

WATER QUALITY OF THE UPPER GREAT LAKES

SUMMARY



INTERNATIONAL JOINT COMMISSION

MAY 1979

Report available from:

United States Section
International Joint Commission
1717 H Street, N.W.
Washington, D.C. 20440

Canadian Section
International Joint Commission
100 Metcalfe Street
Ottawa, Ontario K1P 5M1

Great Lakes Regional Office
International Joint Commission
100 Ouellette Avenue
Windsor, Ontario N9A 6T3

1. SUMMARY

On April 15, 1972 the Governments of Canada and the United States requested the International Joint Commission to determine the extent and causes of pollution in Lakes Superior and Huron, identify practicable remedial measures, and recommend measures to prevent further degradation. These questions have been addressed and reported upon by the Commission's Upper Lakes Reference Group, and a series of public hearings on the Reference Group's findings have been held. The Commission's findings and recommendations are set out in this report.

The Commission finds that the overall water quality of the Upper Lakes is excellent, but there are many sources of pollution which should be reduced or eliminated if the existing high quality is to be maintained. The Commission also finds that transboundary pollution occurs in the St. Marys River as a result of the discharge of phenolic substances by the Algoma Steel Corporation and by the City of Sault Ste. Marie, Ontario.

Water use problems occur in several areas, particularly in Saginaw Bay on Lake Huron and Duluth-Superior Harbor on Lake Superior, as a result of inputs of nutrients, primarily phosphorus, and of organic substances. The nutrient inputs to Saginaw Bay are also degrading the open waters of southern Lake Huron. Bacteriological water quality degradation was found in many localized nearshore areas, with violations of the Great Lakes Water Quality Agreement objectives occurring at several locations. Violations of the Ontario criterion for radium in drinking water supplies continue to occur at Serpent Harbour on the North Channel. Water quality in the western arm of Lake Superior is adversely affected by asbestos inputs from Reserve Mining Company.

In the St. Marys River, the sediments are contaminated with phenolic substances, oil, cyanide, iron, and zinc, and the waters are contaminated with phenolic substances and cyanide, discharged from Algoma Steel Corp. Sediments, water, and fish in many other nearshore areas of both lakes also exhibit unacceptably high concentrations of heavy metals and toxic organic substances as a result of their discharge, both intentionally and inadvertently, into the environment. Because of the nature of the use of some of these substances, it is difficult to prevent their unintentional escape. Further, because toxic organic substances are present in atmospheric and land runoff inputs as well as point source inputs, they also constitute whole-lake problems.

The Commission recommends that Governments implement regulatory and remedial measures to eliminate these problems and to restore water quality. The Commission also recommends those surveillance, monitoring, and research activities which are necessary to assure restoration and maintenance of water quality.

Notwithstanding these instances of pollution, the overall water quality of the main bodies of the Upper Lakes is much better than both the Agreement

objectives and the federal, state, and provincial standards. The Commission considers it imperative that the Upper Lakes be maintained at their present high quality if existing and future uses are to be maintained.

The Commission recognizes that this goal may be difficult to attain if economic growth and development are to be accommodated and if pollution control technology is limiting. The Commission recommends, therefore, that all existing activities and all planned or potential development that may lead to water quality degradation be subjected to an analysis that will ensure that degradation will be prevented. Proponents of development should be required to assure Governments, before they are given approval to proceed with such development, that degradation will not occur.

To avoid degradation, the Commission recommends that phosphorus concentrations in the effluents of municipal and industrial discharges, as well as the phosphorus content of detergents, be limited. The Commission also recommends a policy whereby phosphorus loadings will be maintained or reduced, while accommodating future growth, in order to ensure that the phosphorus loading to the Upper Lakes does not increase in the future and is reduced as much as practicable.

Inputs of several metals to certain areas have been identified as potentially harmful to human health, aquatic life, and the environment. The Commission recommends minimizing the discharge of these materials in these areas until their effects can be determined.

Persistent toxic organic substances represent an urgent problem because of their essentially irreversible effects. The Commission recommends banning the manufacture, import, and use of certain of these substances, including PCB's, PBB's, aldrin, dieldrin, DDT and its derivatives, and other persistent, highly toxic substances, whose entry into the environment is difficult to control, if their use is permitted. As for other such substances with known deleterious effects, the Commission recommends strict regulatory control to prevent entry into the environment. The Commission also recommends that the producers of new organic substances be required to demonstrate the safety of these substances before they are used, and the use of substances presently being produced, but whose safety is not yet known, should be restricted until such safety can be established. The Commission urges Governments to develop and adopt mutually acceptable or compatible methods of determining the persistence and toxicity of such compounds.

The Commission also recommends further efforts to determine clearly the extent of the health hazard posed by asbestos in drinking water so that appropriate standards and objectives can be established and appropriate controls implemented. Because of the possible harmful effects of asbestos on health, the Commission applauds the U.S. federal court decision that Reserve Mining cease discharging tailings into Lake Superior and recommends that steps be taken to minimize erosion from the tailings delta.

The Commission identifies for future action new concerns which have arisen from the study by the Reference Group. Their study indicates that atmospheric inputs may be responsible for up to 40% of the loadings of certain pollutants to the lakes, including phosphorus, heavy metals, toxic organic contaminants, and sulphur dioxide, which contributes to the acid rain phenomenon. The Commission recommends that the contribution of atmospheric inputs to Great

Lakes water quality degradation be addressed by the Governments on a scale broad enough to permit tracing of significant sources of these inputs to the lakes, especially as many of the sources may be located outside of the Basin.

The study has also shown that, if the goals of nondegradation and restoration are to be met, society must develop new and innovative technologies. These must eventually include resource conservation methods as well as new treatment processes. The Commission perceives the role of the Governments to be one of encouraging and coordinating development and implementation of these measures and of providing incentives toward this end. There are many initiatives available to Governments which they must employ if the objectives of the Great Lakes Water Quality Agreement are to be met and nondegradation achieved.

6. ANSWERS TO THE REFERENCE QUESTIONS

REFERENCE QUESTION 1

Are the waters of Lake Superior and Lake Huron being polluted on either side of the boundary to an extent (a) which is causing or is likely to cause injury to health or property on the other side of the boundary; or (b) which is causing, or likely to cause, a degradation of existing levels of water quality in these two lakes or in downstream portions of the Great Lakes System?

The only instance of transboundary pollution from a point source discharge in the Upper Lakes occurs in the St. Marys River and the Lake George area, where phenols discharged from Algoma Steel Corporation and from the municipal wastewater treatment plant in Sault Ste. Marie, Ontario exceed the Agreement objective in U.S. waters.

There are, however, many instances where point-source discharges, often in conjunction with nonpoint inputs, are causing or are likely to contribute to pollution or degradation of existing water quality in Lake Superior and in Lake Huron. These include, most importantly, persistent toxic organics, mercury, and, in local areas, other metals and phosphorus. These are likely to cause injury to health or property on the other side of the boundary unless remedial or preventive action is taken. However, degradation of downstream portions of the Great Lakes System probably will not occur.

REFERENCE QUESTION 2

If the foregoing questions are answered in the affirmative to what extent, by what causes, and in what localities is such pollution taking place?

The Reference Group identified numerous municipalities and industries discharging into the areas of reported pollution or degradation of the Upper Lakes. These point source dischargers and the specific receiving waters were identified in Tables 5 and 6 for Lake Superior and Lake Huron, respectively.

Most dischargers are in compliance with effluent discharge regulations promulgated by the appropriate jurisdiction. However, some of them are directly responsible for violations of Agreement objectives or jurisdictional values. The observed pollution or degradation can be the result of a number of contributing factors:

1. Installation of remedial measures has not been adequate to correct identified pollution problems or to keep pace with expansion, such as at Algoma Steel Corporation at Sault Ste. Marie, Ontario.

2. The pollution control equipment or facilities may be in place but are experiencing operational difficulties, such as for phosphorus removal at some of the municipal sewage treatment plants in the Saginaw Bay Basin and along southern Georgian Bay.
3. The pollution or degradation is residual, due to past discharges which are now controlled or which have ceased, such as the presence of mercury in fish and sediment in the Thunder Bay area.
4. Nonpoint inputs, such as from land runoff, may reinforce the point-source inputs, as is the case of phosphorus loadings in the Saginaw Bay Basin.
5. The assimilative capacity of the receiving water has been exceeded because of the number of discharges, the total quantity of waste discharged, and/or because of the natural water-exchange characteristics of the receiving water with the adjacent portion of the lake, such as for Saginaw Bay.

The relative importance of these factors varies with the location under consideration. The extent to which identified dischargers contribute to observed pollution or degradation is discussed in detail in the Reference Group's report. Chapter 5 of this report highlights the problems, the most significant sources, and the status of the required remedial programs. Some information about the present status of each point source discharger is given in the 1977 Annual Report of the Great Lakes Water Quality Board.

REFERENCE QUESTION 3

If the Commission should find that pollution of the character just referred to is taking place, what remedial measures would, in its judgement, be most practicable to restore and protect the quality of the waters, and what would be the probable cost?

To abate existing point-source pollution, where pollution is defined as a violation of an objective or some jurisdictional value, remedial measures are required for the municipal and industrial dischargers named in Table 9.

The Reference Group was unable to address the question of costs in detail. The Reference Group did, however, compile a summary (Table 10) of capital costs for municipal waste collection and stream discharge treatment facilities for collectors, land acquisition, engineering, and twenty-year treatment plant design capacity. This did not include sewer extensions for new development, operating costs, or alternative treatment or disposal methods. The Reference Group also provided cost estimates for industrial control, based on best practicable waste treatment technology in each country; the estimate also includes \$300 million for an on-land disposal site for mine tailings from Reserve Mining Company. Increased water recycling and modification of manufacturing processes to use less water and to minimize product and by-product losses may reduce the estimated industrial costs. In general, the validity of all these cost estimates may be regarded as an order of magnitude.

TABLE 9

MUNICIPAL AND INDUSTRIAL DISCHARGERS FOR WHICH
REMEDIAL PROGRAMS ARE RECOMMENDED

ISSUE	MUNICIPALITY OR INDUSTRY AND LOCATION
Municipal or Industrial Phosphorus Reduction	Lake Superior - Duluth-Superior Harbor Marquette Munising Ontonagon Thunder Bay Jackfish Bay Nipigon Bay Lake Huron - Alpena Cheboygan Goderich Harbor Beach Penetang Midland Tobermory Owen Sound Collingwood Parry Sound Saginaw Bay Basin (all upstream dischargers) Sault Ste. Marie, Ontario
Bacterial Reduction	Lake Superior - Black River Duluth-Superior Harbor Jackfish Bay Marathon (Peninsula Harbour) Munising Ontonagon Red Rock (Nipigon Bay) Thunder Bay Lake Huron - Alpena Blind River Cheboygan Goderich Harbor Beach Owen Sound Penetang Saginaw River Mouth Sault Ste. Marie, Ontario Spanish River Mouth Tawas City
Metals Reduction	American Can of Canada Ltd., Marathon (mercury) Algoma Steel, Sault Ste. Marie, Ontario (iron and zinc) Collingwood (zinc, cadmium, lead) Saginaw Bay Basin (all upstream dischargers)
Taste and Odour Compounds	Great Lakes Paper Co., Thunder Bay American Can of Canada Ltd., Marathon Kimberley Clark of Canada Ltd., Terrace Bay Eddy Forest Products, Espanola Algoma Steel, Sault Ste. Marie, Ontario
Asbestos	Reserve Mining Co., Silver Bay
Radioactivity	Serpent Harbour (upstream sources)

a. Disinfection for bacterial reduction, in order to protect public health, may be limited to seasonal implementation.

TABLE 10

ESTIMATED CAPITAL COSTS FOR WASTE TREATMENT^a

BASIN	MUNICIPAL	INDUSTRIAL	TOTAL
LAKE HURON			
United States	124,000,000	86,000,000	210,000,000
Canada	31,000,000	48,000,000	79,000,000
LAKE SUPERIOR			
United States	71,000,000	323,000,000	394,000,000
Canada	48,000,000	144,000,000	192,000,000
TOTALS			
United States	195,000,000	409,000,000	604,000,000
Canada	79,000,000	192,000,000	271,000,000

a. 1973 dollars

Although installation of the identified remedial measures should restore water quality to within accepted values for the issues of concern for most impacted areas, population growth, additional industrial development, and nonpoint inputs will require the application of more stringent municipal and industrial source abatement to protect water quality for the future.

In many cases, the responsible jurisdictions have already completed implementation of the necessary remedial measures to correct the problems identified in Table 9 and to bring municipal and industrial discharges into compliance with jurisdictional or Agreement objectives. In other cases, these remedial programs are in the planning or construction stages.

To reduce the phosphorus loading from all plants in the Canadian portion of the Upper Lakes Basin to 1.0 mg/L would require an estimated capital expenditure of \$2,000,000 in addition to that given in Table 10. The costs in Table 10 include the costs to reduce phosphorus in United States municipal discharges to 1.0 mg/L.

These projections are based on achieving a reduction in loadings to meet the 1978 Water Quality Agreement objectives and would not restore the water quality of these areas beyond the objective levels, much less to the quality that obtained prior to human activity. It assumes no increases in inputs. Further improvements beyond this level would require the utilization of alternative treatment methodology, such as land application of wastes, to minimize phosphorus inputs, accompanied by metal and toxics removal, where necessary, to avoid contamination of ground waters. Even with these measures, however, some limitation on growth may be required.

In the U.S. the capital cost of the present program to contain polluted dredge spoil is estimated at \$59,600,000 for Lake Huron and \$4,300,000 for Lake Superior. There is very little dredging of Upper Lakes harbours in Canada, but where contaminated materials are encountered, the spoils are generally incorporated into landfill operations utilizing existing containment areas. No costs are presently available for a permanent dredging disposal area at Thunder Bay.

When a storm overloads the system, storm and combined sewer water bypasses the wastewater treatment plant. Such overflows can contribute large loadings of phosphorus, bacteria, and other wastes directly to the receiving water. Preliminary studies in both countries show that the capital costs of programs to eliminate combined sewers in the U.S. is estimated at \$130,000,000 for Lake Huron and \$30,000,000 for Lake Superior. Similar costs for Canada have been estimated at \$150,000,000 for Lake Huron and \$25,000,000 for Lake Superior.

Costs for vessel waste treatment and control may be large for individual vessel operators but are a relatively small part of the total cost picture. Similarly, costs of measures for spill prevention and control are usually small in comparison with the other costs for pollution control and are often more concerned with operational procedures than with capital costs.

Further cost estimates for the control of inputs from point and nonpoint sources will be available in the Commission's report on the study conducted by the Pollution from Land Use Activities Reference Group.

REFERENCE QUESTION 4

In the event that the Commission should find that little or no pollution of the character referred to is taking place at the present time, what preventive measures would, in its judgement, be most practicable to ensure that such pollution does not occur in the future and what would be the probable cost?

The two major threats facing the Upper Lakes are localized enrichment from phosphorus and lake-wide persistence of synthetic organic compounds. Nonpoint inputs are major contributors, to which conventional point source remedial measures cannot be applied.

PHOSPHORUS

Based on considerations of prevention, nondegradation, and equity, the Commission concludes that a municipal phosphorus effluent limit of 1.0 mg/L should be established for all municipal and industrial dischargers, and more stringent limits should be established, where required, for local water quality. On a whole-lake basis, control of nonpoint sources of phosphorus is not justified.

Phosphorus reduction programs for Lake Huron and Lake Superior are needed to restore, preserve, and protect the immediate receiving water. The specific phosphorus control measures to be implemented depend on the specific receiving water and could take the form of more stringent point source effluent limitations or nonpoint land runoff control, or some combination. Alternative treatment methodologies, such as land application, should be considered to reduce loadings. The discussion provided in Chapter 5 for phosphorus in Duluth-Superior Harbor, the nearshore and embayment areas of southern Georgian Bay, and Saginaw Bay amply illustrate the advantage of a comprehensive management strategy.

PERSISTENT SYNTHETIC ORGANIC COMPOUNDS

For many persistent synthetic organic compounds, laboratory studies have persuasively demonstrated toxicity and other harmful effects at elevated doses. It is also true, however, that there exists only limited knowledge about the effects of these compounds at the concentrations detected in the Upper Lakes ecosystem, or of other compounds presently in use but not yet detected in the environment. The reason is that present toxicity testing procedures for environmental and human health effects for ambient concentrations are expensive, time consuming, and scientifically inconclusive. The problem is further complicated by the persistence of these materials and the irreversibility of their effects. In these circumstances, the Commission believes that responsible prudence requires that human and environmental exposure to these compounds must be prevented as far as possible until safe levels, if they exist, are determined.

If these materials are allowed to escape into the environment, their concentrations in the atmosphere or in land runoff are too low to permit effective control. In addition, specific point source inputs have generally not been identified. The solution, then, in order to prevent pollution or

permanent degradation of the Upper Lakes and its biota, is to strictly regulate the manufacture, sale, transport, and use of these compounds, and to totally ban their discharge into the environment. PCB's, PBB's, aldrin, dieldrin, and DDT are such materials; however, because their high toxicity has been demonstrated and because their uses are such that escape into the environment is probable, if they are used, even strict regulation is not sufficient. These materials must be completely banned from manufacture, transport, and use. The economic disruption of banning these materials can be costly, and transition to alternative materials can take years, but such measures are necessary until safe levels, if they exist, are determined.

Procedures are presently being developed to predict which compounds, either presently in use or being considered for use, could be deleterious to the Upper Lakes ecosystem. Physical, chemical, and toxicological data on as many compounds as possible are being compiled. Predictive methodology is presently being developed wherein the bioaccumulation potential of a compound can be estimated. In addition, the activity of a compound can be estimated by comparing functional groups (component parts) of the new compound with a compound having similar component parts for which activity is known.

A more general response to Reference Question 4 is set forth in Chapter 7, as a policy of nondegradation.

8. RECOMMENDATIONS

The Reference Group made a number of recommendations to the Commission; these are included as Appendix D to this report.

Based on its consideration of the Reference Group's report and recommendations, and the Commission's public hearings, in response to the Reference dated April 15, 1972, from the Governments of Canada and the United States, the International Joint Commission recommends that:

1. To correct the point-source pollution problems identified in this report and summarized in Table 9, and to achieve water quality objectives, appropriate remedial measures be implemented as soon as possible.
2. Surveillance be maintained to assess the receiving waters and the open waters of the Upper Lakes in order to determine trends in, and to ensure protection of the water quality of the Upper Lakes.
3. Where sources of pollution have not been identified, the Governments undertake the necessary investigative studies, and develop and implement remedial measures.
4. The Governments adopt as policy for Lake Huron and Lake Superior the philosophy of nondegradation proposed by the Commission. Inherent in the adoption of this policy to achieve the goals of nondegradation is the obligation to: develop the scientific and technical information base required for proper management; encourage development of new and innovative manufacturing and waste treatment technology; encourage public education and involvement in long-range planning and in the decision-making process; and encourage industrial participation.
5. To restore degraded areas of the Upper Lakes to a more desirable trophic state and to prevent potential future problems, phosphorus loadings be reduced by reducing the phosphorus concentration in all municipal and industrial discharges to 1.0 mg/L and lower where local conditions require, and by limiting the allowable phosphorus content of all detergents to not more than 0.5% phosphorus by weight.
6. To maintain desirable water quality in the Upper Lakes and to achieve nondegradation, while accommodating growth and development, the Governments should consider an offset policy which would require more stringent point source controls to ensure that loadings from point sources do not increase with growth. Further, Governments should apply such measures to control pollution from nonpoint land sources as shall appear in the Commission's forthcoming report on the study conducted by the Pollution from Land Use Activities Reference Group.

7. For the particular metals in the locations cited in this report as exhibiting high concentrations in either the water, sediment, or fish, no further inputs be allowed to those areas unless the discharger can show no consequences to health and property.
8. To protect human health and aquatic life, and to achieve non-degradation, the Governments ban the manufacture, sale, transport, and use of PCB's, PBB's, aldrin, dieldrin, DDT and its derivatives, and all other persistent synthetic organic compounds with known highly toxic effects, the use of which will result in their entry into the environment. The manufacture, sale, transport, and use of all other persistent synthetic organic compounds with known deleterious effects be strictly regulated to prevent their entry into the environment.
9. Predictive methodology be developed and applied to determine the health and environmental effects of other compounds presently in use or detected in the ecosystem, and the uses of such compounds minimized, pending such determination. Furthermore, the introduction of new compounds not be approved until the producer demonstrates that such compounds will not harm man or the environment. To enhance the efficiency of the process and in light of the mobility of the substances, the Governments should establish a cooperative testing and evaluation program and mutually agreeable standards for determining toxicity.
10. Governments address the issue of the effects of the atmosphere on the water quality of the Great Lakes. Consideration should be given to sources, composition, transport, deposition, and effects of atmospheric constituents on the Great Lakes and its watershed. Emphasis should be placed on nutrients, metals, synthetic organic compounds, and acid.
11. Governments complete research into the effects of asbestos fibre size, shape, and concentration on all biological forms in the Upper Lakes, especially when ingested by man. A drinking water standard for asbestos should be established as soon as possible.
12. Governments provide post-spill monitoring to determine the nature and character of the material spilled and the long-term environmental effects of the spills and cleanup operations, and to improve response measures and recovery technology.
13. Comprehensive environmental assessment studies be conducted for thermal discharges to the Upper Lakes.
14. Particular emphasis be given to the design and location of water intake and discharge structures to minimize the entrainment of fish and fish larvae.
15. Governments expedite their consideration of the development of compatible regulations for the control of spills and discharges from vessels, in keeping with the provisions of Annexes 4 and 5 of the 1978 Water Quality Agreement.

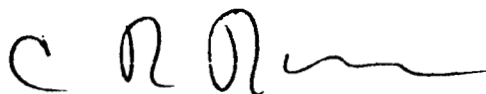
Signed this 30th day of May 1979 as the
International Joint Commission's report to the
Governments of the United States and Canada on
the Water Quality of the Upper Great Lakes.



Robert J. Sugarman



Stuart M. Hodgson



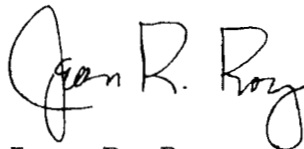
Charles R. Ross



Bernard Beaupré



Kenneth M. Curtis



Jean R. Roy

APPENDIX A

TEXT OF REFERENCE TO THE INTERNATIONAL JOINT COMMISSION TO STUDY POLLUTION PROBLEMS OF LAKE HURON AND LAKE SUPERIOR

I have the honour to inform you that the Governments of the United States of America and Canada, pursuant to Article IX of the Boundary Waters Treaty of 1909, have agreed to request the International Joint Commission to conduct a study of water quality in Lake Huron and Lake Superior, in the light of the provision of Article IV of the Treaty which provides that the boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health and property on the other side, and in the light also of the Great Lakes Water Quality Agreement signed on this date. This reference represents the response of the two Governments to recommendation No. 20 of the Commission in its final report dated December 9, 1970, on pollution of Lake Erie, Lake Ontario, and the International Section of the St. Lawrence River.

The Commission is requested to enquire into and to report to the two Governments upon the following questions:

- (1) Are the waters of Lake Superior and Lake Huron being polluted on either side of the boundary to an extent (a) which is causing or is likely to cause injury to health or property on the other side of the boundary; or (b) which is causing, or likely to cause, a degradation of existing levels of water quality in these two lakes or in downstream portions of the Great Lakes System?
- (2) If the foregoing questions are answered in the affirmative, to what extent, by what causes, and in what localities is such pollution taking place?
- (3) If the Commission should find that pollution of the character just referred to is taking place, what remedial measures would, in its judgement, be most practicable to restore and protect the quality of the waters, and what would be the probable cost?
- (4) In the event that the Commission should find that little or no pollution of the character referred to is taking place at the present time, what preventive measures would, in its judgement, be most practicable to ensure that such pollution does not occur in the future and what would be the probable cost?

The Governments would welcome the recommendations of the Commission with respect to the general and specific water quality objectives that should be established for these lakes, and the programs and measures that are required in the two countries in order to achieve and maintain these water quality objectives.

The Commission should submit its report and recommendations to the two Governments as soon as possible and should submit reports from time to time on the progress of its investigation.

In the conduct of its investigation, the Commission is requested to include consideration of pollution entering Lake Huron and Lake Superior from tributary waters, including Lake Michigan, which affects water quality in the two lakes, and to enquire into and report on the upstream sources of such pollution. The Commission may utilize the services of qualified persons and other resources made available by water management agencies in Canada and the United States and should as far as possible make use of information and technical data heretofore acquired or which may become available during the course of the investigation, including information and data acquired by the Commission in the course of its investigations and surveillance activities conducted on the lower Great Lakes and in the connecting channels.

In conducting its investigation, the Commission should utilize the services of the international board structure provided for in Article VII of the Great Lakes Water Quality Agreement.



International Joint Commission
Great Lakes Regional Office
100 Ouellette Avenue
Eighth Floor
Windsor, Ontario
N9A 6T3