RESTORING THE NATURAL DIVIDE

SEPARATING THE GREAT LAKES AND MISSISSIPPI RIVER BASINS IN THE CHICAGO AREA WATERWAY SYSTEM

JANUARY 2012 // **GREAT LAKES COMMISSION**
GREAT LAKES AND ST. LAWRENCE CITIES INITIATIVE

Great Lakes Commission
des Grands Lacs

Great Lakes and St. Lawrence Cities Initiative
Alliance des villes des Grands Lacs et du Saint-Laurent

PREFACE

From the Executive Committee

WE ARE PLEASED TO RECEIVE this report containing options for separating the Great Lakes and Mississippi River basins in the Chicago Area Waterway System, and look forward to reviewing it in detail. The report, led by the Great Lakes Commission and the Great Lakes and St. Lawrence Cities Initiative, is a critical step forward that lays a foundation for continued dialogue on how to safeguard the Great Lakes and Mississippi River watersheds from Asian carp and other aquatic invasive species. The report correctly concludes that any credible solution must also sustain the system's ability to support recreation, manage flooding, and transport people and goods.

The report reflects an emerging vision for Chicago's waterways, a future that includes cleaner water, less flooding and more efficient transportation. We believe this report, and the collaborative process through which it was developed, will help us achieve this goal while preventing the movement of Asian carp and other aquatic invasive species through Chicago-area waterways. Through our continued work together, we can advance a solution that benefits the Chicago region and the Great Lakes and Mississippi River basins as a whole.

Hon. Pat Quinn
Governor of Illinois

Hon. Rahm Emanuel
Mayor of Chicago

Hon. George Heartwell
Mayor of Grand Rapids

This report and the full study can be found online at www.glc.org/caws.


CHICAGO WATERWAY MAP
LAKE MICHIGAN
Wilmette Pump Station
NORTH SHORE CHANNEL
North Side WWTP
NORTH BRANCH, CHICAGO RIVER
North Branch Pump Station
Chicago River Controlling Works
SOUTH BRANCH, CHICAGO RIVER
CHICAGO RIVER
BUBBLY CREEK
Racine Ave Pump Station
DES PLAINES RIVER
Stickney WWTP
CHICAGO SANITARY AND SHIP CANAL
CHICAGO
CALUMET RIVER
ILLINOIS INTERNATIONAL PORT DISTRICT
LAKE CALUMET
INDIANA HARBOR
T.J. O'Brien Lock
Calumet WWTP
CAL-SAG CHANNEL
BURNS HARBOR
INDIANA HARBOR CANAL
Electric Barriers
GRAND CALUMET RIVER
LITTLE CALUMET RIVER
HART DITCH
Lockport Lock and Dam
Brandon Lock and Dam
TO ILLINOIS RIVER
ILLINOIS
INDIANA
KANKAKEE RIVER
Legend
Chicago boundary
Waterways/rivers
Lock
Pump station
Wastewater treatment plant
N
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2.5
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MILES

Restoring the Natural Divide

Separating the Great Lakes and Mississippi River Basins in the Chicago Area Waterway System

Overview

THE GREAT LAKES COMMISSION AND THE Great Lakes and St. Lawrence Cities Initiative led a project to develop and evaluate alternatives for physically separating the Great Lakes and Mississippi River basins in the Chicago Area Waterway System to prevent the movement of Asian carp and other aquatic invasive species (AIS). This report summarizes the results of the project and shows that separation can be achieved while also maintaining or enhancing water quality, flood management, and transportation. The engineering and economic analyses suggest that separation is feasible and provide a solid foundation on which further dialogue to advance a long-term solution to the AIS threat can proceed. Separation is defined as stopping the flow of water by placing physical structures at key points in the waterway system.

The Chicago Area Waterway System

The Chicago Area Waterway System (or CAWS) includes an approximately 130-mile[1] array of natural and constructed rivers, canals, locks and other structures in Chicago and northwest Indiana. Constructed beginning in the 1890s, the waterway system diverted water from Lake Michigan and created a connection across the mid-continental divide to the Mississippi watershed. There are five connections between the CAWS and Lake Michigan, and the Chicago Sanitary and Ship Canal connects the system to the Illinois River and the Mississippi River watershed. The CAWS provides important benefits to the Chicago region, including conveying treated wastewater, supporting commercial shipping, managing flood water, and moving recreational boats and tour boats. However, the system faces significant challenges in these areas and has the potential to better serve residents, businesses and visitors.

Restoring the Natural Divide

Separation is needed to prevent the movement of Asian carp and other AIS between the Great Lakes and Mississippi River basins in the Chicago-area waterways. Asian carp, in particular, are an imminent threat; in 2010 a bighead carp was collected from Lake Calumet, just five miles from Lake Michigan.[2] Recent research confirms that they can survive and spread in the Great Lakes, and that the CAWS is the most likely point of entry.[3] Current control efforts for the carp are vital, including the electric barriers in the Chicago Sanitary and Ship Canal. However, these efforts are incomplete, costly to maintain, and vulnerable to failure. The electric barriers will not stop the spread of all AIS and may not stop small Asian carp.[4] Monitoring continues to find carp DNA between the barriers and Lake Michigan.[5]

Silver carp, shown here, often feed in schools at the surface and can jump up to 10 feet out of the water when disturbed by boats.

In addition to Asian carp, separation will prevent future AIS from entering the Great Lakes or Mississippi River basins via the CAWS. The U.S. Army Corps of Engineers has identified 39 AIS with a high risk of passing into either the Great Lakes or Mississippi River.[6] More than 250 non-native species are already established in one or both of the basins, and invasive species cost the Great Lakes region alone an estimated $200 million annually.[7] For these reasons, separation appears to be the best long-term option to prevent Asian carp and other AIS from invading the Great Lakes or Mississippi River basins through Chicago-area waterways.

Economic Analysis

Like most major infrastructure projects, the costs of separation are substantial. However, they will be spread over nearly 50 years and will likely be shared among different groups within and beyond the Chicago area. At a regional level, the least expensive alternative would cost households in the Great Lakes region approximately $1 per month or just over $11 annually from 2012 through 2059. Adding households in the Mississippi River basin reduces the cost to just $4 a year during this timeframe. Given the widespread concern over the threat from Asian carp, and the benefits to the populations and economies of the two large watersheds, congressional funding support would be justified.

Separation could generate significant benefits for the Chicago region and the Great Lakes and Mississippi River basins as a whole, with the potential for between $1.4 billion to $9.5 billion in long-term savings from avoided AIS control costs and damages alone, as well as improved water quality, strengthened flood protection, and modernized shipping facilities. While the separation costs will be incurred over a limited timeframe, the benefits will be enjoyed indefinitely. Without separation, new AIS will likely pass through the CAWS, with the potential to cause significant economic and environmental damage. The documented costs from past AIS damages and controls—estimated at up to $500 million annually just for

zebra mussels—illustrate the future costs that separation will help avoid. **The project's technical report concludes that "stopping a single AIS from transferring between basins could avoid billions of dollars in economic loss."**

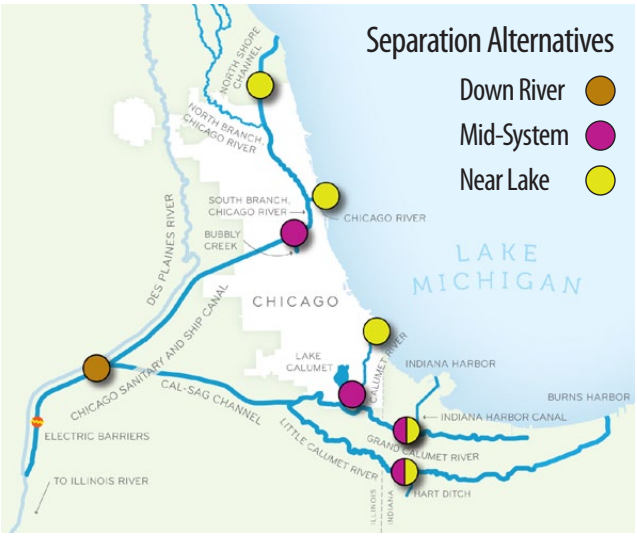
The Separation Alternatives

Three separation alternatives are identified that illustrate the advantages and disadvantages of placing barriers in different parts of the CAWS. The Down River, Mid-System, and Near Lake alternatives refer to the location of the barriers relative to Lake Michigan. Each alternative includes the location for barriers to divide the flow of water in the CAWS; improvements needed to maintain the system's benefits; the timing for implementation; and the costs. The report does not identify a preferred alternative. However, the Mid-System Alternative is the most viable. The costs (presented in 2010 dollars) reflect only the new investments that will be required beyond baseline expenditures already planned or underway, as well as the cost of the barriers themselves. It is noteworthy that the costs of just the barriers are a small proportion—approximately 3 percent—of the total investments needed for separation to succeed. Because of uncertainty about future regulatory standards, a range of costs are shown for the water quality investments required by separation. Finally, implementation depends on completion of Chicago's Tunnel and Reservoir Plan (TARP) for water quality improvement and flood management, scheduled for 2029.

Each of the separation alternatives stops the open flow of water between Lake Michigan and the Mississippi River watershed via the CAWS and maintains or enhances the system's benefits through investments in flood management, water quality and transportation.

Next Steps

The report shows that separation is feasible and can be accomplished in a way that maintains or enhances other vital uses of the Chicago waterway system. The report, and the collaborative process through which it was prepared, provides a strong foundation for developing and advancing a solution that benefits the Chicago region and the Great Lakes and Mississippi River basins as a whole.



Down River Alternative

This alternative includes a single barrier between the confluence of the Chicago Sanitary and Ship Canal and the Cal-Sag Channel and the Lockport Lock. This has the advantage of requiring only one barrier. However, it has significant impacts on water quality, transportation and flood management.

Separation barriers:		$109 million
Flood management:		$2.98 billion
Water quality:		$290 million to $5.85 billion
Transportation:		$560 million
Timeline:	Phase I:	One-way barrier with flood water bypass (lake to river) and all transportation improvements completed by 2022.
	Phase II:	Two-way barrier completed by 2029
Total Investment:		$3.94 - $9.5 billion

Mid-System Alternative

This alternative includes four barriers, one each on the South Branch of the Chicago River just upstream of Bubbly Creek, north of T.J. O'Brien Lock on the Calumet River, and on the Grand Calumet and Little Calumet rivers. This alternative poses the fewest challenges for stormwater management, flood management and transportation compared to the other two alternatives.

Separation barriers:		$140 million
Flood management:		$1.89 billion
Water quality:		$180 million to $1.2 billion
Transportation:		$1.04 billion
Timeline:	Phase I:	One-way barrier with flood water bypass (lake to river) and all transportation improvements completed by 2022.
	Phase II:	Two-way barrier completed by 2029
Total Investment:		$3.26 - $4.27 billion

Near Lake Alternative

This alternative requires five barriers, one each north of the North Side Wastewater Treatment Plant (WWTP) on the North Shore Channel, at the mouth of the Chicago River, at the mouth of the Calumet River, and on the Grand Calumet and Little Calumet rivers. It poses significant challenges for flood management and transportation.

Separation barriers:		$140 million
Flood management:		$3.82 billion
Water quality:		$120 million
Transportation:		$5.45 billion
Timeline:		Chicago River barriers completed by 2029 (with completion of TARP) Calumet River barriers completed by 2026 (with completion of new port facilities)
Total Investment:		$9.54 billion

The Chicago Area Waterway System and the Health of the Great Lakes

IN THE LATE 1800s CHICAGO CONFRONTED a public health crisis caused by untreated sewage in the Chicago River flowing to Lake Michigan, contaminating drinking water for a growing metropolis. Chicago residents were becoming sick and dying from typhoid and other diseases as a result. Something had to be done.

City leaders devised a bold solution to reverse the flow of the Chicago River and send the city's waste away from Lake Michigan. This required connecting the Chicago and Illinois rivers and sending the city's waste to the Mississippi River. This connection eventually became the Chicago Sanitary and Ship Canal, a 28-mile constructed waterway that links the south branch of the Chicago River with the Illinois River. When the canal opened in January 1900, water was diverted from Lake Michigan to dilute Chicago's waste and push it on to the Illinois River.

Over the following century what became known as the Chicago Area Waterway System (or CAWS) grew into a complex and heavily managed array of rivers, canals, locks and other structures. Eventually, the Cal-Sag Channel was created to connect the Calumet River with the Chicago Sanitary and Ship Canal, and the North Shore Channel was formed to connect the north branch of the Chicago River with Lake Michigan at Wilmette. Ultimately, Lake Michigan was opened to the CAWS at five points: the North Shore Channel at Wilmette, mouth of the Chicago River, Calumet River, Grand Calumet River at Indiana Harbor, and Little Calumet River at Burns Harbor.

The CAWS has become a vital part of the infrastructure for Chicago and northwest Indiana. In addition to managing wastewater, the system supports commercial shipping between Lake Michigan and the Mississippi River; conveys stormwater to control flooding; and accommodates the movement of thousands of recreational boats, tour boats and water taxis.

Bold actions in 1900 solved a critical challenge facing a growing city. A century later, however, the Great Lakes region is confronting a different challenge: how to halt the spread of aquatic invasive species—especially Asian carp—through the CAWS. This time, the ecological health and economic well-being of the Great Lakes are at stake.

Digging the canal in Palos Park, Ill., in 1914. Pictured is the construction of the Calumet feeder to the drainage canal.

Chicago Area Waterway System Bubbly Creek (right foreground), south branch of the Chicago River (right, toward downtown) and the Chicago Sanitary and Ship Canal (beginning at the bridge at center left). Metropolitan Water Reclamation District of Greater Chicago, ©MWRDGC2012-01.

Water flow in the Chicago area, circa 1900. Red arrows show the directional flow of water.

The Immediate Crisis: Asian Carp and Many More Aquatic Invasive Species

THE CAWS FORMS A CONTINUOUS hydrological connection that exposes the Mississippi River watershed – encompassing over 40 percent of the continental United States[8] – and the Great Lakes to each other, allowing fish and other aquatic life to pass freely between the two watersheds. The threat posed by this connection became apparent in the late 1990s as Asian carp approached the CAWS and the Great Lakes. This came after other aquatic invasive species (AIS) – such as zebra mussels and round gobies – had already passed through in the other direction, eventually spreading westward throughout the Mississippi River basin. Zebra mussels have infested water bodies in 28 states and have expanded as far west as Lake Mead.[9]

Asian carp threaten native fish populations because they grow rapidly, reproduce quickly, and consume vast quantities of phytoplankton and zooplankton, the foundation of the food chain in a healthy aquatic ecosystem. As a result, they out-compete native fish and disrupt the natural balance of the ecosystem. In addition, silver carp, one species of Asian carp, are easily startled by boat motors and leap out of the water, threatening recreational boaters and anglers. The federal government has recognized Asian carp as "the most acute [aquatic invasive species] threat facing the Great Lakes today."[10]

Asian carp were imported to help control algae in fish ponds in the southern United States. Flooding along the lower Mississippi River in the early 1990s allowed the carp to spread north. Within 10 years, they had spread nearly 1000 miles, moving into the Illinois and Ohio rivers.[11] In the mid 1990s, commercial catch of bighead carp in the Mississippi River grew by over 1000 percent; now commercial fishers in the Illinois River regularly catch up to 25,000 pounds of bighead and silver carp per day.[12] Scientists believe the leading edge of the Asian carp expansion in Illinois to be just 55 miles from Lake Michigan.[13]

Questions have been raised about whether Asian carp will survive and spread in the Great Lakes and whether they truly pose a significant threat to the region's ecological and environmental health. Several studies completed to date indicate that the environmental suitability of the Great Lakes for bighead carp and silver carp is very high;[14] some areas of the Great Lakes have sufficient food to support populations of these fish;[15] and at least 22 tributaries in the Great Lakes basin are potentially suitable for spawning by Asian carp.[16] In addition, a study focused on Lake Erie conducted by the U.S. Geological Survey found that the lake's largest tributaries – including the Maumee, Sandusky and Grand rivers – provide hospitable environments for Asian carp

What are Asian carp and why should we worry about them?

Asian carp is a generic term referring collectively to any of four species of carp native to Asia, including the bighead, silver, grass and black carp. Currently, bighead and silver carp are the most prevalent fish species in the Mississippi and Illinois rivers and are considered the most imminent threat to the Great Lakes.[17] They are voracious eaters, capable of eating up to 20 percent of their body weight each day and growing up to 110 pounds. They consume plankton—algae and other microscopic organisms—stripping the food web of key food for native fish. There are no fish in North America large enough to eat adult Asian carp, and they produce many offspring that grow quickly, rapidly becoming too large for native predators.

Silver carp.

A system of electric barriers, operated by the U.S. Army Corps of Engineers, in the Chicago Sanitary and Ship Canal is a key line of defense protecting the Great Lakes from Asian carp invading through the CAWS.

to reproduce and establish populations.[18] Taken collectively, this research demonstrates that the risk of Asian carp establishing populations in the Great Lakes basin is significant, potentially severe, and certainly very real.

Currently, a system of electric barriers in the Chicago Sanitary and Ship Canal (CSSC) is a key line of defense protecting the Great Lakes from Asian carp invading through the CAWS. The barriers use steel cables secured to the bottom of the canal to disperse a low-voltage electric field. The electric field is uncomfortable for fish and they do not swim across it. While they are an important part of a broader defensive strategy, the electric barriers will not stop many other species – especially viruses and plants – from passing through the CSSC, and their effectiveness in blocking small Asian carp has been questioned. In addition, a critical inherent deficiency is their inability to stop the downstream movement of live organisms, which, even if stunned by the electric current, can still pass through with the flow of water. The barriers also require ongoing maintenance and periodic shut downs, and cost $8 million annually to operate.[19]

The effectiveness of the electric barriers has been called into question by the detection of Asian carp DNA in the CAWS. Since federal agencies began using this new environmental DNA (or eDNA) monitoring technique in 2009, more than 90 positive samples of carp DNA have been detected between the electric barriers and Lake Michigan (that is, on the "wrong" side of the barriers).[20] A positive eDNA sample indicates the presence of Asian carp DNA and the possible presence of live fish. While the technique has limitations, it is an important "early warning" tool.

Electric barriers are a partial defense, but they do not provide a reliable, long-term solution that safeguards both the Great Lakes and Mississippi River watersheds from invasion by all potential AIS through the CAWS. The U.S. Army Corps of Engineers itself has acknowledged that "the electric barrier system is considered [an] experimental and temporary fix to this problem…"[21]

In response to growing indications in 2009 that Asian carp had bypassed the electric barriers, some Great Lakes leaders called for emergency measures to keep carp at bay, including the closure of navigation locks that connect the Chicago and Calumet rivers to Lake Michigan. Others disagreed, noting that lock closure would impact important benefits provided by the CAWS, such as commercial shipping and flood protection.

The dispute over closing Chicago-area navigation locks created divisions among the Great Lakes states and led to lawsuits in federal courts. This dispute threatens to undermine the region's unity and common purpose, which have been vital in advancing Great Lakes protection and restoration efforts over the past decade.

Rapid response activities, conducted by the Illinois Dept. of Natural Resources and other state and federal partners, included application of a chemical piscicide (rotenone) on sections of the CAWS in 2009 and 2010.

> In our view, the proper inference to draw from the evidence is that invasive carp are knocking on the door to the Great Lakes. We need not wait to see fish being pulled from the mouth of the Chicago River every day before concluding that the threat of a nuisance exists. It is enough that the threat is substantial and that it may be increasing with each day that passes. Unlike many nuisances that can be eliminated after they are discovered, this one in all likelihood cannot be. The fact that it would be impossible to un-ring the bell in this case is another reason to be more open to a conclusion that the threat is real.
>
> — U.S. COURT OF APPEALS FOR THE SEVENTH CIRCUIT, AUGUST 2011[22]

Restoring the Natural Divide to Protect the Great Lakes and Mississippi River

THE GREAT LAKES COMMISSION AND THE Great Lakes and St. Lawrence Cities Initiative formally endorsed separation of the Great Lakes and Mississippi River watersheds in the Chicago Area Waterway System as the best long-term solution to safeguard them from AIS, while recognizing the importance of accommodating the system's current uses.[23,24] Regional leaders recognize that current efforts to control Asian carp are critically important and must be sustained and strengthened wherever possible. However, they are also viewed as incomplete solutions to the long-term threat posed by AIS moving through the CAWS.

Preventing the introduction of invasive species is critical. Once established, they are usually impossible to eradicate and difficult and costly to manage or control. For example, more than $20 million is spent annually to control sea lamprey in the Great Lakes[25] (one of the few AIS that can be significantly controlled), and approximately $50 million is now being devoted each year on Asian carp control, management, research and prevention.[26] Without a long-term solution, the costs for Asian carp will continue indefinitely and the door will be left open for new invasive species.

It is important to recognize that separation is about much more than Asian carp and protecting the Great Lakes. While carp prompted the immediate crisis, they are only the latest AIS to threaten the Great Lakes. Over 180 non-native aquatic species are established in the Great Lakes[27] and 163 are established in the Mississippi River basin.[28] More non-native species are predicted to invade in decades to come. This could include not only species transported from foreign waters, but also non-native species already present in either the Great Lakes or Mississippi River watersheds that might pass through the CAWS and expand their range.

A report prepared by the U.S. Army Corps of Engineers as part of the Great Lakes and Mississippi River Interbasin Study (or GLMRIS) underscored this point. It identified 39 non-native invasive species with a high risk of passing through the CAWS, including 10 species poised to enter the Great Lakes and 29 ready to invade the Mississippi River basin. The report emphasized that these species are likely to have a moderate to severe impact on the basin being invaded.[29]

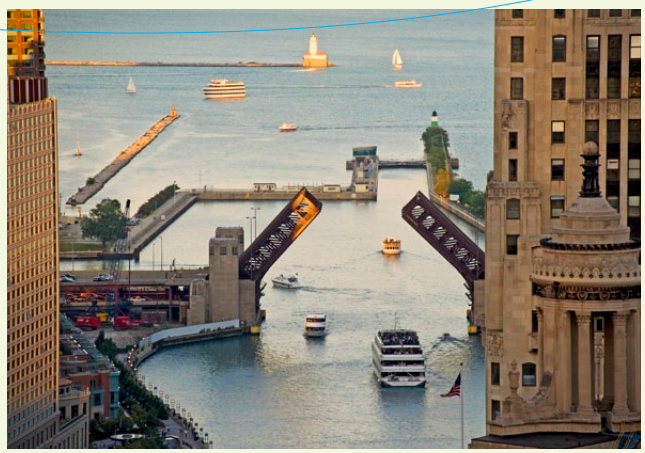
With the connection provided by the CAWS, the Great Lakes and Mississippi River watersheds will remain vulnerable indefinitely to the exchange of AIS and will face an ongoing battle, one species at a time. Control measures that work for one species may not stop other species, requiring constant investment in new technologies, monitoring and other efforts. Thus, re-establishing the natural divide between the Great Lakes and Mississippi River basins is a very effective and efficient long-term option for safeguarding the ecological and economic health of both water bodies.

In addition to the Great Lakes Commission and Great Lakes and St. Lawrence Cities Initiative, other organizations and jurisdictions calling for separation include the Great Lakes Fishery Commission,[30] American Fisheries Society,[31] Alliance for the Great Lakes,[32] Great Lakes United,[33] and the Healing our Waters-Great Lakes Coalition.[34] The 2005 Great Lakes Regional Collaboration restoration strategy called for a study of options for "permanent hydrological and/or biological separation of the Great Lakes and Mississippi River systems" and ranked the CAWS as the top priority for action in the region.[35] In September 2011,

Future AIS threatening the Great Lakes and Mississippi River basins

In addition to Asian carp, separating the Great Lakes and Mississippi River basins will stop the transfer of all future AIS via the CAWS and safeguard both water bodies. The U.S. Army Corps of Engineers has identified 39 AIS with a high risk of passing through the CAWS. These include invasive plants like water chestnut and the dense, mat-forming hydrilla; crustaceans like the spiny water flea and bloody red shrimp; molluscs such as New Zealand mud snail; and fish such as northern snakehead. The Corps predicts that these species are likely to have a moderate to severe impact on the water bodies being invaded.

Invasive species Clockwise from top: hydrilla, bloody red shrimp, northern snakehead.



A view of the Chicago River looking east showing Lake Shore Drive and the Chicago River Controlling Works.

Envisioning a Chicago Area Waterway System for the 21st Century

THE GREAT LAKES COMMISSION AND THE Great Lakes and St. Lawrence Cities Initiative seek to support a 21st Century vision for the Chicago Area Waterway System. This reflects and builds on the visions, plans and programs developed by many others in Chicago and northwest Indiana. Collectively, this emerging vision points to a future with cleaner water, less flooding and more efficient transportation. The project integrates these critical goals, with the added goal of preventing the movement of aquatic organisms through the CAWS.

For well over 100 years, the CAWS has been dedicated almost exclusively to barge traffic, stormwater and wastewater conveyance, tour boats in the downtown area, and some limited recreational boating. Now, more than a decade into the 21st Century, it is time to establish a new vision for the waterway. The nature of the water itself and the surrounding land, how it is used, and the relationship of the people to it are changing rapidly. There is an opportunity to redefine how the waterway shapes Chicago and the region now and into the future.

Chicago Mayor Rahm Emanuel has advanced this process by calling the Chicago River the next "recreational frontier" for the city.[36] For that to become a reality, dramatic improvements in water quality are necessary to meet the goals set in 1972 in the Clean Water Act. The commitment by the Metropolitan Water Reclamation District of Greater Chicago to disinfect its wastewater is a good beginning, but much more needs to be done to make the resource suitable for anglers, kayakers, canoeists, scullers, more tourists, and boaters going to and from Lake Michigan.

With more intense rainfall occurring more frequently, the capacity of the sewer system in the area is exceeded on a regular basis. The Tunnel and Reservoir Plan is helping significantly and will provide even more capacity in 2015 and upon its completion in 2029, but much of the area remains vulnerable to flooding. To deal with this, much work is needed to improve the sewer system, add green infrastructure and surface storage, and prevent stormwater from mixing with sewage. The future should be one where even in the most severe storm events, basements remain dry, streets stay open, and waterways are free of sewage.

Although transportation of goods and materials on Chicago-area waterways accounts for less than 3 percent of the total,[37] it is important and could be much more significant. Improvements in loading and unloading facilities, better multi-modal connections, and other strategies can lead to an integrated system that can take full advantage of the many environmental and energy advantages of waterborne transportation. This can help alleviate the significant problem of congestion on Chicago-area highways and railroads and take advantage of emerging opportunities to transport shipping containers on barges – an area that may grow significantly with expansion of the Panama Canal in 2015. The movement of shipping containers to and from the Great Lakes region, by all transportation modes, is projected to double by 2050.[38] However, Chicago-area ports do not currently have the facilities needed to serve this growing market. As with recreation on the Chicago River, Mayor Emanuel is moving to revitalize the Port of Chicago with a new vision and sorely-needed investments to attract new business.

There is an opportunity for a Chicago Area Waterway System for the 21st Century that is clean, does not flood, moves goods and people efficiently, and prevents the spread of aquatic plants and animals between the Great Lakes and Mississippi River basins.

Canoeists enjoy their paddle down the Chicago River.

the attorneys general of 17 states – from New York to Wyoming – called for aggressive action to "completely sever the ecological connection between the basins."[39]

The city of Chicago recognized the threat from invasive species and the need for separation when it hosted a 2003 meeting of experts who labeled invasive species "the greatest environmental threat to the national economy and to the ecology of the Great Lakes and Mississippi River regions." Among other actions, the experts recommended that "a project should be established that would result in the hydrologic separation of the Great Lakes and Mississippi River basins within 10 years."[40]

Separation: Moving from Concept to a Feasible Solution

WITH THIS CHALLENGE IN MIND, THE Great Lakes Commission and the Great Lakes and St. Lawrence Cities Initiative launched a project to develop alternatives for physical separation in the CAWS. The goal, in brief, is to illustrate how separation can be achieved while maintaining or enhancing other beneficial uses of the waterway system. Toward this end, the project developed three alternatives for physical separation that

1. Prevent the passage of Asian carp and other aquatic invasive species through the CAWS between the Mississippi River and the Great Lakes;
2. Improve water quality throughout the CAWS;
3. Improve the ability of the CAWS to protect against flooding; and
4. Improve the use of the waterways for commercial transportation and recreational boating.

A key premise of the project is that, to be successful, separation must support improvements to the CAWS while also preventing the movement of all AIS between the Great Lakes and Mississippi River basins. An additional project goal is to support and help accelerate the work being done by the U.S. Army Corps of Engineers in the GLMRIS.

The project was led by the Great Lakes Commission and the Great Lakes and St. Lawrence Cities Initiative, with guidance from an Executive Committee comprised of the governors of Illinois and Ohio and the mayors of Chicago, Ill., and Grand Rapids, Mich. A highly qualified consulting team with expertise in the various technical issues related to Chicago's waterway system conducted the technical aspects of the project. An Advisory Committee with stakeholders from Chicago, northwest Indiana, and other areas of the Great Lakes region provided input and ensured that all perspectives were represented and all significant issues were identified. While the committee's contributions were significant, the Great Lakes Commission and the Great Lakes and St. Lawrence Cities Initiative did not seek a formal consensus and the project findings do not necessarily reflect their views. Finally, independent peer reviews were conducted to assess the project methodology and advise the project team.

Initially, 20 potential barrier locations in the CAWS were identified and evaluated. These were narrowed down and, ultimately, three alternatives were chosen for detailed analysis. The three alternatives are the Down River Alternative, Mid-System Alternative, and Near Lake Alternative, with the names referring to their proximity to Lake Michigan. The alternatives include the following:

- The location for physical barriers to stop Asian carp and other AIS from passing through the CAWS
- The improvements needed to maintain or enhance water quality, flood management, and transportation in the CAWS after barriers are installed
- The timing for implementing separation, including a phased process that is coordinated with the completion of other improvements in the CAWS (particularly the Tunnel and Reservoir Plan (TARP))
- An economic analysis of the separation alternatives

What is GLMRIS?

GLMRIS is the Great Lakes and Mississippi River Interbasin Study, being conducted by the U.S. Army Corps of Engineers. It was authorized by Congress in 2007 and is currently scheduled for completion in 2015. The study is identifying potential aquatic pathways between the Great Lakes and Mississippi River watersheds; existing AIS with the potential to pass through the CAWS; and control measures, including separation, to prevent AIS transfer between the basins. When completed, the study will recommend an overall plan to prevent AIS transfer between the Mississippi River and Great Lakes systems. GLMRIS is generating a number of valuable interim reports, available online at http://glmris.anl.gov. This project is intended to inform and help advance GLMRIS.

Key Elements of the Separation Alternatives

THE FOLLOWING ILLUSTRATES KEY ELEMENTS of the Mid-System Separation Alternative that are needed to maintain or enhance water quality, flood protection and transportation in the CAWS while preventing AIS transfer between the Great Lakes and Mississippi River basins. The other two alternatives include similar elements.

Physical barriers could range from a sheet pile or impermeable land bridge without cargo or recreational boat transfer capability on the Little and Grand Calumet rivers, to a barrier with intermodal cargo transfer facilities and boat lifts on the Calumet River at Lake Calumet. The Chicago River barrier could include cargo and boat transfer equipment, depending on the need.

Interim one-way barrier to convey flood water on the Chicago River will prevent flooding until completion of the Tunnel and Reservoir Plan (TARP) in 2029, when it will be upgraded to block the flow of water in both directions. The one-way barrier will prevent AIS movement into Lake Michigan. Flows over the barrier from lake to river would occur infrequently to accommodate large storms.

Backflows to Lake Michigan from the CAWS will prevent flooding during large storms until TARP's completion. Locks and other control structures will remain closed except when backflows are needed to release flood water to Lake Michigan.

Wastewater treatment improvements at the North Side Wastewater Treatment Plant (WWTP) will ensure compliance with water quality standards and allow discharges to Lake Michigan.

Flow augmentation will prevent stagnant water on either side of the barriers. This could be provided by rerouting WWTP effluent or providing water from Lake Michigan to create flow.

Sewer separation within one mile on either side of the CAWS will separate sanitary and storm sewers to reduce peak discharges of flood water to the CAWS, preserving capacity of TARP for large storms.

Green infrastructure will be installed in the TARP service area when roads, sewers and water lines are reconstructed, and private developers will be required to capture more runoff. This will reduce flood water, preserving capacity in TARP for large storms and will improve water quality.

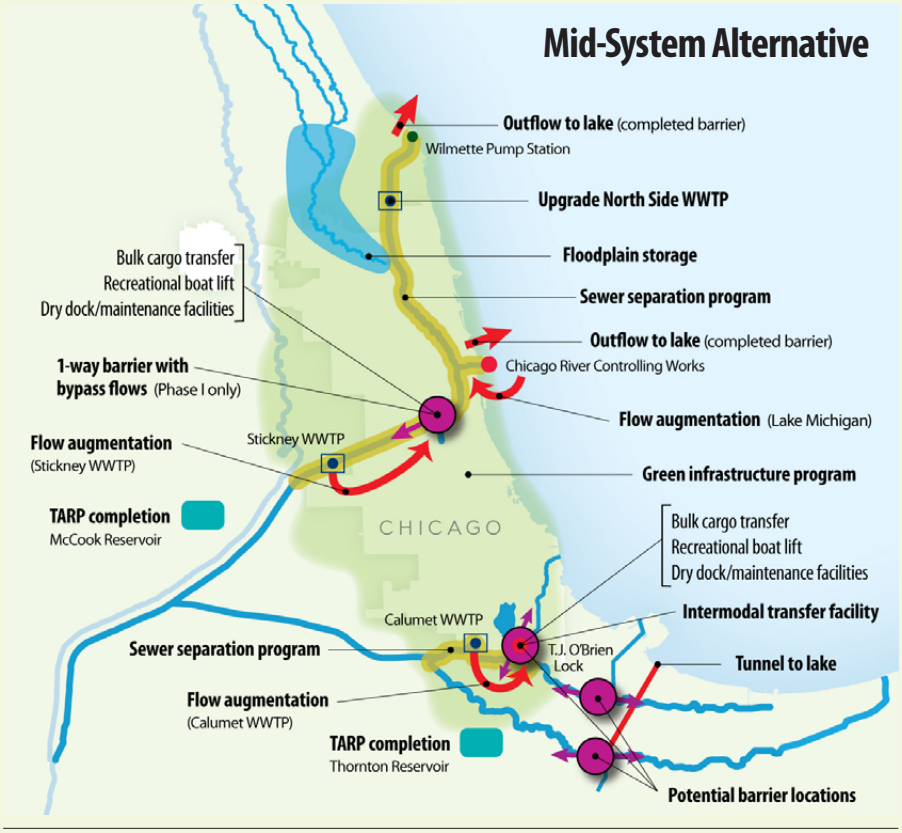
Floodplain storage on the North Branch of the Chicago River will reduce peak discharges of stormwater to the CAWS and conserve storage in the TARP system.

A flood conveyance tunnel will prevent flooding in the Calumet River system by conveying flood water from the U.S. Army Corps of Engineers Little Calumet River Flood Control Project to Lake Michigan.

TARP storage reservoirs will capture flood water and prevent flooding. The Thornton Reservoir, to be completed in 2015, will capture flood water when barriers are installed on the Calumet rivers in 2022. The McCook Reservoir, to be completed in 2029, will allow two-way operation of the Chicago River barrier. TARP is an investment that will help ensure separation is successful, but will occur regardless of the separation project.

Transportation improvements will be completed by 2022 when the barriers are installed and will include facilities to transfer cargo and recreational boats. Intermodal cargo transfer equipment will be provided at the barrier on the Calumet River to accommodate barges coming from the Cal-Sag Channel to the deep-draft areas north of the barrier.

Phased implementation will allow separation to be implemented as quickly as possible, with a one-way barrier in place on the Chicago River and complete barriers on the Calumet River system by 2022, and the two-way barrier implemented on the Chicago River by 2029 when the TARP system is completed.



The following are important factors to keep in mind when considering the alternatives:

The alternatives are intended to show varying impacts from different barrier locations: The alternatives were selected because they illustrate a range of impacts and opportunities that result from placing barriers at different locations in the CAWS. They are intended to clearly contrast each other and illuminate their respective benefits and disadvantages.

The maps show approximate barrier locations: The maps of the alternatives are not intended to show the precise location for each barrier, but the general vicinity where they would be located.

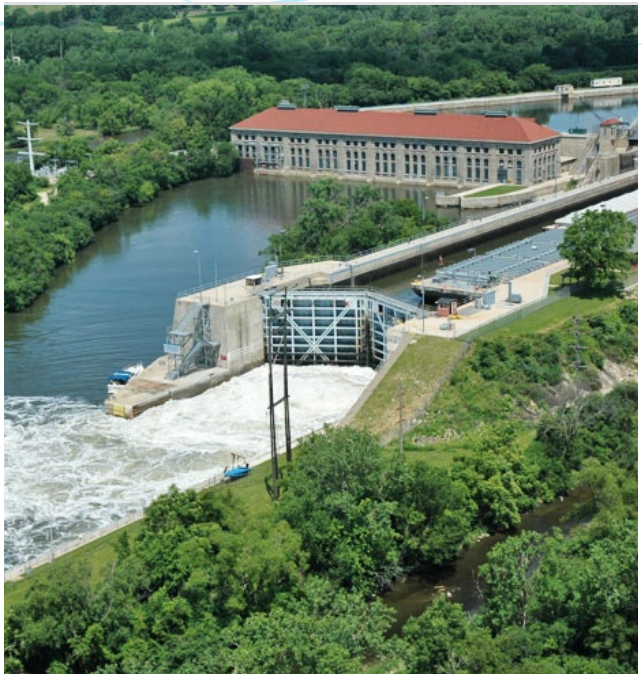
A preferred alternative is not identified: The project's purpose is to provide credible information and a sound analysis of separation alternatives to inform and advance the public dialogue. Using this information, decisionmakers will be equipped to begin considering a preferred alternative.

The alternatives are not assumed to be equally feasible: While the report does not identify a preferred alternative, they clearly differ in their advantages and disadvantages. The report shows, for example, that the Mid-System Alternative is far less expensive and has advantages over the other alternatives. The Great Lakes Commission and the Great Lakes and St. Lawrence Cities Initiative recognize this, but believe it is important to present three different alternatives in order to better inform the public dialogue.

Wastewater treatment costs are uncertain: There is significant uncertainty about future requirements for treating wastewater. While future standards for Lake Michigan and the Mississippi River are likely to be more stringent, it is unclear how much and what type of wastewater treatment plant (WWTP) improvements will be required. Thus, a range of costs are provided for each alternative reflecting varying levels of investments in the three major WWTPs that discharge to the CAWS.

The alternatives will be implemented in phases: The report recommends that separation be implemented in phases to avoid new flooding. The phases are integrated with the TARP program, scheduled for completion in 2029, with significant new floodwater storage coming online in 2015. During phase I, one-way barriers will prevent the movement of water and aquatic organisms from the CAWS into Lake Michigan. Complete separation will be implemented in 2029 when TARP is completed and can manage large storm events and prevent flooding.

Constructing the barriers is a small portion of the overall costs of separation: The costs of the physical barriers are a small proportion of the total investments required for separation, representing at most 3 percent of the cost of each alternative.



Lockport Powerhouse and Lock. Metropolitan Water Reclamation District of Greater Chicago, ©MWRDGC2012-01.

MWRD Stickney water reclamation plant, located in Cicero, Illinois, looking northeast toward downtown Chicago. Metropolitan Water Reclamation District of Greater Chicago, ©MWRDGC2012-01.

Understanding the Chicago Area Waterway System

THE CAWS IS A COMPLEX AND HEAVILY managed array of rivers, canals, locks and other structures. To understand how to implement separation in this context, this report defines a set of "baseline conditions" that reflect how the CAWS currently functions, as well as upcoming infrastructure investments. While these investments will help ensure separation is successful, they are expected to occur regardless of separation. The description of baseline conditions also illustrates current problems and limitations in the waterways and the services they provide. These shortcomings further confirm the importance of defining separation alternatives that improve water quality, flood management and transportation.

Flood Management

Managing stormwater and preventing flooding in the Chicago area is limited by the capacity of sewer pipes, widespread impervious surfaces, flat terrain, and open waterway channels, as well as the interaction of the CAWS with water levels on Lake Michigan. Storms generating just 1.5 inches of precipitation over a two-hour period can exceed the system's capacity, leading to basement and overbank flooding as well as combined sewer overflows (CSOs), when untreated sewage and stormwater are discharged into the CAWS.[41] As a result, the separation alternatives will impact stormwater management operations in the CAWS, requiring modifications and improvements to prevent additional flooding.

Planned improvements in stormwater infrastructure include the Tunnel and Reservoir Plan (TARP), scheduled for completion in 2029 with significant new capacity coming on line in the intervening years. TARP includes improved stormwater and wastewater conveyance and expanded storage. A December 2011 proposed Consent Decree between the U.S. Environmental Protection Agency (U.S. EPA) and the Metropolitan Water Reclamation District of Greater Chicago (MWRD) also requires an expanded green infrastructure program. The separation alternatives are designed to fit in with these and other planned infrastructure improvements to enhance flood protection.

Water Quality

Water quality in the CAWS is degraded by wastewater effluent, stormwater runoff, CSOs, contaminated sediments, and the slow flow of water in the system. There are 263 combined sewer discharge points to the CAWS and less than an inch of rainfall produces CSOs. Between 2000 and 2010 there were 416 CSO events that released more than 8 billion gallons of untreated sewage to local waterways.[42]

Illinois has designated the CAWS as "impaired" because it does not meet certain water quality standards. Current standards for the system are for a riverine system like the Mississippi River, and are less stringent than Great Lakes water quality standards that apply to municipalities across the basin. As a result, separation alternatives that involve the redirection of water flows to Lake Michigan will be subject to more stringent standards and will require upgrades to wastewater treatment plants (WWTPs). However, standards for discharging to the Mississippi River will likely become more stringent over the project period. To deal with this uncertainty and show how different standards will impact separation costs, the alternatives reflect various regulatory requirements and associated costs.

In June 2011 MWRD announced that it will disinfect wastewater discharges from the North Side and Calumet WWTPs (a standard practice for all other major WWTPs in the Great Lakes) in response to de-

September 2008 flooding in communities along the Des Plaines River, southwest of Chicago. Metropolitan Water Reclamation District of Greater Chicago, ©MWRDGC2012-01.

mands by U.S. EPA and Illinois EPA.[43] In calling for this change, U.S. EPA noted that "during the past 25 years, the [CAWS] has been transformed into a valuable recreational asset that citizens increasingly use for boating, canoeing, kayaking, jet and water skiing, tubing and swimming. The State of Illinois is long overdue on updating its water quality standards to provide the Clean Water Act protections that must accompany this transformation."[44] These upgrades are incorporated into the baseline conditions.

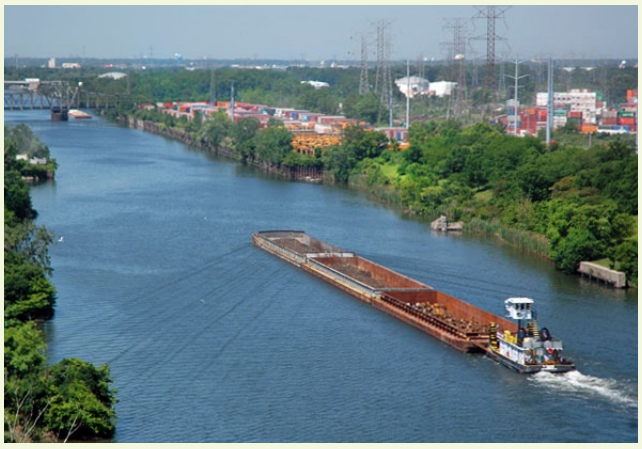
Transportation

Northeast Illinois is the freight capital of North America. Railroads, interstates, airports, and waterways all converge in the greater Chicago area, making it a strategic location as a national freight hub. For example, more than 500 freight trains operate in the region every day.[45] The CAWS, however, is severely underutilized for transporting cargo, with only 3 percent of freight in northeast Illinois moved by water.[46] This reflects a continual decline over past decades even after accounting for the recent economic downturn. At the same time, congestion on Chicago-area highways and rail lines is a significant, long-term problem. Freight trains passing through the region typically are delayed by up to two days, and highway congestion is estimated to cost the region over $7 billion annually.[47]

The decline in waterborne commerce on the CAWS has been driven by a number of factors: less heavy industry in the Chicago area, more reliance on rail and truck transport, and lack of investment in waterborne infrastructure and intermodal material handling equipment. For example, port facilities in the CAWS currently lack the infrastructure to efficiently transfer shipping containers between barges, ships, trains and trucks. The former director of Chicago's Regional Transportation Authority has characterized the Port of Chicago as "inconsequential" in the context of Chicago's role as a transportation hub.[48]

The CAWS has potential to help relieve congestion, move freight, and contribute to the region's economy. Waterways provide the least costly and most environmentally friendly way of transporting cargo, particularly bulk cargo that is not time sensitive. For example, a single 15-barge tow is equivalent to two 100-car trains or 870 trucks.

In addition, the expansion of the Panama Canal in 2015 will present new opportunities for increased cargo traffic in the Mississippi River and Great Lakes-St. Lawrence Seaway systems, including the use of barges to transport containers offloaded from the larger vessels that will be passing through the canal. The expanded canal is expected to shift many ocean-going vessels from West Coast ports to those on the East Coast and Gulf of Mexico. In response, Gulf Coast ports are planning to significantly increase their container capacity over the coming decade.[49] Some of these can be transferred to barges and moved up the Mississippi and Illinois rivers and then through the CAWS to the Great Lakes. Overall, the total market for transporting shipping containers in the Great Lakes region, by all modes, is expected to double by 2050.[50] However, substantial investments in Chicago-area ports and harbors will be needed for the barge industry to take advantage of this opportunity.



Commercial barge traffic on the Chicago Sanitary and Ship Canal. Metropolitan Water Reclamation District of Greater Chicago, ©MWRDGC2012-01.

The CAWS is also heavily used for recreational boating, tour boats and water taxis. Between 2009 and 2010 the tour boat industry saw a 15 percent increase in passengers.[51] In 2010, more than 23,000 recreational boats passed through the Chicago Lock and more than 12,000 passed through the T.J. O'Brien Lock on the Calumet River.[52] The Chicago River is increasingly being used by canoeists and kayakers and the city is developing four new boathouses on the river to improve recreational opportunities. They will be located near expanded trails along the river that will provide river access for runners, bikers and walkers.

Baseline conditions for transportation include investments planned as part of the Chicago Region Environmental and Transportation Efficiency (CREATE) program, which aims to increase the efficiency of the region's rail infrastructure. Planned investments in new marinas by the Chicago Park District are also included and are expected to enhance recreational activity along the waterfront.

The baseline conditions in the CAWS illustrate two key points:

- The Chicago area faces significant challenges managing water
- The region's waterways are underutilized for recreation and commercial transportation and have the potential to provide significantly greater benefits to local residents

With this in mind, and by building on already-planned improvements and investments, the separation alternatives are designed to help solve Chicago's water-related problems and leverage local waterways as a positive amenity while preventing the interbasin transfer of aquatic organisms.

Overview of Separation Alternatives

THE FOLLOWING IS A SUMMARY OF THE separation alternatives, emphasizing the barrier locations; improvements for flood management, water quality and transportation; and the timeline for phased implementation. This reflects only the improvements and associated costs required to make separation successful; it does not include investments that are already planned or anticipated. A detailed evaluation of the alternatives is provided in the project's technical report. It is important to note that the costs of the physical barriers are a very small proportion of the overall costs of separation, accounting for no more than 3 percent of total costs.

Down River Alternative

The Down River Alternative includes a single barrier placed between the confluence of the Chicago Sanitary and Ship Canal and the Cal-Sag Channel and the Lockport Lock. This has the advantage of requiring only one barrier. However, of the three alternatives, this one poses the most significant challenges for water quality and transportation.

Separation Barriers ($109 million)
- Single barrier

Flood Protection ($2.98 billion)
- Green infrastructure in the TARP service area on public rights-of-way based on Chicago's current road, sewer and water construction program and increased stormwater retention for private developments
- Partial separation of sanitary and storm sewers within one mile on either side of portions of the CAWS
- Tunnels from the CSSC, Calumet River and the Little Calumet River to Lake Michigan to convey flood water with a pump station near the Chicago River Controlling Works
- Increased floodplain storage along the North Branch of the Chicago River

Water Quality ($290 million-$5.85 billion, depending on stringency of future standards)
- Upgrades to all three WWTPs in the CAWS to meet Lake Michigan water quality standards
- Flow augmentation to prevent stagnant water on both sides of the barrier

Transportation ($560 million)
- Intermodal transfer facilities for bulk and liquid cargo
- New road and rail connections
- Recreational boat lift and disinfection station
- Dry dock facilities

Timeline for Phased Implementation
- Timeline driven by completion of TARP
  - Phase I: One-way barrier with floodwater bypass (lake to river) and all transportation improvements completed by 2022
  - Phase II: Two-way barrier completed by 2029

Total cost for the Down River Alternative:
$3.94 billion - $9.5 billion, depending on wastewater treatment requirements.

The Down River Alternative would improve the region's resiliency to large floods and provide stormwater management capability equal to or better than existing capacity. Water quality in the CAWS would be improved in order to meet Lake Michigan standards, including the removal of nutrients such as phosphorous and nitrogen. Diversion of water from Lake Michigan to the Mississippi River basin would be significantly reduced. Transportation within the CAWS would be maintained with enhanced access to Lake Michigan since the Chicago and T.J. O'Brien locks would be maintained in an "open" state. The new cargo transfer facility at the barrier location would improve intermodal connections, facilitate container traffic, and help reduce congestion on local roads and rail lines.

Mid-System Alternative

The Mid-System Alternative requires four barriers located on the South Branch of the Chicago River just upstream of Bubbly Creek, north of T.J. O'Brien Lock on the Calumet River, and on the Grand Calumet and Little Calumet rivers. This alternative poses the fewest challenges for stormwater management, flood management, water quality and transportation when compared to the other two alternatives.

Separation Barriers ($144 million)

- Four barriers

Flood Protection ($1.89 billion)

- Green infrastructure in the TARP service area on public rights-of-way based on Chicago's current road, sewer and water construction program and increased stormwater retention for private developments
- Partial separation of sanitary and storm sewers within one mile on either side of the CAWS
- Tunnel from the Little Calumet River to Lake Michigan to convey flood water
- Increased floodplain storage along the North Branch of the Chicago River

Water Quality ($180 million-$1.2 billion, depending on stringency of future standards)

- Upgrades to only the North Side WWTP to meet Lake Michigan water quality standards
- Flow augmentation to prevent stagnant water on both sides of the barriers

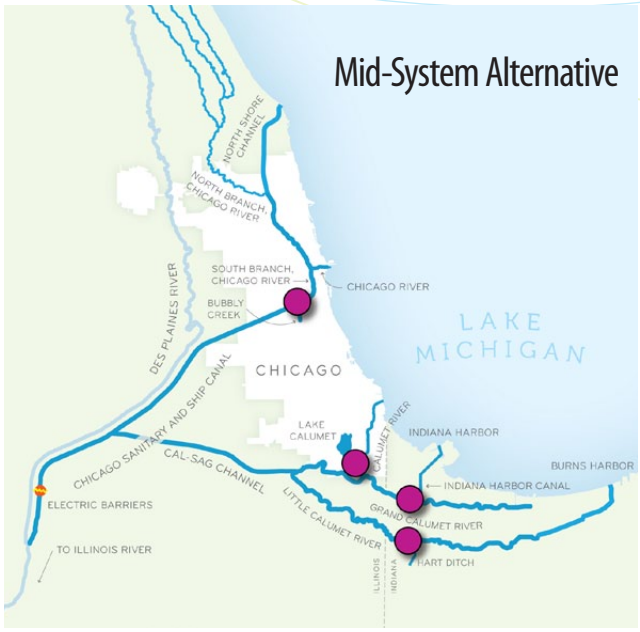
Transportation ($1.04 billion)

- Intermodal transfer facilities for bulk and liquid cargo at the barrier on the south branch of the Chicago River
- Expanded multimodal port infrastructure where the navigational channel on the Calumet River meets the barrier just north of the O'Brien lock to transfer freight, including containers, from barges and other modes of transport, including deep draft vessels coming from Lake Michigan
- Recreational boat lift and disinfection stations
- Dry dock facilities

Timeline for Phased Implementation

- Timeline for separation on the Chicago River system is driven by completion of TARP
  - Phase I: One-way barrier would block species transfer from river to lake, with floodwater bypass (lake to river) and all transportation improvements completed by 2022
  - Phase II: Two-way barrier completed by 2029
- Timeline for separation on the Calumet River system is driven by completion of new port and intermodal cargo transfer facilities: Two-way barriers completed by 2022 (only one phase)

Total cost for the Mid-System Alternative:
$3.26 billion - $4.27 billion depending on wastewater treatment requirements



The Mid-System Alternative would improve the region's resiliency to large floods and provide stormwater management capability equal to or better than existing capacity. Water quality in the CAWS would be improved and discharges from the North Side WWTP would meet Lake Michigan standards, including the removal of nutrients such as phosphorous. A portion of the water diverted from Lake Michigan would be returned. Recreational vessels and tour boats would have open access to Lake Michigan in downtown Chicago and from the North Shore Channel at Wilmette. Expanded port facilities on the Calumet River would improve intermodal connections, facilitate container traffic, and help reduce congestion on local roads and rail lines.

A conceptual rendering of the barrier and transportation improvements on the Calumet River near Lake Calumet.

Near Lake Alternative

The Near Lake Alternative requires five barriers located north of the North Side WWTP on the North Shore Channel, at the mouth of the Chicago River, at the mouth of the Calumet River, and on the Grand Calumet and Little Calumet rivers. This alternative poses significant challenges for flood management and transportation. The outlets to Lake Michigan would no longer be available, requiring construction of three tunnels to convey stormwater to prevent flooding. Freighters coming from Lake Michigan (known as "lakers") would no longer have access to ship terminals on the Calumet River and Lake Calumet, requiring construction of a new port on Lake Michigan.

Separation Barriers ($140 million)

- Five barriers

Flood Protection ($3.82 billion)

- Green infrastructure in the TARP service area on public rights-of-way based on Chicago's current road, sewer and water construction program and increased stormwater retention for private developments.
- Partial separation of sanitary and storm sewers within one mile on either side of the CAWS
- Tunnel from the Little Calumet River to Lake Michigan to convey flood water
- Tunnel from the Cal-Sag Channel/Calumet River to the Thornton Reservoir to convey flood water
- Tunnel from the North Branch of the Chicago River to the McCook Reservoir to convey flood water
- Additional capacity near the TARP reservoirs
- Increased floodplain storage along the North Branch of the Chicago River

Water Quality ($120 million)

- No WWTP upgrades are required
- Flow augmentation to prevent stagnant water on both sides of the barriers

Transportation ($5.45 billion)

- New port at the mouth of the Calumet River with 18 terminals to replace those on the river that would no longer be accessible by vessels coming from Lake Michigan
- Intermodal facilities to transfer cargo, including containers, from barges to lakers, rail and trucks
- Harbor, mooring, launching, dry dock, and disinfection facilities on Lake Michigan for recreational and commercial tour boats
- Recreational boat lift and disinfection stations

Timeline for Phased Implementation

- Timeline for separation on the Chicago River system is driven by completion of TARP and the flood control tunnel: Barriers completed by 2029 (one phase only)
- Timeline for separation on the Calumet River system is driven by completion of new port and intermodal cargo transfer facilities: Barriers completed by 2026 (one phase only)

Total cost for the Near Lake Alternative: $9.54 billion

The Near Lake Alternative would improve the region's resiliency to large floods and provide stormwater management capability equal to or better than existing capacity. Water quality in the CAWS would remain largely unchanged, except for benefits from already-planned improvements to WWTPs. There would be no more wastewater or CSO discharges to Lake Michigan except during large storm events. Barges, recreational vessels and tour boats would have unrestricted movement within the CAWS, but direct access to Lake Michigan would no longer be available. Deep-water vessels coming from Lake Michigan would no longer have access to port facilities on the Calumet River and in Lake Calumet. However, a modern, full-service port with consolidated terminals, intermodal facilities, and recreational boat facilities would be constructed at the mouth of the Calumet River. This could help reduce congestion on area roads and rail lines, increase container traffic in the region, and improve the intermodal efficiency of the freight system.

What is TARP and how does it affect separation?

TARP is the Chicago Tunnel and Reservoir Plan, a system adopted in 1972 to prevent water pollution and flooding in the CAWS and Lake Michigan. It includes 109 miles of tunnels and three large reservoirs that collect and store runoff and sewage from combined sewer overflows (CSOs) during large storms that exceed the capacity of treatment plants. When completed in 2029, the system will be able to capture and store nearly 20 billion gallons of CSOs and floodwater. Along with other measures, the separation alternatives will rely on the TARP system to prevent flooding and water pollution after barriers are installed. As a result, the schedule for implementing separation is largely dependent on completion of the TARP system.

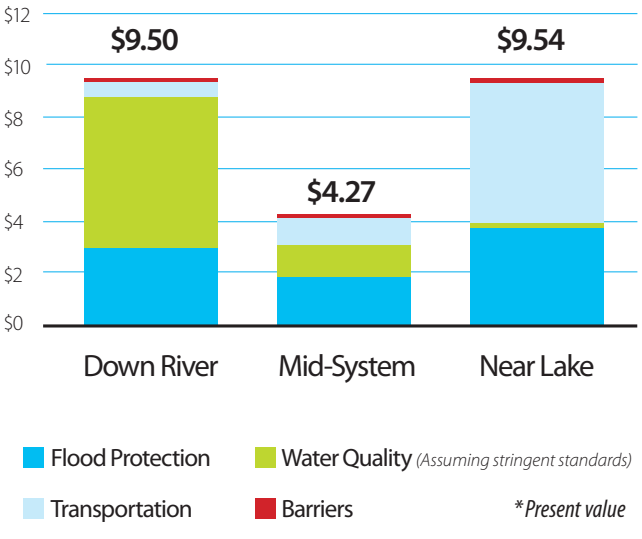
Economic Analysis

Managing the costs of separation

The estimated costs for implementing separation in the CAWS are substantial, ranging from a low of $3.26 billion for the Mid-System Alternative to a high of up to $9.54 billion for the Near Lake Alternative over approximately 50 years, including operation and maintenance. While these costs may appear daunting, they are consistent with the costs of other large-scale public infrastructure projects being implemented in the Great Lakes region and beyond:

- Chicago's Tunnel and Reservoir Plan (TARP): begun in 1972 and expected to cost $3.7 billion when completed in 2029[53]
- Illinois Tollway Capital Plan: projected to cost $12 billion over 15 years[54]
- Boston's Central Artery/Tunnel Project (the "Big Dig"): constructed over nearly a decade at a cost of approximately $15 billion[55]
- Chicago Area Waterway System: construction through 1928 cost approximately $11 billion in today's dollars[56]

Total Costs* ($ Billions)



The Chicago Lock.

Important considerations

Separation will generate important benefits: The separation costs include infrastructure investments that will provide cleaner water, increased flood protection and modernized shipping facilities, all of which will provide significant benefits to the Chicago region, in addition to preventing AIS movement through the CAWS.

Separation investments will be spread over many years: As presented, the separation alternatives would be implemented over nearly 20 years. Thus, the costs would be spread over a lengthy timeframe.

Investments could be shared by different groups within and beyond the Chicago area: Separation will involve a variety of activities that could be considered the responsibility of different sectors, such as utility customers in the Chicago region, waterway operators, local communities, land developers, and state and federal agencies. Thus, the costs likely will be shared among a range of entities, including those in the broader Great Lakes and Mississippi River regions benefitting from the improvements. This justifies a federal investment in implementing separation.

MWRD has a large customer base and relatively low sewer rates: MWRD serves more than 5 million people,[57] providing a large customer base to absorb the costs of upgrading WWTPs. Its rates are among the lowest in the country and are below the average sewer rates paid by residents in other areas of the Great Lakes.[58] For example, the average homeowner in the Chicago area pays about $222 annually for sewer services, while, on average, Ohio homeowners pay over $500.[59] Thus, paying for the water quality improvements required by separation will not put the Chicago area at a competitive disadvantage with other Great Lakes cities.

Recreation in Chicago, from top to bottom: Chicago River Day 2001, a water taxi on the Chicago River, and boating in Lake Michigan off the coast of Chicago.

A federal investment is justified: Great Lakes residents, both U.S. and Canadian – and the elected officials who represent them – are alarmed by the threat from Asian carp and are calling for an effective, long-term solution. In addition, states in the Mississippi River basin are concerned about receiving invasive species from the Great Lakes as well as polluted water from the CAWS. Congress and the public at large recognize the value of the Great Lakes and should support federal funding to help implement separation.

Public-private partnerships and other creative approaches can help finance separation: Some elements of separation – particularly improvements for transportation and commercial shipping – may be financed through public-private partnerships and other innovative financing options. Recent legislation in Illinois promotes such arrangements, authorizing public-private partnerships for the development, operation, and financing of transportation facilities.

Understanding the benefits of separation

Separation will generate significant benefits for the Chicago area and the Great Lakes and Mississippi River regions in general. While many of these benefits are difficult to quantify, they are important to consider. It is also noteworthy that the costs of separation will be incurred over a limited timeframe, while the benefits will be enjoyed indefinitely.

Preventing the transfer of aquatic invasive species

Separation will prevent the transfer of AIS through the CAWS. This is a significant benefit that will prevent future AIS-related damage to the economy and environment of the Great Lakes.

Knowing which AIS would enter the Great Lakes or Mississippi River basins without separation is difficult, but not impossible. As previously discussed, the U.S. Army Corps of Engineers identified 39 AIS with a high risk of passing through the CAWS that would have a moderate to severe impact on either the Great Lakes or Mississippi River basin.[60]

While new AIS could pass through the CAWS without separation, predicting the damage they will do and quantifying the costs incurred is extremely difficult. However, the Great Lakes region has a long history of battling invasive species and the documented costs incurred as a result of existing AIS can illustrate the future costs that could be avoided by implementing separation in the CAWS. Existing AIS costs include

- Sea lamprey control: $20 million annually[61]
- Invasive species introduced to the Great Lakes by ballast water: $150 million annually[62]
- Zebra mussel costs and damages: $300-$500 million annually[63]

These documented costs can be used to illustrate one dimension of the long-term benefits that would be generated if similar costs from future AIS are avoided by implementing separation.

- Avoiding $150 million in annual costs from AIS with similar impacts to those introduced to the Great Lakes by ballast water would generate approximately $400 million to $2.8 billion in long-term savings
- Avoiding $500 million in annual costs from a future AIS with impacts similar to zebra mussels would generate approximately $1.4 to $9.5 billion in long-term savings

As envisioned, separation will generate significant, long-term cost savings. For example, with the Great Lakes commercial and sport fishery generating $7 billion in economic activity annually,[64] the potential for avoiding economic damage from future AIS invasions is clearly evident. The project's technical report concludes that "stopping a single AIS from transferring between basins could avoid billions of dollars in economic loss."

Other benefits from separation

Other benefits from separation, some of which could not be quantified, include

- **Shipping containers on barges:** Over $400 million in economic benefits is estimated from expanded shipping of containers on barges in the CAWS.
- **Reducing flooding:** Local communities will benefit from reduced flooding of basements, streets and businesses as a result of infrastructure investments that will increase capacity in the CAWS to better handle large storm events.
- **Improving water quality:** Improved water quality in the CAWS will generate benefits for local residents. While these benefits are not quantified, studies by U.S. EPA have estimated the value of improvements generated by the Clean Water Act to be approximately $11 billion annually.[65]
- **Avoiding costs:** Avoiding the costs of operating and maintaining shipping locks on the CAWS and conducting AIS-related research and prevention are estimated at over $100 million.
- **Creating jobs:** Like any major infrastructure project, separation will create jobs and generate economic activity. It is estimated that separation will generate between 2,900 and 7,500 jobs annually over the approximately 50-year period evaluated in the report.

The cost of separation per household in the Great Lakes

Another approach to considering the costs and benefits of separation is to determine the cost per household in the Great Lakes and Mississippi River basins and consider if sufficient "willingness to pay" exists to support the effort.

Container ship, Panama Canal.

How Chicago could benefit from an expanded Panama Canal

With expansion of the Panama Canal in 2015, the Chicago region could attract new shipping business and become a primary hub for waterborne commerce. Anticipating a growth in container vessels passing through the Panama Canal, Gulf Coast ports are planning to significantly increase their container capacity over the coming decade.[66] Some of these containers can be transferred to barges and moved up the Mississippi and Illinois rivers and then through the CAWS into the Great Lakes. Containerized shipments make up the largest proportion of global trade, and the market for containerized traffic moving to and from the Great Lakes region, by all modes, is expected to double by 2050, growing to over 70 million containers annually.[67] Increased container-on-barge (COB) traffic could help reverse the decline in business for Chicago-area ports, relieve congestion on roads and rail lines, and link with ports on the Great Lakes and St. Lawrence Seaway. However, the CAWS currently lacks the infrastructure to efficiently serve the COB market. The improvements needed to take advantage of this economic opportunity are included in the separation alternatives.

This "willingness to pay" to prevent the movement of invasive species through the CAWS helps to put the required investments in perspective and provides an overall "reasonableness" test.

Households in the Great Lakes basin (in both the U.S. and Canada) would pay, on average, approximately $11 annually from 2012 through 2059 to implement the Mid-System Alternative. If the Mississippi River basin is included, households would pay approximately $4 annually through 2059. The annual costs through 2059 for the other two alternatives is approximately $24 for just Great Lakes households and $9 with the addition of Mississippi River households.

Next Steps

THIS REPORT SHOWS THAT SEPARATION is feasible and can be accomplished in a way that maintains or enhances other vital uses of the Chicago waterway system. It also illustrates how the management and use of the waterways is evolving and how upcoming investments can help facilitate separation and reduce its cost. Finally, the report proposes a holistic vision for the waterway system that integrates these investments with the steps needed to halt AIS transfer between the Great Lakes and Mississippi River basins.

There was never an intention to present a final plan for separation. More discussion is needed to identify the best location for barriers; integrate separation with Mayor Emanuel's new vision for the river as a "recreational frontier"; planned improvements related to water quality, flood management, and transportation; and incorporate the additional investments needed to achieve separation without compromising the system's benefits. However, this report is a critical step forward that provides a credible foundation for further dialogue on these and other issues.

Beyond the many technical issues, the report illustrates a fundamental challenge: separation will occur in the Chicago and northwest Indiana area and almost all of the expenditures will be made in that area. However, the most significant benefit – safeguarding the Great Lakes and Mississippi River from harmful invasive species – will accrue to the broader Great Lakes and Mississippi River basins. This "non-alignment" of expenditures and benefits suggests the need for continued dialogue and coordination to determine the most equitable sharing of costs. Ultimately, an effective, long-term solution will benefit both local residents and the region as a whole and the sharing of costs should reflect that.

Remaining United and Advancing a Long-Term Solution

THE GREAT LAKES COMMISSION AND THE Great Lakes and St. Lawrence Cities Initiative present this report to our members – the Great Lakes states, provinces and mayors – and the region's stakeholders and decision-makers. The report outlines solutions to the threat from Asian carp and other invasive species moving through Chicago-area waterways while also maintaining and enhancing the system's benefits. The report shows that separation is achievable from an engineering perspective. To move forward, political, jurisdictional and financial issues must be addressed and resolved.

Chicago skyline.

Over the past decade the Great Lakes region united to develop and implement a comprehensive strategy to restore this priceless natural resource through the Great Lakes Restoration Initiative. This unity and common purpose led to unprecedented investments, from all levels of government, to clean up the lakes and leverage them as a vital economic and environmental asset for our region and the nation as a whole. The region also adopted the Great Lakes-St. Lawrence River Basin Water Resources Compact and Agreement, an unprecedented and far-sighted plan for protecting Great Lakes water resources from diversions and over-consumption.

Asian carp have threatened this regional unity. This project, and the collaborative process through which it was conducted, is intended to lay the foundation for preserving regional unity while finding a solution to the serious and costly threat from AIS.

The Great Lakes Commission and the Great Lakes and St. Lawrence Cities Initiative look forward to collaborating with the many agencies and organizations responsible for Chicago's waterway system, together with other U.S. and Canadian partners, to advance a long-term solution that safeguards the Great Lakes and Mississippi River basins from aquatic invasive species while maintaining the important benefits the system provides to the residents of Chicago and northwest Indiana. Ultimately, any feasible solution must achieve both of these fundamental goals. Therefore, it is critical that the region remain united moving forward toward this end.

Summary of Findings for the Down River Alternative

	Flood Protection	Water Quality[b]	Transportation
Opportunities	■ Continual connection between the CAWS and Lake Michigan	■ Provides impetus for improving CAWS water quality	■ Maintains movements within the CAWS ■ Maintains laker access to CAWS terminals ■ No disruption to commercial tour boats, water taxis, and most recreational travel ■ Improved river-to-lake travel for commercial tour and recreational vessels
Challenges	■ Lose downstream conveyance outlet for flood water	■ More-stringent WWTP discharge standards ■ Flow stagnation along CSSC and Cal-Sag Channel ■ Reduction in flows downstream of barrier (water supply, habitat, and hydropower impacts) ■ Flood water (and potential pollutants) directed to Lake Michigan	■ Prevents movement of barges into and out of CSSC ■ Interrupts all traffic between the CAWS and the Illinois River
Improvements	■ Green infrastructure and sewer separations ■ Additional conveyance (lake outlets and tunnels) and storage (floodplain)	■ WWTP upgrades (North Side, Calumet, and Stickney)	■ Enhanced intermodal facilities and connections ■ New COB market potential
Investments	■ Emergency barrier bypass	■ Flow augmentation	■ Bulk and liquid cargo transfer ■ Recreational boat lift with disinfection ■ New dry dock
Timeline	Chicago and Calumet River System: ■ Overall timeline driven by TARP completion ■ Phase I – One-way barrier with bypass by 2022 ■ Phase II – Completed barrier by 2029		
Barrier Costs[a]	■ $109 million		
Investements by Area[a]	■ $2.98 billion	■ $0.29 – $5.85 billion	■ $0.56 billion
Total Investment[a,b]	■ $3.94 billion – $9.50 billion		

Summary of Findings for the Mid-System Alternative

	Flood Protection	Water Quality[b]	Transportation
Opportunities	■ Continual connection between the CAWS and Lake Michigan	■ Provides impetus for improving CAWS water quality	■ Minimal interruption to commercial tours and water taxis ■ Minimal interruption to recreational vessels using Chicago Lock ■ Maintains laker access to Lake Calumet and Calumet River terminals
Challenges	■ Lose downstream conveyance outlet for flood water at Bubbly Creek	■ More-stringent WWTP discharge standards ■ Flow stagnation near South Branch and Lake Calumet barriers ■ Flood water (and potential pollutants) directed to Lake Michigan	■ Prevents movement of barges and recreational vessels directly to Lake Michigan
Improvements	■ Green infrastructure and sewer separations ■ Additional conveyance (lake outlets) and storage (floodplain)	■ WWTP upgrades (North Side)	■ Enhanced intermodal facilities and connections ■ New COB market potential ■ Furthers community goals of open space and industrial revitalization
Investments	■ Emergency barrier bypass	■ Flow augmentation	■ Bulk and liquid cargo transfer ■ Recreational boat lift with disinfection ■ Dry dock facilities
Timeline	Chicago River System: ■ Overall timeline driven by TARP completion ■ Phase I – One-way barrier with bypass by 2022 ■ Phase II – Completed barrier by 2029	Calumet River System: ■ Overall timeline driven by port and intermodal facility construction ■ Phase I – Completed barrier by 2022 (only one phase)	
Barrier Costs[a]	■ $144 million		
Investements by Area[a]	■ $1.89 billion	■ $0.18 – $1.20 billion	■ $1.04 billion
Total Investment[a,b]	■ $3.26 billion – $4.27 billion		

Summary of Findings for the Near Lake Alternative

	Flood Protection	Water Quality	Transportation
Opportunities	■ Reduces backflows to Lake Michigan	■ CSOs and WWTP discharges remain riverside ■ Eliminates diversions from Lake Michigan	■ Maintains barge, commercial tour, water taxi, and recreational vessel movement within the CAWS
Challenges	■ Lose multiple conveyance outlets to Lake Michigan for flood water	■ Flow stagnation in NSC and Calumet River	■ Interrupts all barge and laker traffic to and from the lake ■ Interrupts all commercial tour and recreational vessels to and from the lake
Improvements	■ Green infrastructure and sewer separations ■ Additional conveyance (tunnels) and storage (floodplain and reservoir)	■ Not applicable	■ Modern, full-service port facility with consolidated terminals, intermodal facilities, and recreational vessel facilities ■ New COB market potential ■ Furthers community goals of open space and industrial revitalization
Investments	■ Emergency barrier bypass	■ Flow augmentation	■ Consolidated terminals ■ New container terminal ■ Recreational boat transfer with disinfection ■ Dry dock facilities
Timeline	Chicago River System: ■ Overall timeline driven by TARP completion and stormwater elements ■ Phase I – Completed barriers by 2029 (only one phase)	Calumet River System: ■ Overall timeline driven by port and intermodal facility construction ■ Phase I – Completed barrier by 2026 (only one phase)	
Barrier Costs[a]	■ $143 million		
Investements by Area[a]	■ $3.82 billion	■ $120 million	■ $5.45 billion
Total Investment[a,b]	■ $9.54 billion		

Notes:

a All costs represent median present values with a 3% discount rate.

b Based on the range of assumed WWTP upgrades that may be required, depending on future water quality standards for Lake Michigan and the Mississippi River.

List of Acronyms

AIS	aquatic invasive species
Cal-Sag Channel	Calumet-Saganashkee Channel
CAWS	Chicago Area Waterway System
CREATE	Chicago Region Environmental and Transportation Efficiency Program
CSO	combined sewer overflow
COB	container-on-barge
CSSC	Chicago Sanitary and Ship Canal
eDNA	environmental deoxyribonucleic acid
GLMRIS	Great Lakes and Mississippi River Interbasin Study
MWRD	Metropolitan Water Reclamation District of Greater Chicago
TARP	Tunnel and Reservoir Plan
USACE	United States Army Corps of Engineers
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WWTP	wastewater treatment plant

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ACKNOWLEDGMENTS

Acknowledgments

THE GREAT LAKES COMMISSION AND THE Great Lakes and St. Lawrence Cities Initiative are honored to have been entrusted with leadership for this effort and we thank the funders who made it possible: the Joyce Foundation, the C.S. Mott Foundation, the Great Lakes Fishery Trust, the Wege Foundation, the Great Lakes Protection Fund and the Frey Foundation.

We appreciate the support and wise counsel from the project's executive committee: Illinois Governor Pat Quinn, Ohio Governor John R. Kasich, Chicago Mayor Rahm Emanuel and Grand Rapids Mayor George Heartwell.

We benefitted tremendously from the project Advisory Committee, whose members contributed important technical information and diverse perspectives that informed and strengthened our work. We did not seek their endorsement, however, and the findings in this report do not necessarily reflect their views. We also thank the members of the Resource Group, representing government agencies, who also contributed to the project.

We especially wish to recognize and thank our lead consultant, HDR, Inc., and their multidisciplinary team of experts, for their outstanding technical analysis and success in addressing a multitude of complex challenges in a limited timeframe. Environmental Consulting and Technology, Inc. administered the project's independent peer review and provided invaluable counsel, support and guidance throughout the process.

This report would not have been possible without the excellent work of Matt Doss and Erika Jensen who helped with every phase of the project, the outstanding work of Laura Andrews in designing the report, and Christine Manninen and Dave Knight's communications expertise.

Finally, we thank our boards of directors for their strong leadership and their willingness to take on this challenging project. We hope our work meets the expectations of everyone involved and helps advance a solution that safeguards the health of the Great Lakes while preserving and enhancing the benefits of the Chicago Area Waterway System.

Tim Eder
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Credits

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The Great Lakes Commission, chaired by James Tierney, assistant commissioner for water resources at the New York State Department of Environmental Conservation, is an interstate compact agency established under state and U.S. federal law and dedicated to promoting a strong economy, healthy environment and high quality of life for the Great Lakes-St. Lawrence region and its residents. The Commission consists of governors' appointees, state legislators and agency officials from its eight member states. Associate membership for Ontario and Québec was established through the signing of a "Declaration of Partnership." The Commission maintains a formal Observer program involving U.S. and Canadian federal agencies, tribal authorities, binational agencies and other regional interests. The Commission offices are located in Ann Arbor, Michigan. Learn more at www.glc.org.

The Great Lakes and St. Lawrence Cities Initiative is a U.S. and Canadian coalition of over 80 cities representing more than 14 million people that works actively with federal, state, tribal, First Nation and provincial governments and other stakeholders to advance the restoration and protection of the Great Lakes and St. Lawrence River basin. For more information on the Cities Initiative, visit www.glslcities.org.

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