

Status of Restoration Activities in Great
Lakes Areas of Concern: A Special Report

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Report of the
International Joint Commission

FINAL

Executive Summary

Nearly a decade after the revised 1978 Great Lakes Water Quality Agreement was signed by Canada and the United States to "restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem," the two nations agreed that the worst areas would be given priority attention. Subsequently, 43 such areas were designated as Areas of Concern because they contained contaminated sediment, inadequately treated wastewater, nonpoint source pollution, inland contaminated sites or degraded habitat to a greater degree than the rest of the Great Lakes. Twenty-six of these are solely in the United States, 10 are solely in Canada, and five are binational waterways.

Annex 2 of the Great Lakes Water Quality Agreement directs Canada and the United States, working with state and provincial governments, to develop plans (known as Remedial Action Plans) to restore and protect ecosystem health so that the water is drinkable, beaches are swimmable and fish are safe to eat, among other such beneficial uses. Pursuant to the commitment made in the Commission's 2002 Eleventh Biennial Report on Great Lakes Water Quality and the requirements of the Great Lakes Water Quality Agreement, the International Joint Commission produced this report to inform the public on how much has been done in restoring beneficial uses in Areas of Concern. The Commission greatly appreciates the cooperation and assistance of the two governments in its preparation.

In many cases, information on remedial action to date, on future activities, and on the restoration of beneficial uses is unavailable or incomplete. Moreover, it is difficult to determine the actual impact of work done in the Great Lakes basin outside of the Remedial Action Plan program on the restoration of beneficial uses in Areas of Concern. However, we do know that the general direction toward restoration is positive. While the Great Lakes Water Quality Agreement does not prescribe the means to implement the restoration called for in Remedial Action Plans, it does call on governments to ensure that such plans are implemented. As such, the approach in each country is different. Although a significant level of effort toward Remedial Action Plan implementation has been observed in the Great Lakes Areas of Concern, much more work remains to be done. For the best information available on indicators of progress for each Area of Concern, see the Matrix of Restoration Activities that accompanies this report. These indicators include sediment remediation, wastewater infrastructure, habitat rehabilitation, nonpoint source pollution control, and remediation of hazardous waste sites.

The Commission observes that the magnitude of restoration required in the United States is greater than in Canada, and therefore, the resources allocated to remediation tend to reflect this distinction.

The findings of the Commission are as follows.

1. Two Areas of Concern in Canada have been delisted, and two Areas of Concern, one in Canada and one in the United States, are recognized as being Areas of Concern in a Recovery Stage.

2. In Canada, work to remediate sediment has taken place or is ongoing in two of 10 Canadian-only Areas of Concern. Natural recovery^a has been selected as the remedial strategy in seven Canadian-only Areas of Concern. To date, approximately \$33 million (CAD) has been spent on sediment remediation in Areas of Concern. In addition, approximately \$270 million (CAD) has been spent on wastewater infrastructure in Areas of Concern.

3. In the United States, work to remediate sediment has taken place or is ongoing in 14 of the 26 United States-only Areas of Concern. To date, the United States reports that \$160 million (USD) has been spent in Areas of Concern, and several billion dollars has been spent on wastewater treatment. Aside from Presque Isle Bay (Pennsylvania) and Torch Lake (Michigan), no United States Area of Concern has decided whether natural recovery will be its strategy for remediating sediment. Cleanup of contamination at nonaquatic sites that contribute to restoration of Areas of Concern has occurred under other programs, such as the United States Superfund program, but cleanup of these nonaquatic sites is not always specifically associated with Remedial Action Plans.

^a Allowing natural physical, chemical or biological processes to reduce the mass, toxicity, mobility, volume or concentration of contaminants in sediment.

4. Work to remediate contaminated sediment has taken place or is ongoing in two of the five binational Areas of Concern in Canada and in four of the five binational Areas of Concern in the United States.
5. The governments are not adequately reporting biennially on progress in developing and implementing Remedial Action Plans and in restoring beneficial uses, as called for in Annex 2 of the Agreement.
6. Key challenges facing the governments in implementing Remedial Action Plans and restoring beneficial uses are:
 - securing the resources to implement the plans;
 - identifying accountability and responsibility;
 - defining restoration targets where they do not exist;
 - setting priorities; and
 - monitoring recovery.
7. Information gaps on what has been implemented and what needs to be done limit the governments' ability to estimate and successfully acquire resources necessary to restore beneficial uses in the Areas of Concern.
8. Many Areas of Concern, particularly those in the United States, do not have clearly defined geographic boundaries as required by Annex 2 of the Great Lakes Water Quality Agreement, thereby making it difficult to

determine a full accounting of restoration activities within the Areas of Concern.^b

9. The governments' management of Remedial Action Plans requires more clearly delineated accountability and responsibility, however, some recent progress in this regard is noted.
10. The criteria and rationale for selecting natural recovery as the method of sediment remediation are not clear.
11. Although the Agreement does not use the term, the two governments are recognizing or designating Areas of Concern as being in a recovery stage.
12. Without clear restoration targets for each impaired beneficial use in each Area of Concern, particularly in the United States, it is difficult to quantify the specific costs of the remaining work. The United States government, however, has currently estimated that costs of \$7.4 billion (USD) will be required to address the wastewater infrastructure and sediment improvements necessary to restore beneficial uses in selected Areas of Concern for which detailed information is available. No information is available on future costs in its remaining Areas of Concern. The Canadian

^b The Commission is encouraged by the United States Environmental Protection Agency's expectation to develop GIS boundaries for each Area of Concern by June/July 2003

government has estimated a cost of \$1.9 billion (CAD) to address these improvements across all Canadian Areas of Concern.

In view of our obligations, studies and discussions with the parties, the recommendations of the Commission are as follows.

1. The two governments should document their considerable investment and achievements to date in order to provide the public with a true reflection of their accomplishments.
2. The two governments should meet their responsibility to formally report biennially on the degree to which each impaired beneficial use in each Area of Concern has been restored, as required by Annex 2, Paragraph 7(b), of the Great Lakes Water Quality Agreement.
3. The two governments should ensure that monitoring, data support and information management systems are in place and that the governments soon provide an update of the Matrix of Restoration Activities to the Commission. The Commission believes that the utility of the matrix would be greatly enhanced by maintaining it as a living, web-based document available to governments and the public, and invites governments to help make this happen.

4. The two governments should report to the Commission and the public on the criteria and rationale for selecting natural recovery as the method of sediment remediation.
5. The United States government should soon provide the Commission with a schedule for the development of restoration targets for each impaired beneficial use in each Area of Concern.
6. Federal, state and provincial governments should ensure accountability and responsibility for Remedial Action Plan implementation and set clear lines of authority for each of the Areas of Concern.
7. Federal, state and provincial governments should ensure that maps for the Areas of Concern clearly define the geographic boundaries of each Area of Concern, particularly in the United States, and that they identify the sources of degradation.
8. Federal, state and provincial governments should report to the Commission and the public on their rationale for determining priorities for remedial measures and identify those priorities within and among the Areas of Concern.
9. The two governments should report to the Commission and the public the criteria and rationale for recognizing or designating Areas of Concern in a Recovery Stage.

In the Canada-Ontario Agreement of 2002 and the United States Great Lakes Strategy of 2002, both Environment Canada and the United States Policy Committee identify plans to address several of these recommendations. The Commission looks forward to reporting on their implementation.

Background

Areas of Concern

The 1978 Great Lakes Water Quality Agreement (GLWQA; see Box 1), signed by the governments of Canada and the United States and amended in 1987, improved accountability and encouraged the implementation of best practices and the use of new technology in remediation activities. The two countries, working in cooperation with state and local governments and the Commission, designated areas that were particularly degraded as “Areas of Concern.” Figure 1 shows the current Areas of Concern.

Purpose of This Report

Within the limits of available information, the International Joint Commission describes the status of remedial activities in Great Lakes Areas of Concern and notes the future actions and resources required to restore beneficial uses (see Box 2). The Commission also makes

Box 1

The Boundary Waters Treaty and the Great Lakes Water Quality Agreement A Legacy of Leadership to Protect and Restore Our Shared Resources

The 1909 Boundary Waters Treaty stipulates that "boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other." The treaty created the International Joint Commission to prevent and resolve disputes along the boundary. Commencing in 1912, the Commission, at the request of the U.S. and Canadian governments, conducted several studies on pollution affecting the Great Lakes. A 1970 Commission report, completed at the request of the U.S. and Canadian governments, noted pollution problems in lakes Erie and Ontario and the St. Lawrence River¹, and culminated in the signing of the Great Lakes Water Quality Agreement in 1972.

Excess nutrients (e.g. phosphorus) in the lakes were the target of the original agreement. In 1978 the governments strengthened their commitment to restore the Great Lakes and called for the “discharge of any or all toxic substances to be virtually eliminated.” In addition, the goals of the Agreement were broadened from restoring and enhancing "water quality in the Great Lakes system" to restoring and maintaining the "chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem."

recommendations to the Canadian and United States governments on actions they can take to achieve restoration

Figure 1. Areas of Concern in Canada and the United States.

Annex 2 of the Agreement, which deals with Areas of Concern, indicates that the ability of plants, animals and humans to thrive in these locations can be particularly compromised by the presence of contaminated sediment, urban wastewater pollution, nonpoint source pollution, inland contaminated sites and degraded habitat. To restore and protect environmental quality in the Great Lakes, Annex 2 calls for the development and implementation of Remedial Action Plans for Areas of Concern.

In 1987, the two governments designated 42 Areas of Concern, with 25 sites in the United States, 12 in Canada and five in connecting channels shared by the two countries. Plans are being developed and implemented binationally at three of the shared Areas of Concern—the St. Marys River, St. Clair River and Detroit River Areas of Concern. The United States and Canada are developing and implementing

Box 2

Impairment of Beneficial Uses

The Great Lakes Water Quality Agreement [Annex 2, Section 1(c)] states that “impairment of beneficial use(s)” means a change in the chemical, physical or biological integrity of the Great Lakes System sufficient to cause any of the following:

- (i) restrictions on fish and wildlife consumption;
- (ii) tainting of fish and wildlife flavour;
- (iii) degradation of fish and wildlife populations;
- (iv) fish tumors or other deformities;
- (v) bird or animal deformities or reproduction problems;
- (vi) degradation of benthos (bottom-dwelling organisms);
- (vii) restrictions on dredging activities;
- (viii) eutrophication or undesirable algae (increased nutrient levels lead to increased algae levels);
- (ix) restrictions on drinking water consumption, or taste and odour problems;
- (x) beach closings;
- (xi) degradation of aesthetics;
- (xii) added costs to agriculture or industry;
- (xiii) degradation of phytoplankton and zooplankton populations (free floating plants and animals); and
- (xiv) loss of fish and wildlife habitat.

separate national Remedial Action Plans for the other two shared Areas of Concern—the Niagara River and St. Lawrence River Areas of Concern. In 1991, the United States government added an Area of Concern (Presque Isle Bay, Pennsylvania), making a total of 26 Areas of Concern in the United States.

The Canadian government declared two Areas of Concern restored (Collingwood Harbour, 1994 and Severn Sound, 2003) and one Area of Concern (Spanish Harbor, 1997) as an Area of Concern in recovery. In 2002, the United States government designated Presque Isle Bay as an Area of Concern in Recovery Stage².

Responsibilities of the Commission

The Great Lakes Water Quality Agreement [Annex 2, Section 4(d)] requires the two governments to submit Remedial Action Plans for each Area of Concern to the Commission for review and comment at three stages:

1. when a definition of the problem has been completed;
2. when remedial and regulatory measures are selected; and
3. when monitoring indicates that identified beneficial uses have been restored.

The Great Lakes Water Quality Agreement [Annex 2, Section 7(b)] also requires the governments to report every two years to the Commission on progress toward restoration of beneficial uses in the Areas of Concern. The Agreement also requires the

Commission to include information from these reports in its biennial reports [Annex 2, Section 7(b)]. Since 1987, only one comprehensive report on the status of beneficial uses has been prepared by the governments, and this report was submitted in 1994.

The Commission has submitted 11 biennial reports to the governments on progress toward restoration of Great Lakes water quality, the most recent one in September 2002. It has also submitted four detailed reports that assess progress in the Detroit River, Hamilton Harbour, St. Marys River and Niagara River Areas of Concern. The Commission also has commented on all Stage 1, Stage 2 and Stage 3 reports that have been submitted by the governments (see www.ijc.org). In addition, in 1991, the Commission developed and published guidelines for the listing and delisting of Areas of Concern.

Stages of Remedial Action Plan Development and Implementation

United States	Canada	Connecting Channels (Binational)
Stage 1: 12	Stage 1: 4	Stage 1: 1
Stage 2: 13	Stage 2: 6	Stage 2: 6 (St. Marys, St. Clair and Detroit rivers, two each for Niagara and St. Lawrence rivers)
Stage 3: 1 ^c	Stage 3: 2	Stage 3: 0

In the past year, the Commission has undertaken a comprehensive review of progress in developing and implementing Remedial Action Plans for all the Areas of Concern. As part of this work, in December 2001, the Commission requested

^c Waukegan Harbour submitted a Stage 3 report to the Commission. The Commission did not concur that the report met the requirements of a Stage 3 document.

information from the two governments regarding Remedial Action Plan implementation and management. In January 2002, the governments provided some data, noting that much of the requested information was not available. In April 2002, information was gathered from surveys of Canadian and United States officials and community representatives on implementation activities, management of and accountability for the Remedial Action Plan process, and key challenges and successes. During October and November 2002, the governments worked with the Commission on filling information gaps. The Commission greatly appreciates the cooperation and assistance of the two governments in the preparation of this report.

The Matrix of Restoration Activities in the Areas of Concern that accompanies this report reflects this cooperative effort and represents, at this time, the best available indicators of progress on Areas of Concern. The CD-ROM of the Commission's Eleventh Biennial Report also includes this report, the Matrix of Restoration Activities and a clickable map of all Areas of Concern.

Responsibilities of the Governments

Federal governments—in cooperation with state and provincial governments, and in consultation with local governments and communities—were to jointly develop and cooperatively implement the Remedial Action Plans [GLWQA, Annex 2, Section 2(e)].

The governments assigned personnel—whether federal or state/provincial, assisted by agency technical and scientific experts—to define and describe the environmental problems, the impaired beneficial uses, the degree of impairment and the geographic extent of such impairment. The governments were also to define the causes of the impairments and describe all known sources and other possible sources of pollutants. This information makes up the content of a Stage 1 report.

Public advisory committees were assembled in most Areas of Concern to work with the governments on a plan to restore beneficial uses. These committees typically had representatives from multiple sectors, possessing unique points of view and representing particular stakeholder groups.

Federal and state governments, working with local governments and communities, selected actions necessary to restore beneficial uses. These recommended actions are the basis for Stage 2 reports.

As previously noted, the governments also are required to report biennially on progress, including the status of beneficial uses. The only comprehensive report was prepared in 1994.

Remedial Action Plan Process

According to Annex 2 of the Agreement, each Remedial Action Plan “shall embody a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses in Areas of Concern or in open lake waters” [Section 2(a)] and “serve as an important step toward virtual elimination of persistent toxic substances and toward restoring and maintaining the chemical, physical and biological integrity of waters of the Great Lakes Basin Ecosystem [Section 2(b)].”

To date, Remedial Action Plans have focused on the remediation of major sources such as contaminated sediment and inadequately treated wastewater. In addition, plans have addressed nonpoint source pollution, habitat rehabilitation, pollution prevention and other actions to restore beneficial uses.

Work in some toxic sites within the United States Areas of Concern has taken place under other programs, such as the United States Superfund program, and has not in the past been documented consistently in Remedial Action Plan reports despite substantial levels of expenditure and clearly positive impacts on environmental quality in some Areas of Concern (e.g. Niagara River).

Work in Areas of Concern is carried out by dozens of organizations, including federal, state, provincial and local governments and volunteer groups and businesses, among others. Funding mechanisms are equally complex and vary by country and also by state within the United States.

Remedial Action Plan practitioners include staff in public agencies at the local, state, provincial and federal levels as well as private parties and community members.

Private parties can become funding partners through legal settlements via the United States Superfund program and other enforcement programs, and through other mechanisms such as citizen lawsuits or voluntary agreements. Any change in Remedial Action Plan participants and leadership can also slow the pace of plan development.

Information for the Canadian and United States Areas of Concern, presented in the Matrix of Restoration Activities that accompanies this report, represents an initial attempt by the Commission to compile indicators of restoration activities and the organizations responsible for carrying them out.

The Commission recognizes that an unquantified number of person-years of effort and billions of dollars have been devoted to restoration activities by the governments and the private sector. Additional tracking and data collection by the governments are necessary to more accurately quantify past effort and estimate future needs.

In the 16 years since Areas of Concern were identified, considerable progress has been made in:

- identifying baseline problems ;
- developing remediation plans ; and
- building community support for restoration plans.

Despite such progress, in most Areas of Concern significant challenges remain, including:

- determining the status of restoration;
- setting priorities;
- securing resources to support restoration; and
- coordinating implementation efforts.

Gaps in information on what needs to be done make it difficult for governments to predict and secure adequate resources to restore beneficial uses. Much work remains to be done, especially in the Areas of Concern, to achieve the visionary goal of restoring the chemical, physical and biological integrity of the waters of the Great Lakes basin ecosystem. (For a discussion of approaches used by the two governments in dealing with restoration of Great Lakes water quality, see Box 3.)

Box 3

National Approaches to the Restoration of Great Lakes Water Quality

The quality of the waters of the Great Lakes is affected by contamination occurring within the Areas of Concern as well as by contamination originating outside the Areas of Concern that reaches the lakes via tributaries, groundwater and airborne deposition. Contamination comes from nonpoint source pollution, such as agricultural and urban runoff, point source discharges of contaminants, groundwater, and airborne movement of contaminants from hazardous materials sites. Such sites also represent hazards to those who live in the immediate vicinity (e.g. Love Canal).

United States Approach

To deal with this multitude of contaminants, federal and state governments operate under a number of separate but interrelated programs. These include the Resource Conservation and Recovery Act, the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund), the Clean Water Act, the Toxic Substances Control Act, the Oil Pollution Act and many state statutes, regulations and initiatives. These programs often require the government to seek the parties responsible for the original pollution and, where feasible, require them to clean up the sites or to fund cleanup efforts (the “polluter pays” approach).

Faced with remediation activities across the basin and the nation and with variations in funding from year to year, both federal and state governments seek funds for remediation from all programs available to them. In addition, they seek funds through legal proceedings from potentially responsible parties. When funds are provided, they are often limited to a specific site or program, greatly reducing flexibility. Funding requests by governments and funding decisions by legislatures are based in large part on their understanding of the relative risks to affected citizens. Remediation of sediment and work on wastewater plants take a position in line for funds. The efforts of the U.S. government to restore the integrity of the Great Lakes involve activities of many programs, most of which operate outside of those programs focused specifically on sediment remediation and wastewater infrastructure upgrades. The relative priority among these programs is established based on the government's assessment of relative need among programs.

Canadian Approach

In Canada, there are a series of acts that help direct environmental protection and litigation. At the federal level they include, but are not limited to, the Fisheries Act, the Canadian Environmental Protection Act, the Canadian Environmental Assessment Act, the Canada Water Act, and others. In Ontario there are the Municipal Industrial Strategy for Abatement regulations, the Ontario Water Resource Act, the Safe Drinking Water Act, hazardous waste regulations, the Pesticides Act, the Nutrient Management Act, the Environmental Protection Act as well as other statutes and permitting processes relevant to restoring Great Lakes water quality. In Canada, the Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem contributes to Canada meeting its commitments under the Great Lakes Water Quality Agreement including those for Areas of Concern. The administration of the Canada-Ontario Agreement is entrusted to a Management Committee³, which includes a co-chair from Environment Canada and a co-chair from the Ontario Ministry of the Environment, as well as Regional Director General and Assistant Deputy Minister level representatives from all departments and ministries who are signatories to the Canada-Ontario Agreement³.

Progress Toward Restoration

Governments and stakeholders in the Great Lakes basin have initiated or completed a wide variety of remedial actions in various Areas of Concern in the United States and Canada, representing considerable investment with some well-documented successes, such as the following.

- The governments no longer consider Collingwood Harbour and Severn Sound (Ontario) to be Areas of Concern because conditions have improved to the point that beneficial uses have been restored (Box 4). The Commission concurred.

- The two governments have recognized Spanish Harbour in

Ontario and Presque Isle Bay in Pennsylvania as Areas of Concern that are in a recovery stage (Box 4).

Box 4

Restoration Achievements Noted in Both Canada and the United States

Recently, the U.S. Environmental Protection Agency recognized Presque Isle Bay as an Area of Concern in a Recovery Stage—the first such designation of an Area of Concern in the United States. In Canada, Collingwood Harbour and Severn Sound have been designated as restored and have been delisted as Areas of Concern, and Spanish Harbour has been recognized as an Area of Concern in a recovery stage.

Progress in improving water quality in this bay surrounded by Erie, Pennsylvania, is a microcosm of work done basinwide. In this case, for example, \$100 million (USD) has been invested to upgrade Erie's sewer system, and pollution from major industrial sources and runoff was stopped.

In Presque Isle Bay, as in many Canadian Areas of Concern, natural recovery has been chosen as the consensus strategy for dealing with contaminated sediment because widespread low levels of pollutants do not pose a direct threat to the biota living in the bay.

Source Control

- The United States government has reported that at a cost of nearly \$130 million (USD), more than 1.27 million cubic meters (1.6 million cubic yards) of sediment contaminated with polychlorinated biphenyls (PCBs) have been removed from the Kalamazoo River, Manistique River, Maumee River, Rouge River, Saginaw River, Saginaw Bay, and the United States side of the St. Lawrence River.

Much of the contaminated sediment inventory in the Great Lakes basin exists because of inputs from municipal and industrial sources that predate point source regulation. Although these point sources have been strictly regulated, continued inputs to receiving waters can occur through uncontrolled waste sites and the transport of contaminated material from upland areas including industrial and agricultural sites. Achieving suitable reductions in such sources is referred to as “source control.” Failure to address significant inputs of contaminants precludes the successful use of other management options. Because of the wide range of activities that may need to be undertaken to achieve acceptable source control, cost estimates are highly site-specific.

Natural Recovery (Attenuation)

Physical, chemical or biological processes that result in a reduction of mass, toxicity, mobility, volume or concentration of contaminants are referred to as “natural attenuation.” These processes include burial through sedimentation, volatilization, dispersion and biodegradation. Burial with clean sediment is one process that most often results in risk reduction. Natural attenuation in and of itself has no cost, but is preceded by assessment and followed by monitoring.

Thick-Layer Capping

Thick-layer capping is an onsite management technique that involves placing a 20 centimeter (eight inch) to one meter (three feet) thick layer of clean material over the area of contaminated sediment. To date, there have been limited demonstrations of capping in the Great Lakes basin. Based on one proposal of full-scale capping, the cost was estimated at \$50–\$60 (USD) per cubic yard of contaminated sediment⁴.

Environmental Dredging

Environmental dredging is the most commonly used sediment remediation technique. Dredging of contaminated sediment in the Great Lakes basin is accomplished through hydraulic or mechanical dredging. Typical costs are in the range of \$100–\$200 (USD) per cubic yard⁵. These costs are several times those of navigational dredging. Hydraulic dredging minimizes sediment resuspension, but requires treatment of large quantities of water. Enhanced designs of mechanical dredges have resulted in improved performance with low volumes of excess water being produced.

- The Canadian government reports that approximately \$270 million (CAD) has been invested by the federal and provincial governments over the last 10 years to

improve the condition of wastewater infrastructure in various Canadian Areas of Concern. The United States government reports investing \$3.4 billion (USD) to upgrade wastewater infrastructure in two United States Areas of Concern.

The status of activities directed toward remediation of contaminated sediment, wastewater infrastructure, and fish and wildlife habitat and restoration of other beneficial uses are discussed in the following sections of this report.

Contaminated Sediment

Sediment in Areas of Concern is often contaminated with industrial or agricultural pollutants, such as PCBs, DDT, mercury or polycyclic aromatic hydrocarbons, presenting both financial and ecological challenges to agencies and communities. Most pollutants in sediment within Areas of Concern were released into the environment long ago and constitute a “legacy of pollution.” Other contaminants continue to enter the environment, such as through the burning of fossil fuels and from runoff from agricultural and urban areas.

Toxic chemicals in sediment can enter the food chain and threaten the health of fish, wildlife and humans. For example, contaminated sediment is the major source of contaminants found in fish and results in fish consumption advisories. The risk of adverse health effects from eating contaminated fish is particularly high for pregnant women, fetuses and infants. From an economic standpoint, contaminated sediment can

prevent or delay dredging, limiting navigation and recreational boating⁶. Contaminated sediment also can reduce property values and threaten the multi-billion dollar commercial and sport fish industries⁷.

Upon confirmation by Remedial Action Plan participants that contaminated sediment at a site poses an unacceptable risk to human or ecosystem health, the practitioners evaluate an array of potential remedial measures for possible use to reduce that risk. These potential measures include source control and natural recovery (attenuation), thick-layer capping and sediment removal through hydraulic or mechanical dredging (Box 5). In addition to these remedial options, there are a variety of dredged material treatment technologies such as thermal desorption, solvent extraction and soil washing. Though they provide a permanent solution, the thermal and nonthermal technologies are costly and are not likely to compete on a cost basis with the disposal of dredged material in a confinement facility⁸.

To date, it is difficult to assess progress in addressing the sediment remediation problem (Figure 2). In Canada, more than 100,000 cubic meters (132,000 cubic yards) of contaminated sediment have been dredged from its Areas of Concern, and in the United States, more than 1.27 million cubic meters (1.6 million cubic yards) have been dredged from its Areas of Concern for remedial purposes. According to the United States government, “Great Lakes agencies have completed or are currently addressing the remediation of more than 3 million cubic yards of contaminated sediment in the Basin⁹.”

At this time, the governments are not able to clearly define either their cleanup targets for contaminated sediment or the volumes of sediment still requiring active remediation. The lack of a framework for making prioritized decisions regarding remediation was identified by the Commission in 1997 as an obstacle to progress¹⁰. Without endpoints, progress cannot be assessed.

Figure 2. Status of Contaminated Sediment Remediation

***Box 6
Risk Management Is Helping Target Cleanups in Both the United States and
Canada***

Researchers in both the United States and Canada are developing methods to assist in making decisions regarding the management of contaminated sediment. These methods help set priorities and assist partners in determining cleanup targets. For example, Canadian researchers have developed the Benthic Assessment of Sediment (BEAST) model to determine whether sediment requires remediation¹¹.

The U.S. National Research Council (NRC) publication "A Risk-Management Strategy for PCB-Contaminated Sediments¹²." provides advice pertinent to contaminated sediment decision making. Decisions for specific contaminated sediment sites must be based on a consideration of the advantages and disadvantages of available options and by balancing the various risks, costs and benefits associated with each option. Of particular relevance to the Commission is the NRC's recommendation that the first priority must be the management of overall risks to humans and the environment rather than the selection of a remediation technology (e.g. dredging, capping or natural attenuation).

Although priority setting represents a political and institutional challenge, at least three U.S. Areas of Concern—the Kalamazoo River, the Grand Calumet River, and the Lower Green Bay/Fox River—remain severely contaminated and are releasing significant

amounts of PCBs and other persistent toxic substances to the open waters of Lake Michigan. Clean up of these sites should be a priority and the Commission notes that remedial actions in these Areas of Concern are currently underway. The information gathered in the Green Bay Mass Balance Study, and the current Fox River Natural Resources Damage Assessment demonstrate progress in arriving at management decisions. Nearly 453,600 kg (one million pounds) of PCBs have been removed from Waukegan Harbour, the largest source to Lake Michigan, and a \$330 million (USD) settlement will finance the remediation of the Fox River.

Funding for Sediment Remediation

Environment Canada's Great Lakes Sustainability Fund provides \$30 million (CAD) over five years for work in the Great Lakes. Some of this funding may be available for sediment remediation in Areas of Concern. In addition, Ontario has allocated \$50 million (CAD) over five years for the Great Lakes, a portion of which could be made available for sediment remediation in Areas of Concern.

In the United States, the 2002 Great Lakes Legacy Act provides a national focus on Great Lakes sediment remediation. The act amends the Clean Water Act to authorize \$250 million (USD) over five years for the U.S. Environmental Protection Agency to conduct remediation of sediment in the Areas of Concern. Local cost-sharing would provide an additional \$87 million (USD). The act also authorizes additional funds for information dissemination and research. The United States president's fiscal year 2004

budget includes \$15 million to support the Great Lakes Legacy Act and the clean up of contaminated sediment.

Wastewater Infrastructure Maintenance and Upgrades

The maintenance of and improvements to sewage treatment plants and wastewater

Box 7 ***Wastewater Treatment and Discharges to the Great Lakes***

Depending on the extent to which wastewater is purified, sewage treatment is classified as primary, secondary or tertiary. **Primary treatment** removes floating and heavier suspended solids but does not reduce the concentration of soluble nutrients such as phosphorus. In seven Ontario Areas of Concern some municipalities have primary treatment plants

Secondary treatment uses biological methods in which bacteria break down the dissolved organic matter. The wastewater is then allowed further settling to remove particles. Metal salts are added to remove phosphorus. With **tertiary** or advanced wastewater treatment, all but a negligible amount of bacteria and organic matter can be removed. Sand filters or additional basins can be used to improve the quality of treated water released. Dechlorination is sometimes needed to minimize environmental impacts. Secondary treatment is the general treatment standard in the Great Lakes.

Although the quality of effluent discharged by most sewage treatment plants in the Great Lakes basin has greatly improved, combined sewer and sanitary sewer overflows continue to severely degrade the waters near many urban Area of Concern. Combined sewers were designed to carry both raw sewage and storm water to sewage treatment plants. Overflows of untreated water and sewage occur during or after severe storm events and are discharged directly into the waterways. Sanitary sewer overflows are discharges of raw or inadequately treated sewage from separate sanitary sewer systems. Industrial waste that has been discharged to the sewer system also can be present in these overflows.

Such overflows often result in beach closings because of bacterial pollution. They can also affect the quality of drinking water and can cause excessive growth of aquatic plants. Costs associated with even partial treatment are considerable. For example, even though the cost of a deep tunnel system in Milwaukee exceeded \$2 billion (USD), an estimated 49.2 billion litres (13 billion gallons) of untreated wastewater has been released since the project was completed^{13, 14}.

infrastructure, together with the need to reduce sanitary sewer and combined sewer overflows, represent a costly challenge in many Areas of Concern (see Box 7). Although such maintenance and improvements are essentially a municipal or regional responsibility, funding can come from higher levels of government, depending in part on the ability of the municipal government to finance the improvements.

No information was provided by the United States government regarding wastewater infrastructure (Figure 3) for most United States Areas of Concern. Data was available for the United States Detroit River and Milwaukee Estuary Areas of Concern, where \$1 billion (USD) and \$2.2 billion (USD), respectively, already have been invested in upgrading wastewater infrastructure. According to the United States government, these two Areas of Concern have a remaining need of at least \$2.4 billion (USD) and \$1 billion (USD), respectively, to complete the upgrade of their wastewater systems, and the Cuyahoga River Area of Concern (Cleveland, Ohio) has a remaining need of \$1 billion (USD). No other information was available regarding the amount already spent or the amount needed to be spent to complete upgrades necessary to restore beneficial uses.^d

Approximately \$270 million (CAD) has been spent over the past 10 years by federal and provincial governments for wastewater infrastructure improvements in Canadian Areas of Concern. Environment Canada notes that remaining wastewater infrastructure improvements across Canadian Areas of Concern will require approximately \$1.8 billion (CAD). The Hamilton Harbour Area of Concern alone has an estimated need of \$545–\$600 million (CAD).

^d As of February 2003, the United States Environmental Protection Agency informed the Commission that work is in progress to consolidate this information

**Figure 3. Status of Wastewater Infrastructure
Investments**

Fish and Wildlife Habitat

Progress in habitat restoration within Areas of Concern has been described by the governments in terms of the number and cost of projects. For the Canadian Areas of Concern, the government reports that 187 projects have been completed at a total cost of \$80.26 million (CAD). Although habitat work is underway in the United States portion of the Great Lakes basin, the United States government was not able to report on progress within most of its Areas of Concern.

In Canada, the restoration of fish and wildlife habitat is progressing more rapidly than are more complex projects such as sediment remediation and infrastructure improvements. However, the benefits to fish and wildlife populations are not well quantified and are infrequently reported¹⁵.

Few participants involved in Remedial Action Plan development and implementation on both sides of the border could quantify the extent to which fish and wildlife habitat and populations have been restored, despite a considerable number of projects designed to enhance and protect habitat. The quantification of progress requires more than a catalogue of dollars expended and hectares or acres of habitat protected or

rehabilitated.^e It requires restoration targets, clearly defined endpoints and estimates of the degree to which those targets are being met.

The Commission acknowledges that work is proceeding but without the above information the Commission cannot evaluate to what degree the actions reported by the governments contribute to the full restoration of beneficial uses.

Waste Sites and Nonpoint Source Pollution

The remediation of hazardous waste sites that contribute contamination to the Areas of Concern is necessary to reduce the exposure of fish, wildlife and human populations to persistent toxic substances because land-based sites can leach contaminants into groundwater and surface water or release contaminants to the atmosphere. There are multiple hazardous waste sites in several United States Areas of Concern. The cost to date for remediation on the United States side of the Niagara River Area of Concern alone has been \$382 million (USD), and future outlays are estimated at \$249 million (USD), excluding long-term operation, maintenance and monitoring costs for the sites. Hazardous waste sites identified in United States Areas of Concern are illustrated in Figure 4^f. Because the geographic boundaries of some of the United States Areas of Concern are uncertain, it is not possible to determine how many such sites are located within the Areas of Concern. Canada has reported that contaminant levels are such that

^e The two governments recognize this but were unable to report on the degree to which beneficial uses were restored

^f This figure only identifies Superfund National Priority List hazardous material sites. Information on other sites addressed by other programs was not provided to the Commission.

remedial actions related to hazardous waste sites are not necessary in Canadian Areas of Concern¹⁶.

Figure 4. Hazardous waste sites within U.S. AOCs.

Reductions in phosphorus and sediment inputs from agricultural nonpoint sources have been a part of government-funded programs in both countries since the mid-1980s. Environment Canada reports spending over \$20 million (CAD) since the inception of the Remedial Action Plan program to curtail these types of inputs within Canadian Areas of Concern. Although there are several United States federal programs supporting reductions of nonpoint source pollution, the United States government has not identified expenditures within its Areas of Concern. As previously noted, because the geographic boundaries of Areas of Concern in the United State are not clearly defined, the extent of nonpoint source pollution in the Areas of Concern is difficult to determine.

Accountability and Responsibility for Remedial Action Plans

In verifying the list of federal, state, provincial and local Area of Concern contacts provided by the Parties, the Commission discovered numerous cases where the named contact was no longer employed by the agency, retired, or no longer responsible for the Area of Concern.

The Commission believes that for the governments to effectively address the multi-billion dollar remediation challenge, management responsibilities across a broad range of programs must be clearly defined. Government agencies should ensure that:

- technical input and oversight are provided;
- information is managed effectively and is coordinated among a variety of government and nongovernment organizations; and
- public engagement, which supports and sustains the momentum for Remedial Action Plan implementation, continues.

Governments also should ensure that those who work or live in Areas of Concern know:

- the individual who is responsible for each Area of Concern;
- the direction of the program; and
- progress toward restoring beneficial uses.

United States Approach

Of the 31 United States and binational Areas of Concern, 27 have federal contacts and 26 have state coordinators. In some United States Areas of Concern, including many in Michigan, agencies view local community groups as being responsible for Remedial Action Plan implementation, while the community groups view the agencies as being responsible.

Recognizing concerns about Remedial Action Plan management and coordination, the United States Great Lakes Strategy ¹⁷ made reform a key objective, promising to “accelerate the pace of sediment remediation, working to overcome barriers to progress identified at each site.”

Canadian Approach

The presence of a federal or provincial coordinator was reported by the government for 14 of the 15 Canadian and binational Areas of Concern, and all Areas of Concern have been assigned a government contact. However, the assignment of a coordinator was not always known by the community contacts, revealing a lack of communication between local participants and the government. The 2002 Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem¹⁸ commits the province to take the lead in many Areas of Concern, noting in part:

“Canada and Ontario will co-lead Remedial Action Plan management in Toronto and Region, Severn Sound (delisted January 2003), St. Marys River, St. Clair River and Detroit River Areas of Concern. Canada will lead the process in Thunder Bay, Hamilton Harbour, Port Hope, and the St. Lawrence River Areas of Concern.

“Ontario will lead the process in Nipigon Bay, Jackfish Bay, Peninsula Harbour, Spanish Harbour, Wheatley Harbour, Niagara River and the Bay of Quinte Areas of Concern.”

Community-based Alliances

In Canada and the United States, cases exist where community-based groups have developed formal agreements with different levels of government and/or business/industry to take the coordinating role (e.g. Toronto and Region, Ashtabula River). These Remedial Action Plan participants have demonstrated promising results and effective management practices. The community groups are active and knowledgeable and are dedicated to restoring beneficial uses. In particular, community representatives receive help from such alliances in developing project proposals, acquiring matching funding and generating more technical data in support of project development and implementation.

Confirming the Status of Restoration Efforts

Implementation efforts can often exceed 10- to 20-year periods, during which environmental conditions and scientific understanding can change. Because environmental monitoring can reveal the response of ecosystems to remedial actions that have been designed to restore beneficial uses, the Remedial Action Plans may need to be adjusted based on the observed environmental responses.

As scientific knowledge advances, restoration targets, where they exist, also change. For example, environmental and health impacts of new contaminants, or lower doses of already known contaminants, are the subject of numerous studies and government directives, including fish advisories. Accordingly, restoration targets must be updated to reflect the latest research, and remedial strategies may need to be adapted to accommodate new knowledge.

Environmental monitoring is clearly required to ensure that remedial measures are resulting in the intended ecosystem recovery. As the Commission sought information for this report, it became evident that few Remedial Action Plan practitioners could estimate the degree to which the local environment was responding to remedial actions taken, partly because monitoring is insufficient to provide this information.

Approximately three-quarters of the United States Areas of Concern do not have restoration targets against which to compare changes in environmental conditions. Without these restoration targets, it is impossible for the Commission to evaluate progress or to assess restoration efforts.

Keeping the Focus on Beneficial Uses

The Commission notes that many of the actions being implemented in United States Areas of Concern are driven by a multiplicity of programs with different priorities, such

as the U.S. Superfund program. As actions in the United States Areas of Concern approach a point where large-scale projects near completion (such as sediment remediation under a United States Superfund action), the challenge is to revitalize the Remedial Action Plan process and focus on fully restoring beneficial uses. The United States Great Lakes Strategy¹⁹ recognizes this need:

“By 2006, the SOLEC [State of the Lakes Ecosystem Conferences], LaMP [Lakewide Management Plan], and Remedial Action Plan processes will provide clear information on Great Lakes water quality measures, trends, and actions (e.g., water quality trends, fish tissue trends, beach closures, Remedial Action Plan and LaMP implementation, ecosystems restored); will be accessible to the public via the Internet; and will be updated on a regular basis.”

(Note: SOLEC is a binational, biennial initiative organized by Environment Canada and the U.S. Environmental Protection Agency to develop and report on indicators of the state of the Great Lakes ecosystem.)

This United States commitment to the SOLEC process apparently represents a consensus between both governments. On September 25, 2002, Environment Canada and the U.S. Environmental Protection Agency, in cooperation with the Commission, launched a cooperative tracking program designed to more completely account for planning and implementation efforts related to contaminated sediment, wastewater infrastructure, fish and wildlife habitat, and hazardous waste sites in Areas of Concern. This initiative could help the government meet their commitment to SOLEC and Remedial Action Plan reporting.

Because of the centralized coordination in the early 1990s (i.e. oversight through the federal-provincial, multiagency Canada-Ontario Agreement Review Committee), 14 of the 15 Areas of Concern in Canada (including binational sites) had developed restoration targets. Planning participants in 14 of the 15 sites have reassessed the status of beneficial use impairments within the past five or six years²⁰.

The Commission finds that there is confusion or a lack of knowledge on the part of some Area of Concern participants regarding the extent to which beneficial uses are impaired. According to the Canada-Ontario Agreement²¹, Canada and Ontario have committed to make "publicly available environmental monitoring information for evaluating environmental recovery and adjusting remediation strategies."

Considering that the restoration of beneficial uses in Areas of Concern is a goal of Annex 2 of the Great Lakes Water Quality Agreement, the Commission is concerned that the general lack of knowledge regarding the status of beneficial uses by the agencies and the engaged public reflects shortfalls in Remedial Action Plan management, data support, communication and coordination.

Funding for Remediation and Planning Efforts

As previously discussed, based on information supplied by the governments, an estimated \$7.4 billion (USD) will be required to address wastewater infrastructure and sediment improvements necessary to restore beneficial uses in selected Areas of Concern. Values

for the remaining United States Areas of Concern are unknown. Costs for all the Canadian Areas of Concern are presently estimated at \$1.9 billion (CAD). Due in part to the lack of restoration targets, the Commission cannot relate these estimates to the magnitude of real costs. If government, industry, business and local communities are expected to find and invest these resources, governments must provide more accurate and complete information, set priorities and demonstrate progress in restoring Areas of Concern. Securing these resources, whether from public or private sources, is ultimately the responsibility of the federal governments, in cooperation with the state and provincial governments.

Better communication and coordination among Remedial Action Plan practitioners and federal and state project managers of programs that may be operating within Areas of Concern but not covered in the Remedial Action Plan would also improve information exchange on cleanup actions. This would improve the focus on the Remedial Action Plan's purpose to restore beneficial uses.

Corporate/Private Spending on Remediation

Little information is available regarding the level of corporate spending for remedial activities in the Areas of Concern. The Commission does know, however, that corporate expenditures to control contamination from hazardous waste sites in the New York state portion of the Niagara River Area of Concern will exceed \$600 million (USD), excluding operation and maintenance expenses. The Commission believes that such investments by

the private sector be monitored by the governments and that their contribution to the overall cleanup effort be recognized in order to provide the full accounting the Commission and the public deserve.

Findings

A significant level of effort toward Remedial Action Plan implementation has been observed in the Great Lakes Areas of Concern. The Matrix of Restoration Activities that accompanies this report summarizes, for each Area of Concern, information on restoration activities provided by the governments to the Commission.

The findings of the Commission are as follows.

1. Two Areas of Concern in Canada have been delisted, and two Areas of Concern, one in Canada and one in the United States are recognized as being Areas of Concern in a Recovery Stage.
2. In Canada, work to remediate sediment has taken place or is ongoing in 2 of 10 Canadian-only Areas of Concern. Natural recovery^g has been selected as the remedial strategy in seven Canadian-only Areas of Concern. To date, approximately \$33 million (CAD) has been spent on sediment remediation in Areas of Concern. In addition, approximately \$270 million (CAD) has been spent on wastewater infrastructure in Areas of Concern.
3. In the United States, work to remediate sediment has taken place or is ongoing in 14 of the 26 United-States only Areas of Concern. To date, the United States reports that \$160 million (USD) has been spent in Areas of Concern, and several billion dollars has been spent on wastewater

^g (allowing natural physical, chemical or biological processes to reduce the mass, toxicity, mobility, volume or concentration of contaminants in sediment)

treatment. Aside from Presque Isle Bay (Pennsylvania) and Torch Lake (Michigan), no United States Area of Concern has decided whether natural recovery will be their strategy for remediating sediment. Cleanup of contamination at nonaquatic sites that contribute to restoration of Areas of Concern has occurred under other programs, such as the United States Superfund program, but cleanup of these nonaquatic sites is not always specifically associated with Remedial Action Plans.

4. Work to remediate contaminated sediment has taken place or is ongoing in two of the five binational Areas of Concern in Canada and in 4 of the 5 binational Areas of Concern in the United States.
5. The governments are not adequately reporting biennially on progress in developing and implementing Remedial Action Plans and in restoring beneficial uses, as called for in Annex 2 of the Agreement.
6. Key challenges facing the governments in implementing Remedial Action Plans and restoring beneficial uses are:
 - securing the resources to implement the plans;
 - identifying accountability and responsibility;
 - defining restoration targets where they do not exist;
 - setting priorities; and
 - monitoring recovery.
7. Information gaps on what has been implemented and what more needs to be done limit the governments' ability to estimate and successfully acquire resources necessary to restore beneficial uses in the Areas of Concern.

8. Many Areas of Concern, particularly those in the United States, do not have clearly defined geographic boundaries as required by Annex 2 of the Great Lakes Water Quality Agreement, thereby making it difficult to determine a full accounting of restoration activities within the Areas of Concern.^h
9. The governments' management of Remedial Action Plans requires more clearly delineated accountability and responsibility, however, some recent progress in this regard is noted.
10. The criteria and rationale for selecting natural recovery as the method of sediment remediation are not clear,
11. Although the Agreement does not use the term, the two governments are recognizing or designating Areas of Concern as being in a recovery stage.
12. Without clear restoration targets for each impaired beneficial use in each Area of Concern, particularly in the United States, it is difficult to quantify the specific costs of the remaining work. The United States government, however, has currently estimated that costs of \$7.4 billion (USD) will be required to address the wastewater infrastructure and sediment improvements necessary to restore beneficial uses in selected Areas of Concern for which detailed information is available. No information is available on future costs in its remaining Areas of Concern. The Canadian government has estimated a cost of \$1.9 billion (CAD) to address these improvements across all Canadian Areas of Concern.

^h The Commission is encouraged by the United States Environmental Protection Agency's expectation to develop GIS boundaries for each Area of Concern by June/July 2003

In view of our obligations, studies and discussions with the parties, the recommendations of the Commission are as follows.

1. The two governments should document their considerable investment and achievements to date in order to provide the public with a true reflection of their accomplishments.
2. The two governments should meet their responsibility to formally report biennially on the degree to which each impaired beneficial use in each Area of Concern has been restored, as required by Annex 2, Paragraph 7(b), of the Great Lakes Water Quality Agreement.
3. The two governments should ensure that monitoring, data support and information management systems are in place and that the governments soon provide an update of the Matrix of Restoration Activities to the Commission. The Commission believes that the utility of the matrix would be greatly enhanced by maintaining it as a living, web-based document available to governments and the public, and invites governments to help make this happen.
4. The two governments should report to the Commission and the public on the criteria and rationale for selecting natural recovery as the method of sediment remediation.

5. The United States government should soon provide the Commission with a schedule for the development of restoration targets for each impaired beneficial use in each of the Areas of Concern.
6. Federal, state and provincial governments should ensure accountability and responsibility for Remedial Action Plan implementation and set clear lines of authority for each Area of Concern.
7. Federal, state and provincial governments should ensure that maps for the Areas of Concern clearly define the geographic boundaries of each Area of Concern, particularly in the United States, and that they identify the sources of degradation.
8. Federal, state and provincial governments should report to the Commission and the public on their rationale for determining priorities for remedial measures and identify those priorities within and among the Areas of Concern.
9. The two governments should report to the Commission and the public the criteria and rationale for recognizing or designating Areas of Concern in a Recovery Stage.

In the Canada-Ontario Agreement of 2002 and the United States Great Lakes Strategy of 2002, Environment Canada and the United States Environmental Protection Agency identify plans to address several of these recommendations. The Commission looks forward to reporting on their implementation.

Notes:

1. IJC 1970
2. U.S. EPA 2003
3. COA 2002
4. NRC 2001
5. NRC 2001
6. U.S. Policy Committee 2002
7. SedPAC, 2002
8. NRC, 2001
9. U.S. Policy Committee 2002
10. SedPAC, 1997
11. Reynoldson et al., 1995
12. NRC, 2001
13. USEPA 2001
14. Milwaukee Journal Sentinel, 2002
15. Krantzberg et al., 1999
16. COA, 2000
17. U.S. Policy Committee 2002
18. COA 2002
19. U.S. Policy Committee 2002
20. Krantzberg et al., 1999
21. COA 2002

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