.

Partial Body Contact:

Secondary Contact - *E. coli* exceeds 576 per 100 ml. in more than 10% of the samples taken during any 30-day period; or fecal coliform exceeds 5000 per 100 ml in more than 10% of the samples taken in any 30-day period.

The St. Louis River AOC anticipates that this impairment can only be met when the entire AOC attains the target rather than just designated beach areas. The St. Louis River AOC target considers control of sanitary and stormwater sources, absence of impaired water listings, and establishment of an effective bacterial monitoring program.

The Canadian side of the Detroit River based its delisting targets generically that total or partial body contact standards, guidelines and objectives not be exceeded, and that there are no beach closures as a result of water quality problems for two years.

The Grand Calumet AOC's currently proposed target, which is being reviewed for update/revision, is that when waters used for total-body contact or partial body-contact recreation do not exceed standards, objectives, or guidelines for use, this BUI can be delisted. The Rouge River set its target for

concentrations of bacteria during dry weather flow to be below full-body contact criteria at all its recreational areas for three consecutive summers. Saginaw River is similar. The St. Clair River's delisting target is zero beach closures for two years.

4.2.9 Degradation of Aesthetics

The IJC guidance specifies that restoration constitutes elimination of unnatural oily sheens, turbidity, color and odor. The Four Agency Framework bases criteria on the river/shore being devoid of objectionable deposits such as no visible oil sheen. Milestones are set at eliminating combined sewer overflows (CSOs) and separating all sewers. A decline in the number of spills and complaints must be reported.

The MDEQ (2006) specifically states that this BUI will be considered restored when "monitoring data for two successive monitoring cycles indicates that the water bodies in the AOC do not exhibit persistent, high levels of the following 'unnatural physical properties' (as defined by Rule 323.1050 of the MI WQS) in quantities which interfere with the State's designated uses for surface waters: turbidity, color, oil films, floating solids, foams, settleable solids, suspended solids, and deposits." These apply only to sources that are man-made or exacerbated by human-induced activities such as excessive algae growth due to nutrient loading. It specifically states that natural physical features that occur in normal ecological cycles are not considered impairments and may in fact serve a valuable role in providing fish and wildlife habitat.

The Ohio delisting is similar in terms of the descriptors for unaesthetic water, but states that the AOC should be free of substances entering the water from human sources that are "toxic to human, animal or aquatic life and/or are rapidly lethal in the mixing zone." Also, the Ohio delisting states that the AOC waters should be "free from public health nuisances associated with raw or poorly treated sewage."

Delisting targets for this BUI are also generic in approach on the Canadian side of the Detroit River.

The delisting targets for White Lake specified that "public areas should not contain quantities of contamination, debris, and algal scum that impede the access and enjoyment of this resource. In addition, no more than 10% of the lake should be covered with algal scum for 5 consecutive days."

The currently proposed targets in the St. Louis River AOC are that there have been no sightings of oil slicks, spills, or other unnatural phenomenon for a period of five consecutive years.

Only Rochester Embayment, New York had very specific delisting targets of their own:

- There is virtually no persistent decomposing algae (algae does not persist more than 10% of summer days) along the Lake Ontario shoreline that is not part of a lake-wide problem, for 5 consecutive years; AND
- There is no odor due to chemical seeps at the Lower Fall; AND
- There are no alewive die-offs for a 5-year period or dead alewives along the Lake Ontario shoreline are part of a lake-wide problem to which the Rochester Embayment watershed does not contribute; AND

- There are no reports of discarded salmonids along the shoreline of the lower Genesee River, due to fishing practices, for 5 consecutive years; AND
- There is virtually no litter caused by combined sewer overflows or left by fishermen or other recreational users in the lower Genesee River or adjacent shoreline; AND
- Suspended sediment concentrations in the Genesee River remain less than 30 mg/l for at least 80% of a year, and exceed 200 mg/l for no more than 5 events with a combined duration of not greater than 20 days, as determined by a 5-year average (habitat delisting criterion on suspended sediment).

In the Milwaukee AOC, many of the other BUI delisting targets will aid in the aesthetics problems such as those that address eutrophication, habitat restoration, and best management practices to reduce sediment and nutrient loading.

4.2.10 Degradation of Phytoplankton and Zooplankton Populations

In Michigan, the only AOC impacted by this BUI is Saginaw. The MDEQ (2006) guidance states that this BUI will be considered restored when "the Statewide delisting targets for the Eutrophication or Undesirable Algae BUI have been met in Saginaw River/Bay/AOC."

The only other AOCs impacted besides Milwaukee and Saginaw are the Rochester Embayment, (New York), Cuyahoga River (Ohio), and Waukegan Harbor (Illinois).

For the Rochester Embayment, the delisting target is: "Ninety percent of ambient water samples (collected monthly for one year), compared to a control, cause no chronic toxicity to Ceriodaphnia dubia."

The Waukegan Harbor, Illinois delisting target is: "Provide water and sediment quality throughout the harbor and nearshore lake area which is not detrimental to the development and growth of phytoplankton and zooplankton populations."

The State of Ohio's delisting target is: "Phytoplankton or zooplankton bioassays (e.g. Ceriodaphnia, algal fractionation bioassays) confirm no toxicity in ambient waters and/or community structure is diverse and contains species indicative of clean water."

4.2.11 Loss of Fish and Wildlife Habitat

The MDEQ guidance for this BUI is the same as for Degradation of Fish and Wildlife Populations. Water quality standards must be met, and if not, sources of water quality contamination must be controlled. A restoration plan must be developed and implemented which includes (A) a short narrative on the historical fish and wildlife population loss and degradation in the AOC, including how habitat has been impaired by water quality; (B) a description of the impairment and location for at least one critical habitat site or for multiple sites where determined appropriate at the local level; (C) a locally derived restoration goal/target for each habitat site. Restoration goals can be based on those for population BUI #3; (D) a list of all other ongoing habitat restoration planning processes in the AOC, and a

description of their relationship to the restoration projects proposed in the plan; and (E) a work plan including:

- Specific habitat restoration actions(s) to be completed
- Timetable
- Funding
- Responsible entities
- Indicators and monitoring
- Public involvement

A specific plan for reporting on habitat restoration implementation actions(s) to the MDEQ must be included. Fish and wildlife populations need not be fully restored before delisting.

The Ohio (2005) delisting targets are as follows:

For Fisheries Habitat:

For mainstem and tributaries, habitat quality shall average a QHEI score of 60 or better throughout the free flowing stream stretches of the AOC ***and*** Ohio Aquatic Life Water Quality Standards are met OR Fish and Wildlife officials do not identify loss of or poor quality habitat as cause for non-attainment with fishery goals.

For Wildlife Habitat:

Forested buffers exist on 50% of residential tributaries and 25% of urban tributaries ***and*** For headwater streams, HHEI habitat quality shall average a score of 30 for warm water streams and 70 for cold water streams OR For headwater streams and wetlands, State Aquatic Life Water Quality Standards are met OR Wildlife officials do not identify loss of or poor quality habitat as cause for non-attainment with wildlife goals.

The Ohio milestones include:

- Buffers, conservation easements, riparian setback ordinances, or other protective mechanisms are in place on more than 80% of the streams and tributaries
- over 10% of major watershed and over 6% of sub-watershed are high quality wetland habitat
- over 75% of the stream length is naturally vegetated
- less than 15% of watershed is impervious
- over 30% of the watershed is in forest cover
- track Headwater Habitat Evaluation Scores; percentage of forested riparian buffers along streams in residential and urban areas; management goal attainment
- habitat is sufficient to support wildlife goals for the AOC.

The philosophy expressed in the Ohio delisting milestones can be applied to the Milwaukee Estuary AOC to some degree, but have to be critically reviewed rather than just directly applied.

The Detroit River on the Canadian side set the following delisting targets:

- The amount of habitat required to meet applicable fish and wildlife management goals has been achieved. Loss of productive fish and wildlife habitat has ceased, and existing quality habitat is protected. At a minimum, twelve percent of the AOC watershed should be comprised of quality natural cover, and a buffer of natural riparian vegetation should border 75 percent of all First-to-Third Order streams and virtually all wetlands.

The Saginaw AOC developed the following delisting targets for this BUI:

- Dissolved oxygen criteria: 5 mg/L during summer
- Protection of coastal marsh
- Targeted restoration: documentation of natural reproduction of Lake Sturgeon in Saginaw River, abundance measures for Yellow Perch and Walleye.

Citing the uniqueness of its ecosystem within the Great Lakes, the St. Louis River AOC based its delisting target on indicator metrics within its area-specific habitat plan as well as the absence of impairments reported under the Clean Water Act 303(d) and 305(b) requirements.

In the Milwaukee Estuary AOC, as in other AOCs, some of the other BUI delisting targets will aid in the restoration of habitat.

4.3 PROPOSED MILWAUKEE ESTUARY AOC DELISTING TARGETS FOR EACH BUI

4.3.1 Restrictions on Fish and Wildlife Consumption

There are two approaches that can be used for setting delisting/restoration targets based on the overall goals of the AOC. If the primary goal is “delisting” then the target for restrictions on fish and wildlife consumption should be based strictly on advisories and comparison to other similar or control sites if an advisory still exists in the AOC. If the goal is “restoration” then the primary target should be based on the contaminant concentration in the fish/wildlife within the AOC. Assuming that the Milwaukee Estuary AOC goal is for restoration, the delisting targets for restrictions on fish and wildlife consumption should be similar to those proposed for the St. Louis River AOC.

Remediation Target

The remediation of limitations to fish consumption is based on contaminants in fish tissue and the ability for the public to safely manage their consumption. Remediation of this BUI will be determined by the following steps and targets:

- 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

- A statistically valid sampling program demonstrates that the edible portion of fish tissues do not contain man-made BCOCs at levels exceeding fish consumption advisories for unrestricted consumption (currently identified as 0.05 ppm PCBs, and 10 ppt dioxin and furan congeners – as TCDD toxicity equivalent concentrations); and
- 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 U.S. EPA every two years); and
- Waters within the Milwaukee Estuary AOC do not have special fish consumption advisories due to mercury in the Healthy Guide for Eating Fish in Wisconsin for two document cycles.

Or if the above is not achievable within 10 years:

- all known man-made sources BCOCs (including PCBs, mercury, dioxins, and furans) within the AOC and tributary watershed have been controlled or eliminated; and
- 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.

Actions

- Determine appropriate fish species for tissue concentration trend analysis.
- Implement an appropriate monitoring program within the AOC that will isolate on-going sources of PCB/Mercury to the AOC.
- Implement sediment monitoring in the Milwaukee Harbor Estuary AOC to locate historic sites of PCB/Mercury contamination impacting the AOC.
- Establish appropriate control/comparison sites within the AOC or a similar watershed for evaluating relative progress toward attaining the restoration targets utilizing comparative contaminate analysis. The studies should be designed to control variables known to influence contaminant concentrations such as species, size, age, sample type, lipids, and collection dates. The control site should be chosen based on physical, chemical, and biological similarity to the AOC.

4.3.2 Degradation of Fish and Wildlife Populations

Background and Extent of Impairment

Fisheries

It should be noted that this BUI is closely aligned with the Loss of Fish and Wildlife Habitat BUI and the delisting of these two BUIs will likely be addressed together.

The Stage 1 RAP (WDNR, 1990) and 1994 RAP update indicated that fish populations in the AOC were severely degraded and that the fish species resident in the AOC were mostly pollution tolerant species. 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.

At the time of the publication of the 1994 RAP, the potential removal of the North Avenue Dam was being studied. The dam is the location that defines the upstream extent of the AOC within the Milwaukee River watershed. The 150-year-old dam created a large impoundment that influenced the quality of the fisheries upstream and downstream from the dam. Water quality and habitat within the impoundment and downstream of the dam were severely degraded. In addition, the dam prevented migration of fish throughout the watershed. The dam was removed in 1997.

The WDNR Lake Michigan Fisheries Program conducted a six-year study to describe the fish community, assess overall biological integrity, and evaluate fish community changes as a result of the dam removal (WDNR 2005). Improvements in the riverine habitat and water quality following dam removal increased fish species diversity in the former impoundment several-fold. The total number of fish species captured increased from seven in 1996 to 37 species overall. The number of native species increased five-fold.

The overall environmental quality measured as the Index of Biotic Integrity (IBI) in the former impoundment increased from 20 (poor) in 1996 to 80 (excellent) in 2000-2001. The dam removal, combined with habitat improvement measures, sediment management activities, and improvement in point and nonpoint source contributions, has lead to efforts to initiate native walleye and lake sturgeon restoration projects in the lower Milwaukee River and estuary.

The Menomonee River and canals within the AOC were sampled less frequently than the Milwaukee River during the same time period. Because this area is channelized for shipping and the canals have poor water circulation, the habitat and water quality is degraded. A warm water discharge into the Menomonee River from an electric power company and debris from storms further degrade water quality. Despite poor conditions, fish surveys recorded a diverse fish community with 16 native species.

The Kinnickinnic River fishery is dominated by species tolerant of low dissolved oxygen conditions. Native fish species diversity and abundance is low, which indicates poor water quality and habitat conditions. The Kinnickinnic River watershed is nearly 100 percent urban, with over 60 percent of the river network comprising of enclosed conduit or concrete lined channel (SEWRPC, 2008). Until measures can be taken to improve these upstream habitat and water quality conditions, establishing a balanced fishery in the Kinnickinnic River will not be possible.

The best opportunities for establishing balanced fishery populations within the AOC lie within the Milwaukee River and Menomonee River portions. The WDNR *Lake Michigan Integrated Fisheries Management Plan, 2003-2013* (http://dnr.wi.gov/fish/lakemich/LMIFMP%202003-2013.pdf), sets goals for establishing native fish populations and improving habitat within Lake Michigan and tributaries, including those within the AOC.

Targets and Actions Needed

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

- A local fish and wildlife management and restoration plan has been developed for the entire AOC 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 restoration 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 responsibility for all fish and wildlife population restoration activities needed within the AOC.
- The programs 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.

Actions

- Determine population trends for native fish species in the AOC.
- Determine the extent of improvement that can be achieved within the areas of the AOC that were historically or currently modified and dredged for commercial navigation since the habitat improvements necessary to sustain foraging and spawning will not be achievable. Controlling sources of dissolved oxygen deficits (like sediment oxygen demand) and other water quality improvements may make these areas suitable for travel corridors for native and migratory species.

Wildlife

The 1994 RAP indicated that sufficient evidence was not available to show wildlife impacts from chemical contaminants or water quality within the AOC. The report indicated that since contaminants exist in the AOC, the use should be considered impaired because the potential to have effects on reproduction and growth.

Due to the highly urbanized nature of the AOC, lack of habitat is most likely the determining factor for limiting wildlife populations.

Actions

- Assess wildlife populations and the possible extent of any impairment within the AOC before setting specific wildlife population targets.

4.3.3 Fish Tumors and Other Deformities

Background and Extent of Impairment

The 1994 RAP included this BUI as suspected because the concentrations of certain polycyclic aromatic hydrocarbons (PAHs) in AOC sediments were similar to concentrations in areas with verified

fish tumors. No fish health surveys have been conducted within the AOC to determine the extent (or existence) of this impairment, so a statistically significant study should be the first milestone toward delisting or removing this as impaired.

Proposed Delisting Targets and Actions

The first step toward delisting this suspected impairment is to determine if this use in the AOC is impaired. If surveys totaling at least 50 fish do not show a tumor incidence of greater than 5% of the population surveyed, this use can be considered not impaired. If the use is considered impaired, comparisons to non-impacted reference sites should be conducted to see if the occurrences of tumors are significantly higher than the reference sites. In all cases, and regardless of the extent of the impairment, source control for PAHs is an important long-term and ongoing step.

Delisting may occur if:

- All known major sources of PAHs and chlorinated organic compounds within the AOC and tributary watershed have been controlled or eliminated.
- A fish health survey of resident benthic fish species such as white suckers finds incidences of tumors or other deformities at an incidence rate of less than 5 percent.

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 non-impacted reference sites, indicate that there is no statistically significant difference (with 95% confidence) in the incidence of liver tumors or deformities.
- A comparison study of resident non-benthic fish of comparable age and maturity in the AOC and non-impacted reference sites indicate that there is no statistically significant difference (with 95% confidence) in the incidence of external deformities, lesions and tumors related to contaminant exposure.

Actions

- Secure funding to conduct initial fish health survey to determine extent of this impairment. If impaired, compare to reference sites to determine if impairment is significantly different.

4.3.4 Bird or Animal Deformities or Reproduction Problems

Background and Extent of Impairment

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 have the potential to impair reproduction and development in wildlife, this use was considered impaired in the 1994 RAP.

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

Delisting Targets and Actions Needed

This BUI can be delisted if:

- Studies conducted in the AOC indicate that the beneficial use should not be considered impaired, or
- If studies conducted in the AOC determine that this use is impaired, then two approaches can be considered for delisting:
    - Approach 1 – Observational Data and Direct Measurements of Birds and other Wildlife
        - Evaluate observational data of bird and other animal deformities for a minimum of two successive monitoring cycles in indicator species identified in the initial studies as exhibiting deformities or reproductive problems. If deformity or reproductive problem rates are not statistically different than those at minimally impacted reference sites (at a 95% confidence interval), or no reproductive or deformity problems are identified during the two successive monitoring cycles, then the BUI can be delisted. If the rates are statistically different than the reference site it may indicate a source from either within or from outside the AOC. Therefore, if the rates are statistically different or the data are insufficient for analysis, then:
        - Evaluate tissue contaminant leels 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:
    - Approach 2 – Fish Tissue Contaminant Levels as an Indicator of Deformities or Reproductive Problems
        - If fish tissue concentrations of contaminants of concern 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 of concern identified in the AOC are not statistically different than Lake Michigan (at 95% confidence interval), then the BUI can be delisted. Fish of a size and species considered prey for the wildlife species under consideration must be used for the tissue data.

Actions Needed

- For the two approaches above, establish target species to be used for evaluating the improvement and trends for this BUI.

4.3.5 Degradation of Benthos

Background and Extent of Impairment

This beneficial use is considered impaired within the Milwaukee Estuary AOC due to 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 Milwaukee RAP documents recognize that monitoring is required to better define this impairment. Further, because physical conditions within the Milwaukee AOC are very diverse, different targets may be required for different habitat types within the AOC. For example, the free-flowing reaches of the Milwaukee River will have the capacity to harbor a more diverse benthic community than the slow-moving, sediment-laden depositional areas comprising the Milwaukee Harbor. The difficulty in evaluating this impairment lies with determining the factors leading to the impairment.

Because some sediments within the Milwaukee AOC are known to be contaminated with a variety of pollutants, including PCBs, PAHs, and heavy metals, one can assume they are having an effect on the biological environment. The extent to which this has been determined for benthic macroinvertebrates has not been defined. Monitoring will be essential to better understanding the extent of this impairment and for determining appropriate delisting targets.

Urban watersheds like those comprising the Milwaukee AOC tend to have benthic macroinvertebrates that are tolerant to pollution. Because we lack studies comparing these water bodies to less contaminated reference conditions, the factors leading to the degradation are not well understood. Without use of reference conditions, it is not possible to determine for sure if the impairments are from physical habitat limitations, water quality, or sediment chemistry.

Proposed Delisting Targets and Rationale

This delisting target is to be based on benthic community health and the impacts of chemical contaminants on that community. The anticipated benthic community quality must be established on a site-specific basis considering conditions that impact the benthic community that cannot be changed, such as dredging activity in navigation channels, wave-induced sediment resuspension, ice scour and prop wash, to assure that the endpoint comparison is consistent with the ability of the habitat and external impacts to support a viable benthic community.

Delisting may occur if:

- Known contaminant sources contributing to sediment contamination and degraded benthos have been identified and control measures implemented, and

- All remediation actions for contaminated sediments are completed and monitored according to the approved plan with consideration to using consensus based sediment quality guidelines and equilibrium partitioning sediment benchmarks; or
- The benthic community within the site being evaluated is statistically similar to a reference site with similar habitat and minimal sediment contamination.

Since contaminated sediments are known or suspected contributors to several BUIs, following the contaminated sediment management strategy described in the 1994 Milwaukee Estuary RAP is the most important step toward delisting for the AOC. The strategy includes evaluating and controlling ongoing sources of contaminants, identifying, characterizing, and setting priorities for sediments in need of remediation, conducting remedial actions, and evaluating success. The strategy also noted that for sediment remediation projects to be successful in the long term, the furthest upstream contaminated sediment sites in each watershed must be controlled prior to launching large-scale sediment clean-ups within the AOC. Tools to identify, prioritize, and evaluate sediment projects are to employ consensus-based sediment quality guidelines (CBSQGs) and equilibrium partitioning sediment benchmarks (ESBs).

WDNR developed guidance for and recommends use of CBSQGs and ESBs for managing sediment throughout the state. Used alone, the CBSQGs suggest correlation between sediment contaminants and benthic macroinvertebrates, but do not measure causation. The methods used for calculating ESBs do take biological effects into account and therefore correspond to causation. The most comprehensive approach to using sediment data for examining benthic degradation would be to employ a combination of the two. If toxicity testing were to be employed, it should be completed only as another line of evidence in support of the CBSQGs and ESBs rather than as an endpoint unto itself.

Benthic community structure within the AOC is not well-defined, nor are there guidelines in Wisconsin for evaluating benthic community health in depositional river mouth areas. Therefore benthic community structure evaluations for delisting purposes should be conducted in comparison with “least impacted reference sites” with similar habitat conditions.

Actions

- Incorporate benthic macroinvertebrate evaluations for sediment management actions within the AOC.
- Determine suitable reference sites for the different habitat areas within the AOC. For some areas this may mean evaluating upstream sites within the same water bodies. For the depositional areas this may mean looking for other sites with similar characteristics but limited sediment contamination.

4.3.6 Restrictions on Dredging Activities

Background and Extent of Impairment

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. 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, it was necessary to establish a contaminated sediment management strategy (Chapter 6) to provide a blueprint for meeting RAP goals with the intent of moving toward delisting. The RAP contaminated sediment management strategy consists of three main components:

1. Evaluate and Control Sediment Pollution Sources
2. Characterize Upstream and AOC Sediment
3. Develop and Implement Remedial Options

The Restriction on dredging BUI relates to special or additional handling and disposal requirements related to dredging contaminated sediment within the AOC, regardless of navigational dredging requirements. Additional handling means more than is required at minimally impacted reference site(s) without known sediment contamination sources. Additional sediment management activities become necessary when there is a potential human health or ecological risk (e.g. degradation of benthos BUI) associated with disturbing contaminated sediment.

Examples of Restrictions on Dredging include:

- Additional sediment sampling costs (e.g. as required by Chapter NR 347, Wisconsin Administrative Codes)
- Additional sediment management costs during the dredging action, such as specific equipment, dewatering, wastewater treatment to remove contaminants and contaminant monitoring costs, contaminated material transport, confirmation monitoring.
- Additional disposal costs due to contamination levels
- Additional consulting expertise (costs) or training, sediment fate and transport modeling, risk assessments, contaminated sediment handling.

While sediment remediation is an important component in meeting RAP goals, an effective sediment strategy has a balance of pollution prevention activities and enhanced nonpoint source control in addition to clean-up of strategic sediment hot spots.

Delisting Targets and Actions Needed

Delisting of this BUI can occur when:

- Contaminated sediment hot spots within and upstream from the AOC have been identified.
- 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 delisting is possible.

- There are no restrictions on routine navigational dredging done by the U.S. Army Corps of Engineers and/or private dredging companies due to contamination originating from controllable sources within the AOC.

4.3.7 Eutrophication or Undesirable Algae

Background and Extent of Impairment

The 1994 RAP considered this use impaired because phosphorus, nitrogen, and chlorophyll *a* concentrations within the AOC indicated eutrophic conditions. Low dissolved oxygen concentrations are 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 oxygen concentrations. The estuary rivers currently have variance criteria 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.

The Milwaukee River Estuary, including the lower Menomonee, Milwaukee, and Kinnickinnic Rivers, is listed on the Wisconsin 2006 Impaired Waters (303(d)) list for excess phosphorus and low dissolved oxygen concentrations. In addition, Bradford and McKinley beaches were closed several times during 2006 due to impacts from algae in the beach areas.

Since the 1994 RAP was produced, nuisance algae, mainly in the form of *Cladophora* sp., have become increasingly common. When *Cladophora* die and detach from the lake bottom, the algae accumulate in large mats along the lake shore, leading to beach closings, strong stench, avoidance of the area, and many complaints. Nutrients, especially phosphorus, were identified as the critical variable controlling *Cladophora*. Phosphorus has been identified as the limiting nutrient for *Cladophora* in Lake Michigan, which may indicate that increased availability of phosphorus is the cause of recent problems. The source of this phosphorus is not clear. Budgets of P-loading to the lakes provide some evidence for higher P inputs by some Wisconsin rivers in the short-term, but it seems unlikely that rivers can provide all the P necessary to drive the blooms.

Wisconsin does not currently have criteria developed for nutrients, however criteria are currently under development for phosphorus. Mean concentrations of total phosphorus in the Milwaukee Estuary were 0.115 mg/l. Mean concentrations in the Menomonee River portion were 0.092 mg/l, Milwaukee River (0.117 mg/l), and KK River (0.126 mg/l) (SEWRPC 2008).

A workshop was convened at the Great Lakes WATER Institute in 2004 to share research and management information regarding the causes of the *Cladophora* problems within nearshore Lake Michigan. For more information see:
http://www.glwi.uwm.edu/research/aquaticecology/cladophora/Cladophora_Proceedings.pdf

Delisting Targets and Actions Needed

Delisting of this BUI can occur when:

- Total phosphorus concentrations within the AOC rivers do not exceed 0.05 mg/l *OR* in-river total phosphorus concentrations meet Wisconsin criteria when promulgated.
- Total phosphorus concentrations in the inner and outer harbor areas do not exceed 0.02 mg/l OR total phosphorus concentrations meet Wisconsin criteria when promulgated.
- Total phosphorus concentrations in near shore waters do not exceed 0.01 mg/l OR total phosphorus concentrations meet Wisconsin criteria when promulgated.
- There are no violations of the minimum dissolved oxygen concentrations established in Chapter NR 102, Wisconsin Administrative Code within the AOC due to excessive sediment deposition or algae growth.
- Chlorophyll *a* concentrations within the AOC lake and impoundment areas do not exceed 4.0 ug/l.
- 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 Wisconsin Impaired Waters list submitted to U.S. EPA every two years.
- There are no beach closures in the AOC due to excessive nuisance algae growths.

Actions

- Develop and implement nutrient TMDLs within the AOC and within tributary areas impacting the AOC, including the necessary programs addressing traditional point sources, nonpoint sources, and stormwater.
- Develop a scientifically based monitoring program to establish baseline conditions and trends and to determine when targets have been met.

4.3.8 Beach Closings and Body Contact

Background and Extent of Impairment

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 do not consistently meet water quality standards for total body contact recreation. Data from the lower river system also exceed the state partial body contact recreation standards. The 1994 RAP Update indicates that there were essentially no changes in the status of BUI 3 between the initial RAP document and the Update. Beach closings and recreation restrictions were still considered an impaired beneficial use in the AOC. Potential sources of contamination were CSO events and both urban and rural storm water. The RAP Update states that the lower Milwaukee, Menomonee, and Kinnickinnic Rivers have no swimming beaches. South Shore beach along Lake Michigan closed periodically, for 48 to 96 hours, when high bacteria counts occurred after CSO events (Milwaukee County Health Department, 1992).

In 1990 and 1991 there were 28 beach closings in Milwaukee County; all of the beach closings occurred after a rainfall (WDNR, 1992). Because bacteria levels in the lower rivers exceed recreational standards, the waters were supporting partial body contact (e.g. boating, canoeing, fishing, and

incidental contact) rather than full body contact. Hence, full recreational potential is not being realized within the AOC.

Beach monitoring data from 2006 indicates that this BUI continues at the Lake Michigan beaches within the AOC. Bradford Beach was closed 28 days in 2006 and South Shore Beach was closed 43 days in 2006. Bradford, McKinley, and South Shore Beaches are listed on the Wisconsin Impaired Waters list because they are not meeting their full recreational uses due to bacterial contamination. Beaches are evaluated for inclusion on the impaired waters list by calculating a percent exceedance of the single sample maximum criterion of 235 colony forming units (cfu) per 100 ml of water. At least 15 samples must be taken within any given year for analysis to be considered. The proposed 2008 listing includes the three AOC beaches. Because there are at least three years worth of data available at these beaches, if more than 15 percent of samples collected exceed the single sample maximum (235 cfu/100 ml), the beach must be listed. See Wisconsin's Impaired Waters Program web site (http://dnr.wi.gov/org/water/wm/wqs/303d/2008/2008Updates.htm) for more information.

Several potential sources of contamination have been suggested as contributing to the high concentrations of *E. coli* detected at Lake Michigan beaches. The potential sources of contamination cited include overflows from combined and sanitary sewers, discharges of stormwater from outfalls near beaches, runoff from parking lots and other impervious areas adjacent to beaches, mobilization of *E. coli* from reservoirs in sand and sediment, contributions of *E. coli* from wildlife visiting or residing at beaches or in adjacent areas, and mobilization from reservoirs in algal mats on beaches or in nearshore waters. It is important to note that beach closings and advisories are not always related to elevated bacteria concentrations. When they are, the source of the bacteria causing the closing or advisory is not always obvious (SEWRPC 2008).

It is important to note that water quality indicator organisms, such as *E. coli*, contributed by these and other sources can persist in beach sand and mats of *Cladophora* present on or adjacent to beaches. The presence, concentration, and persistence of indicator bacteria in beach sand can be affected by the particular methods of beach grooming used. In any case, precipitation and wave action may mobilize indicator bacteria present in sand or algal mats to beach water (SEWRPC 2008).

Actions are underway within the AOC to address some of the causes of beach pollution. A study conducted at Bradford Beach found that runoff from parking lots and road surfaces was delivered to the beach through stormwater outfalls. Milwaukee County is in the process of implementing a strategy at Bradford Beach to keep the stormwater from reaching the beach. Studies at South Shore beach indicated that parking lot runoff entered the water adjacent to the beach at the boat ramp. The parking lot runoff was directed to a treatment system before reaching the water. The study also recommended that South Shore beach be relocated to a more suitable area to the south.

Delisting Targets and Actions Needed

Targets:

This BUI will be considered restored when:

- All known sources of bacterial contamination to the AOC and tributary watershed have been identified and, if feasible, have been controlled or treated to reduce exposures; and

- No sanitary sewer overflows or un-permitted combined sewer overflows have occurred within the AOC during the previous five year period as a result of a less than 25-year precipitation event or snow/ice melt conditions; and
- All municipalities within the AOC have adopted and are implementing storm water reduction programs including an illicit discharge elimination program; and
- 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 which is submitted to U.S. EPA every two years; and
- 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.

Actions:

- Continue ongoing bacterial monitoring programs within the AOC and expand as necessary.
- Conduct annual review of the data collected to determine if sample numbers and/or locations should be increased or decreased.
- Document implementation effectiveness of Phase II storm water programs within the AOC.
- Conduct periodic public surveys to determine effectiveness of public education campaigns.

4.3.9 Degradation of Aesthetics

Background and Extent of Impairment

This beneficial use is considered impaired because of the poor visual quality of the water resources and adjacent land and the resultant reduction in ability to use the Milwaukee AOC resources. The 1994 Milwaukee RAP contributed 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.

Visual observations within the AOC indicate that much of the AOC trash can be attributed to sources within and upstream of the AOC. After storms, considerable debris can be seen near combined sewer overflow and storm sewer outfalls. 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, storm water runoff.

The City of Milwaukee operates a skimmer boat that primarily focuses on cleaning up floatable trash on the Milwaukee River, and has started to clean up the Menomonee River during the last several years. In spring 2005, the Menomonee Valley Business Improvement District teamed up with the City of Milwaukee to hire a local Valley contractor, Cramer Marine, to haul out most of the heavy debris from a particular corner of the Menomonee River north of the Emmber Lane Bridge; it took two men 2.5 days

to remove approximately 24 cubic yards of logs, bottles, and other trash. This was a short-term solution, and the floating trash returned quickly. It was thought that with the heavy accumulation of trash removed, the City's skimmer could keep the corner clean. Unfortunately low water levels and sediment accumulation in this corner have made skimmer boat access difficult.

In recent years large quantities of decaying algae have been fouling Wisconsin's Lake Michigan shoreline. As the bacteria and organisms trapped in the algae rot, they generate a pungent septic odor that many people confuse with sewage. Nutrient (phosphorus) sources, zebra mussels, and declining lake levels have been implicated in the recent increase in nuisance algae abundance. The presence of rotting *Cladophora* on Lake Michigan beaches presents aesthetic and odor problems that impair recreational uses of Lake Michigan. This algae, a green algae, does not present a risk to human health (unlike blue-green algae that can produce toxins). However, the rotting algae may provide adequate conditions for bacterial growth, and microcrustaceans deposited on the beach with the decaying *Cladophora* may attract large flocks of gulls resulting in increased bacteria concentrations from gull fecal material. The causes of the *Cladophora* resurgence in the Great Lakes are not known for certain, but probably include changes in both dreissenid (zebra and quagga) mussels and phosphorus inputs and/or availability (*Southeastern Wisconsin Regional Planning Commission. 2008. A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds. Technical Report No. 39).*

The Milwaukee River Greenway Corridor Interim Study Overlay District (MROD) is a proposal passed by the City of Milwaukee in 2007. MROD consists of the Milwaukee River Corridor from the former North Avenue Dam to City limits at Silver Spring Drive. This portion of the Milwaukee River Corridor is predominantly natural and forms an important natural resource, education, and recreational asset for the community. The purpose of the MROD is to permanently protect existing natural areas along the Milwaukee River primary environmental corridor, floodplains, and river bluffs, and improve public access to this natural resource. These areas are important in protecting water quality, providing migratory pathways for wildlife, and minimizing flooding. The MROD will also study establishing building setbacks, height restrictions and design guidelines for new multi-family residential, multi-lot, and commercial developments in the immediately adjacent neighborhoods that will preserve the natural character of the greenway corridor and viewshed, and enhanced guidelines to control erosion and stormwater run-off from entering the river (http://protectmilwaukeeriver.org/mrwg-vision.pdf).

Delisting Targets and Actions Needed

This delisting target is consistent with Chapter NR 102, Wisconsin Administrative Code, 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.

(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.

(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.

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.

Rationale

The Degradation of Aesthetics BUI is subjective compared to most impairments. Milwaukee AOC utilizes existing Wisconsin standards as they apply to all surface waters of the state. If any of the properties are persistent, then the beneficial use has not been restored. Any single occurrence due to such instances as an accident, line break, or equipment breakdown would not be considered an impairment.

Actions

- Review numeric indices developed in other AOCs for potential use in the Milwaukee Estuary AOC. Although there are no specific numeric limitations/criteria for aesthetics established in the Wisconsin Water Quality Standards, a similar approach could also be used within the Milwaukee Estuary AOC.
- Establish a baseline of data within the Milwaukee Estuary AOC to determine the degree of degradation, trends in aesthetic improvements, and when the delisting targets have been met.

4.3.10 Degradation of Phytoplankton and Zooplankton Populations

Background and Extent of Impairment

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.

Phytoplankton populations in the Outer Harbor were representative of nutrient enriched (eutrophic) conditions. Nearshore phytoplankton assemblages had some tolerant organisms, but were more indicative of mestrophic conditions. 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 nutrients loads to the rivers and harbor. An increase in species tolerant of eutrophic conditions indicates degraded water quality conditions.

Zooplankton populations were also affected. Studies in the 1980s 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.

The Milwaukee Metropolitan Sewerage District (MMSD) had a phytoplankton and zooplankton monitoring program from 1979 to 1988, which provided the basis to listing this use as impaired. The program was suspended in 1988. It is unclear whether consistent phytoplankton and zooplankton monitoring has been conducted in the Estuary since that time.

It is necessary to update the information related to the extent of this impairment in relationship to the changes Lake Michigan and the Estuary have undergone since invasive species like zebra and quagga mussels became dominant. These species have direct and indirect effects on phytoplankton and zooplankton and are implicated in changing the nutrient dynamics in the lake, especially related to phosphorus.

In addition to examining community structure, the IJC listing guideline also uses ambient water toxicity to confirm impairment due to toxic contamination. The effect of toxicity on phytoplankton and zooplankton has not been evaluated in the estuary, so the extent of the impairment in this case is also unknown.

Delisting Targets and Actions Needed

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.
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.
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 U.S. EPA every two years).

4.3.11 Degradation of Fish and Wildlife Habitat

Background and Extent of Impairment

Fish

This beneficial use is considered impaired by the 1994 Milwaukee AOC RAP. The urban development in areas adjacent to the estuary has greatly diminished aquatic and wildlife habitat. Natural stream banks do not exist below the 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 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, or other vegetation to provide shade that could temper high water temperatures in summer months.

The Milwaukee Harbor estuary and nearshore areas of the Lake Michigan fishery are inextricably linked to the quality, diversity, and abundance of the fishery as well as the entire food web of Lake Michigan. In general, the removal of the North Avenue dam, along with point source and combined sewer overflow pollution abatement, has opened up many opportunities to enhance the fishery in the area through improved water quality and increased river access for both resident and migratory fish. Addition of instream structures and bank stabilization measures add to the complexity of structure and fish cover for both resident as well as migratory species (SEWRPC 2008).

The WDNR initiated a fish spawning habitat rehabilitation project on the Milwaukee River downstream from the former North Avenue Dam. Following a feasibility analysis, a single large reef covering about 0.6 acres was constructed in 2006. Studies to determine use of the reef by spawning fish are underway.

Wildlife

Loss of wildlife habitat was not considered impaired in the 1991 RAP because it was not considered caused by contamination, but by lack of physical habitat. The 1994 RAP expanded the scope to include lack of physical habitat as a source of 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 urban waterways.

The confined disposal facility 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 Confined Disposal Facility (CDF). The study concluded that ducks released into the CDF did not accumulate significant concentrations of contaminants compared to field and background levels. 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.

The Milwaukee River Greenway Corridor Interim Study Overlay District (MROD) was initiated in 2007 to study ways to protect existing natural areas along the Milwaukee River corridor which are important for protecting water quality, providing habitat and migration pathways for wildlife, and minimizing

flooding. The lower boundary of the MROD begins at the former North Avenue Dam, adjacent to the AOC. Because there is very limited wildlife habitat within the AOC, it is important to protect and enhance the adjacent areas.

Delisting Targets and Actions Needed

This BUI will be considered delisted when the following have occurred:

- A local fish and wildlife habitat management and restoration/rehabilitation plan has been developed for the entire AOC that:
    - Defines the causes of all habitat impairments within the AOC;
    - Establishes site-specific habitat and population targets for fish and wildlife species within the AOC;
    - Identifies all fish and wildlife habitat restoration programs and activities within the AOC and establishes a mechanism to assure coordination among the programs/activities including identification of lead agencies;
    - Establishes a timetable, funding mechanisms, and lead agency responsibility for all fish and wildlife habitat restoration activities within the AOC.
- The programs and actions necessary to accomplish the recommendations identified in the fish and wildlife management and restoration plan are implemented, and modified as needed to ensure continual improvement.

5.0 PATHWAY TO RESTORATION – HOW DO WE GET THERE?

5.1 BASIC IMPLEMENTATION CONCEPTS

Setting Restoration Goals
This project is a first step towards establishing restoration targets that are locally derived and measurable and meet the criteria for the frequency and longevity of monitoring that is consistent with federal and state regulations and GLWQA Annex 2. These goals should focus both on the overall watershed and the individual sub watershed areas as appropriate.

Evaluate Delisting on the Basis of Outside or Natural Factors
BUIs should be evaluated for factors outside the watershed. If restoration of a BUI is not possible because of factors outside the AOC, or is typical of lake-wide or region-wide conditions, recommend delisting on this basis and refer BUI to Lakewide Management Plan (LaMP). If the BUI is due to natural causes, not human sources, recommend delisting on this basis.

Implementing Restoration Goals
The vehicle for ultimate implementation of the delisting/restoration efforts within the AOC focused at achieving the delisting targets is the RAP. An updated RAP report will be completed for the Milwaukee Estuary AOC in the near future. This next generation RAP, and subsequent iterations, will help identify and prioritize BUIs that can be most easily delisted and identify the steps necessary to work towards implementing restoration for all BUIs. This updated RAP constitutes a restoration work plan that must include:

- Establishment of a realistic restoration budget
- Selection of reference sites where needed
- Establishment of a timeline for implementation including such major milestones as:
    - contaminant removal
    - point source pollution monitoring and prevention
    - non-point source BMP implementation
    - habitat restoration
- Development of long-term funding sources and agreements
- Establishment of necessary monitoring networks to create baseline data and measure progress in achieving delisting targets
- Establishment of implementation alternatives such as evaluation of low level, widespread contamination for feasibility of natural attenuation as a restoration alternative

Once it has been established that delisting targets have been met or that progress is moving extensively towards delisting goals, the BUI or sub-watershed can be recommended for delisting or placement in the “recovery” stage. A RAP implementation committee, working in consultation with the public and stakeholders, would then submit a recommendation to delist the AOC, or portions thereof,

and complete a Draft Final RAP Stage 3 Report to U.S. EPA and WDNR. The recommendation spells out the roles and responsibilities for implementation of the RAP.

Formal request to have AOC delisted

A long-term monitoring plan must be written. Restoration must be completed or well underway and meeting restoration goals at all sites before an AOC can be delisted. Resources are needed for long-term monitoring and protection must be in place to prevent future degradation from occurring.

6.0 CONCLUSIONS

Restoration targets have been developed to address the eleven BUIs within the Milwaukee Estuary AOC. The targets were reviewed and adopted by the WDNR and the project steering committee. These targets were developed specifically for the Milwaukee Estuary AOC. Each BUI delisting target write-up includes recommendations for actions necessary to meet the delisting targets. In addition to the specific actions identified, delisting the AOC will depend upon the following:

- Completion of sediment remedial actions for Cedar Creek, Milwaukee River near Estabrook impoundment, and the Moss America Superfund site. These actions are critical to contaminant source control for the Milwaukee Estuary AOC.
- Establishment of a monitoring program for Lake Michigan AOCs. Such a program is necessary for evaluating progress toward delisting the eleven Milwaukee Estuary BUIs.

The Milwaukee Estuary AOC has benefited from the cooperative effort of many individuals, groups, organizations, and agencies throughout the three AOC watersheds. The success towards delisting BUIs will be a community effort and collective commitment. Future watershed plans will benefit from this integrated approach and should incorporate delisting target information as well as broader actions that will benefit Lake Michigan.

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