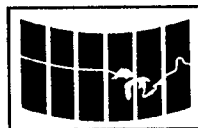


**Methods of Alleviating
the Adverse Consequences of
Fluctuating Water Levels in the
Great Lakes – St. Lawrence River Basin**

*A Report to
the Governments of
Canada and the United States*

December 1993



International Joint Commission
Commission mixte internationale

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FOREWORD

This report of the International Joint Commission responds to an August 1986 Reference from the Governments of Canada and the United States under the Boundary Waters Treaty of 1909. It draws upon the work of the Commission's Great Lakes Water Levels Task Force that examined potential crisis measures, the Project Management Team that assisted the Commission during the first phase of the study, the Levels Reference Study Board that carried out the investigations during the final phase of work under the Reference and the Citizens Advisory Committee that also assisted both the Study Board and the Commission during the final phase. Several hundreds of individuals devoted thousands of hours to this overall effort, many on a volunteer basis. The Commission greatly appreciates the contributions made by all study participants.

TABLE OF CONTENTS

Introduction	1
Conclusions and Recommendations	3
The Ecosystem Approach	3
Guiding Principles	4
Public Involvement and Response	4
Environmental Assessment	6
Shore Damage Estimates	7
Structural Measures to Reduce Erosion and Flooding Damage	8
New Water Levels Regulation Works	8
Changes to Existing Regulation	11
Other Hydraulic Measures	11
Shore Protection	12
Measures to Ensure that Human Presence and Behaviour in the Coastal Zone Are Appropriate	13
Measures to Help Ensure that Public Expectations and Attitudes Concerning Living on the Shoreline Are Realistic	14
Information Center	14
Visibility, Transparency and Accessibility of the Regulation Process	14
Development of Improved Operational and Management Tools	15
Measures to Plan for and Manage Water Levels Crises	16
Appendices	
A Text of the August 1, 1986 Reference to the International Joint Commission ...	21
B Previous International Joint Commission Reports under the Reference	23
1. Text of Letter of November 14, 1986 to Federal Governments	24
2. Text of Letter of December 10, 1986 to Federal Governments	28
3. Summary of Conclusions and Recommendations from <i>Interim Report on 1985-86 High Water Levels in the Great Lakes-St. Lawrence River Basin</i> , October 1988	29
C Text of Conclusions and Recommendations from the First Phase Project Management Team Report <i>Living With the Lakes: Challenges and Opportunities</i> , May 1989	31
D Summary of Levels Reference Study Board Recommendations	41
E Additional Citizens Advisory Committee Recommendations	49
F Text of Articles III, IV and VIII of the Boundary Waters Treaty of 1909	51
G List of Persons Who Appeared at the International Joint Commission's Public Hearing on the Final Report of the Levels Reference Study Board Held in Windsor, Ontario on September 11, 1993	53

INTRODUCTION

On August 1, 1986, following a period of record high water levels throughout much of the Great Lakes-St. Lawrence River Basin, the **Governments of the United States and Canada** (Federal Governments) gave the **International Joint Commission** (Commission) a Reference pursuant to Article IX of the Boundary Waters Treaty of 1909. This Reference, the full text of which appears in Appendix A, requested the Commission to examine and report upon methods of alleviating the adverse consequences of fluctuating water levels in the Great Lakes-St. Lawrence River Basin. It provided an extremely broad context for this task and specifically requested the Commission to:

- a. propose and evaluate measures that governments could take during periods of extreme high or low water levels;
- b. review and revise its earlier studies on lake level regulation;
- c. examine evolving land use and management practices throughout the basin;
- d. compare, to the maximum extent practicable, the costs and benefits of alternative land use and shoreline management practices with the costs and benefits of lake regulation schemes;
- e. investigate feasible methods of improving the outflow capacities of connecting channels and the St. Lawrence River;
- f. develop an information program to be carried out by responsible governmental agencies to better inform the public about lake level fluctuations.

The Reference requested that the Commission examine the effects of measures it considered on a broad range of interests, both within and outside the basin. Where water control works or other measures appeared to be economically and environmentally practicable, the Commission was asked to determine the full costs and benefits, and indicate how the various interests on either side of the boundary would be affected. The Commission was also asked to determine the need for, and costs of, remedial or compensatory works or measures to offset costs to the interests that may be adversely affected by any proposed regulatory measure. In addition, the Reference requested the Commission to submit an interim report focusing on measures to alleviate the high water crisis that existed in 1986.

The Commission's initial formal response to the Reference was a letter report dated November 14, 1986, which outlined actions the Commission had taken within its areas of responsibility to address the high water situation and which described measures that were available for consideration by the Federal Governments (see Appendix B). In addition, the Commission established a **Great Lakes Water Levels Task Force** (Task Force) to consider these latter measures in greater detail. The work of the Task Force served as the basis for the Commission's report entitled *Interim Report on 1985-86 High Water Levels in the Great Lakes-St. Lawrence River Basin*, which was submitted to the Federal Governments in late 1988 (see Appendix B). No formal response to the report was received from the Federal Governments.

Studies of measures to address the adverse effects of fluctuating water levels over the longer term were undertaken in two phases. In the first phase, studies began in fall 1987 under the leadership of a Project Management Team composed of experts in several disciplines from both countries. The Commission sent the Project Management Team's final report entitled *Living With the Lakes: Challenges and Opportunities* to the Federal Governments with a cover letter on August 25, 1989. Appendix C contains the conclusions and recommendations of that report. The first phase established the base for the final phase by defining the issues and outlining many of the potential solutions. The final phase studies began in Spring 1990 under the **Levels Reference Study Board** (Study Board). By letter dated August 12, 1993, the Commission formally sent the Study Board's final report entitled *Levels Reference Study, Great Lakes-St. Lawrence River Basin* to the Federal Governments. The Study Board's recommendations are found in Appendix D.

The investigations carried out under the Reference on the Commission's behalf were extremely complex and lengthy. In preparing this report, the Commission has drawn principally upon the work of the first phase Project Management Team and the final phase Study Board, as well as written and oral comments received from the interested public throughout the study. A great deal of time and energy was contributed by hundreds of dedicated individuals, many of whom were volunteers. The Commission greatly appreciates their contributions.

Notwithstanding the work that has been done, several issues could not be resolved definitively as will be discussed later in this report. **Nevertheless, the Commission considers that sufficient information is available to enable it to submit this final report under the August 1, 1986 Reference.** The many findings and conclusions of the Great Lakes Water Levels Task Force, Project Management Team and Levels Reference Study Board are available in the reports of those groups and are not repeated here. In this report, the Commission suggests how governments, the public and, in some cases, the Commission itself might best make use of the considerable material developed under the Reference.

CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations of the International Joint Commission on the various areas of study under the Reference are presented below.

The Ecosystem Approach

Governments and citizens are learning to recognize that everything contained by the Great Lakes-St. Lawrence River Basin, including water, land, air and human and other life, comprise a single ecosystem. Because the component processes and structures of this ecosystem are integrated in a complex web of interdependent relationships, the Commission is convinced of the need to plan and act with these relationships in mind at all times.

In its studies under the Reference, the Commission has explicitly attempted to organize an inquiry into water levels and flows that, for the first time on this scale, takes into account the full range of component processes and structures of the basin. These components include its environmental, hydrological and political features as well as other socioeconomic factors. Under the Reference, the Commission has studied not only changes in water levels and the impacts of water's action on the shoreline, but also to a limited degree, how humans respond and adapt to changes in their environment.

The Commission is keenly aware of the difficulties in attempting to apply the ecosystem approach to issues as broad and complex as those raised in the Reference. Nevertheless, the Commission considered it essential that this study be carried out in a manner that used inclusive ecological criteria for observation rather than the traditional approaches used by the Commission and others in previous studies. Traditional reductionist or even multidisciplinary approaches are no longer capable of providing the full range of information needed by decision makers. Indeed, as all aspects of life are interconnected, ways of integrating the many social, ethical and economic values related to water level issues are required. Many of these ideas were addressed by the Project Management Team during the first phase (see Appendix C).

The International Joint Commission recommends that governments continue to use, and promote the use of, the ecosystem approach in managing water levels and flows in the Great Lakes-St. Lawrence River Basin.

The Commission believes that the work under this Reference has been largely successful and represents a major step forward in approaching water quantity issues in an ecosystemic way. In particular, the Commission endeavoured to integrate individuals reflecting many disparate but relevant points of view into the decision-making process of the study. This objective was met to a significant extent.

As the study proceeded, it became clear that not all of the Commission's goals for an ecosystemic approach could be achieved within a reasonable time-frame and that, as a result, there would be less than complete information in some areas. For example, as will be discussed later in this report, serious gaps remain in the data needed to estimate damages that have occurred to shore property in the past or might be expected to occur in the future. In addition, little useful environmental or social impact information is available to assist with the assessment of potential measures to alleviate the adverse effects of fluctuating water levels.

These inadequacies have led the Commission to conclude that it cannot, at this time, accept some of the recommendations of the final phase Study Board. While the Commission recognizes that additional studies could provide an improved understanding of the potential benefits and adverse effects of possible measures, such studies would be both costly and time consuming, and still might not provide a significantly sounder basis for action. Accordingly, the Commission decided that there is no merit in requesting further funding under the Reference and in delaying its final report.

Guiding Principles

The Study Board devoted a great deal of time and resources to develop guiding principles for managing the Great Lakes-St. Lawrence River System. The principles are meant to be broad guidelines to enhance coordinated, systemwide management of future water levels and flows issues.

The principles differ in some fundamental respects from those found in existing international agreements such as Article VIII of the Boundary Waters Treaty of 1909 (see Appendix F). Furthermore, it is not clear how these general principles would fit with others that have been or are being developed for the Great Lakes-St. Lawrence River System in other institutions.

As the Study Board noted, it did not recommend changes to the Boundary Waters Treaty of 1909, but proposed that the guiding principles be used within the limits of the treaty. The Study Board intended that governments take these principles into account in dealing with matters related to management of the system, and accordingly the guiding principles are appended to this report (see Appendix D) for use by the governments as they deem fit.

Public Involvement and Response

It became clear during the first phase of the Reference studies that years of communication efforts and the release of several reports by the International Joint Commission and others had not eliminated widespread public misunderstandings about water level fluctuations and the ability of humans to affect lake levels. The most outspoken of the riparians voiced the long-standing belief that governments were not being fully open about the objectives of lake regulation and activities that affect water levels as well as the actions that governments could take to help them. In addition, despite the provisions that have been made for shoreline interests in existing regulation plans, many riparians appeared convinced that levels and flows were being controlled almost exclusively for the benefit of the hydropower and shipping interests. As a result, many riparians and riparian organizations demanded that they be listened to and involved in shaping policies to deal with the fluctuating water levels problem.

The Commission recognized that progress in addressing the water levels issue depended in large part on public understanding of the causes of water level problems, and the recognition that most proposed solutions could have consequences for others. To help accomplish these ends, the Commission involved the major interests and the relevant public directly in the final phase studies under the Reference.

The scope of citizen involvement in the final phase was unprecedented for an International Joint Commission reference study. Of particular note, individuals drawn from the relevant publics were included on the Study

Board and the Study Board's working level subgroups. A **Citizens Advisory Committee** (Advisory Committee) was also appointed.

The Study Board itself included four nongovernmental members: two appointed by the Commission and two selected by the Advisory Committee from among its members.

In addition, the Commission asked the Study Board to carry out a comprehensive public outreach program giving the general public ample opportunities throughout the study to help shape the results. That program consisted of a series of eight bilingual newsletters and 17 public workshops, progress review meetings and forums, as well as ongoing networking among the interest groups by Advisory Committee and Study Board members. The Study Board's public participation and information program is described in greater detail in Annex 1 of the Study Board's final report. This important program enabled the Study Board to reach the public at large and allowed the public's views to be heard in a timely fashion.

The Advisory Committee had a significant influence on the direction and outcome of the study. The views of its members are included in the Advisory Committee's report to the Study Board, which is Annex 5 of the Study Board's final report to the Commission. Although not every member agreed with all of the Study Board's conclusions and recommendations, the Advisory Committee as a whole supported the Study Board's recommendations. In addition, the Advisory Committee provided several recommendations of its own pertaining to the Commission's responsibilities and activities, which are included in Appendix E of this report. Several members also provided minority reports which are appended to the Advisory Committee's report to the Study Board.

The Commission considers that the public involvement experience was an overall success. It allowed individuals with diverse interests to find common ground on many aspects of the fluctuating water levels issue.

The International Joint Commission recommends that the Federal Governments review the Commission's public involvement experience under the Reference and use this experience as a model for future large-scale studies of natural resource matters.

The Commission itself intends to address the many considerations and recommendations contained in the final reports of the Study Board and Advisory Committee that pertain directly to the Commission's areas of responsibility. Some of these recommendations will require a review of existing Commission Orders of Approval in accordance with provisions of the Boundary Waters Treaty of 1909 and the Commission's Rules of Procedure. Others call for widespread consultation within and among Commission boards, discussions with officials from the Governments of the United States and Canada or receipt of new references from the Federal Governments.

The Study Board held four public meetings in November and December 1992 to present the findings of the final phase studies, receive public input on options for action and discuss the Study Board's preliminary recommendations. The Study Board held a second set of four public meetings in February 1993 to present and solicit views on its draft final report. These meetings took place in various communities around the Great Lakes-St. Lawrence River Basin. Reports on the meetings are contained in Annex 1 of the Study Board's final report.

The Commission held a public hearing on the final report of the Study Board in Windsor, Ontario on Saturday, September 11, 1993. The purpose of this hearing was to provide another opportunity for all interested parties to present to the Commission their views on the work of the Study Board. Simultaneous interpretation for official languages was provided at that hearing.

Much of the testimony received at the public hearing came from riparians who stated that the information base and analysis used by the Study Board were not, in their view, adequate to reject the option of building control structures in the Niagara River and instituting a three-lake regulation plan. They called for an independent assessment of the Study Board's economic analysis and reconsideration of three-lake regulation. In addition, speakers raised objections to land use measures and pointed out that the personal suffering of losing one's property to shore erosion was not reflected in the study's analysis.

Representatives from organizations representing the Great Lakes states and environmental interests voiced support for the Study Board's recommendations and for an ecosystemic management approach to the issue of water levels fluctuation in the Great Lakes-St. Lawrence River System.

The names of all those who appeared at the public hearing are listed in Appendix G. A verbatim transcript of the hearing and all written comments provided during and subsequent to the hearing are on file and available for examination at the offices of the Commission in Ottawa and Washington.

Environmental Assessment

The Reference requested the Commission to examine the effects of any measures it proposed on fish, wildlife and other environmental aspects. To keep the task of the initial environmental assessment manageable, the Study Board selected wetlands as the primary indicator of how changes in water level conditions might impact the health of the Great Lakes-St. Lawrence River Ecosystem. This decision was taken with the understanding that, should any measure affecting the natural system be found feasible, a full environmental assessment would be required to determine its desirability. Nevertheless, the Commission considered it important and helpful to obtain an early indication of possible adverse environmental effects.

Studies under the Reference found that the wetlands of the Great Lakes-St. Lawrence River Basin and the habitats they support are, to a large degree, dependent on water level fluctuations. Water levels, which are strongly related to weather and climate, have a significant impact on the abundance and productivity of wetland acreage.

While each wetland is unique, narrowing the range of water level fluctuations generally results in less wetland acreage and less diverse plant communities, and often results in dominance by some plant species. For example, the Study Board concluded that the reduction in the range of water level fluctuations resulting from regulation has adversely affected the extent and diversity of Lake Ontario's wetlands. The Study Board also concluded that altering natural water level conditions on Lake Ontario resulted in the appearance of many undesirable plant species in its wetland habitats. In addition, the Study Board concluded that regulation of Lake Ontario has caused losses of floodplain forests along the St. Lawrence River through flooding and erosion.

The Commission notes that the Study Board relied heavily on qualitative assessments of environmental impacts and recognizes the value of the considered judgments rendered by the wide range of experts. However, because of the importance of environmental considerations in decision making, the Commission suggests that governments take steps to improve the body of quantitative information on the environmental impacts of water level fluctuations on wetlands. A comprehensive inventory of Great Lakes coastal wetlands was not required for purposes of this Reference, but would be an asset in establishing more definitively the impacts that changes in water level conditions have on Great Lakes-St. Lawrence River wetlands. The beginnings of such an inventory were identified by the Study Board.

The International Joint Commission recommends that the inventory of the location, extent and quality of existing wetlands be completed and that long-term monitoring and evaluation of the effects of water level fluctuations on wetlands be carried out.

This will support the work the two Federal Governments have agreed to undertake pursuant to the revised 1978 Great Lakes Water Quality Agreement.

Shore Damage Estimates

For many years economic efficiency has been central to decisions on the desirability of public water and related land-based projects and programs. The most critical components are estimates of potential economic benefits and costs of the proposals. The level of detail and degree of confidence in these estimates must be suitable to the magnitude and context of projects under evaluation. Over a half century of experience with comprehensive river basin and regionwide water and related land resource studies has shown that the task of estimating benefits and costs increases greatly, and the precision of the estimates decreases, as the study area increases in size and the problems, needs and users multiply in number and complexity. This difficulty can become so great that it is impractical to seek estimates of some of the economic impacts. Estimating past and possible future shore damages throughout the Great Lakes-St. Lawrence River Basin may be such a case.

The damage data available to the Study Board were developed in the 1970s and used in earlier Commission studies. The Commission has, however, raised serious questions regarding both the data and the methodology used to develop previous damage estimates. Since those earlier studies, there have been no significant improvements in the data gathering process. For example, little information was gathered in either country on damage to shore property that occurred following storm events. The Study Board considered the following three ways to obtain improved estimates of damages and benefits:

- (1) employing a new, systemwide mathematical model linking hydrologic and topographic data with damage evaluation formulae;
- (2) undertaking a series of detailed site studies, the results of which would be extrapolated to estimate impacts over larger areas;
- (3) improving the shore damage database and the damage estimating methodology.

Adequate topographic data were not available to develop a new systemwide model and site studies were not practicable given the data and other resources available.

Accordingly, the Study Board chose to update the existing database and damage estimating method and to conduct a limited number of site-specific studies.

However, in spite of concerted effort, the Study Board was not able to significantly improve the database and estimating methodology as required to produce a more definitive analysis of shore damages. It was determined that significant additional time and money would likely be required to reach more definitive conclusions on measures having basinwide effects. The Commission concluded that such an effort was not practical for the studies under the Reference. However, it is the Commission's view that a long-term effort to gather shore-property damage data is required to provide an appropriate context for future analyses of lake levels issues.

The International Joint Commission recommends that governments undertake a sample potential-damage survey to improve flood damage estimates.

The International Joint Commission further recommends that the first priority for the sample potential-damage survey be Lake Ontario and the St. Lawrence River.

The International Joint Commission recommends that governments undertake storm and flood damage assessments during or immediately following such events.

The International Joint Commission recommends that governments undertake long-term monitoring of shoreline erosion and bluff recession and that the information and methodologies developed under this study be used to improve erosion damage assessment capabilities.

The International Joint Commission recommends that governments undertake without delay programs to build improved information bases in the following additional areas:

- a. comprehensive land use inventory;
- b. identification of shoreline areas that are particularly vulnerable to storm surge activity;
- c. inventory of shore and near-shore installations at risk, particularly high risk installations.

The International Joint Commission recommends that governments undertake studies to improve forecasts of the frequency of extreme water level events, including the joint probability of combined static and storm induced water levels.

Structural Measures to Reduce Erosion and Flooding Damage

New Water Levels Regulation Works

A large portion of the study effort was devoted to trying to find technically feasible plans to regulate all five of the Great Lakes (five-lake regulation) or, alternatively, Lakes Superior, Erie and Ontario (three-lake regulation).

From the results of its studies, the Study Board concluded that, although it may be technically possible to build the additional engineering works required to regulate

all five of the Great Lakes, it would not be economically or environmentally feasible to do so. To accomplish five-lake regulation, massive concrete dams and control gates would need to be built in the St. Clair and Detroit Rivers downstream from Lakes Michigan and Huron, and in the Niagara River at the outlet of Lake Erie. Major deepening of portions of the St. Clair, Detroit and Niagara Rivers, as well as further major enlargements of the channels in the St. Lawrence River, would also be required to compensate for the additional flows these rivers would have to pass during periods of high water. In addition, downstream interests would need to be protected against damage and loss from higher and lower levels and flows resulting from regulation of the upstream lakes.

All of these regulation and protection works would cost billions of dollars to install and hundreds of millions of dollars annually to operate and maintain. Yet for all their cost, these works would not permit full control of lake levels. The best that could be expected is to reduce the range of levels fluctuation by moderately reducing the peak levels and raising the low levels. Compressing the range of levels on one lake, however, tends to increase the range of fluctuations of levels and flows on downstream lakes and rivers, often in an exaggerated fashion.

An example of the limited ability of humans to control water levels occurred on Lake Ontario in the Spring of 1993 when the level of this "regulated" lake began to rise dramatically. This occurred because so much snow and rainfall was received in the lake basin in a short period of time that it was impossible to drain the water from the lake fast enough without flooding and eroding interests downstream in the St. Lawrence River. In response to the emergency situation, the Commission acted to ensure that the interests of riparians were given priority consideration as regulatory decisions were made. As a result, severe flooding on the lake was avoided by obtaining the cooperation of the downstream interests to maintain extraordinarily high flows in the river and the decision of the shipping authorities to temporarily reschedule navigation in the seaway.

All of this was necessary because the control structures in the St. Lawrence River at Cornwall, Ontario and Massena, New York are not capable of full control of the levels and flows in the system. They are capable only of moderating the fluctuations in the levels and flows and keeping them within certain bounds when water supplies to the lake are within the range for which the project was designed. Further, there is no effective control of levels and flows in the river below Cornwall and Massena. Riparian communities and other interests in that part of the river are completely vulnerable to level and flow variations from upstream regulation as well as to inflows from the Ottawa River.

The futility of human aspirations to control levels and flows in a major watercourse was also demonstrated tragically by events on the Mississippi River in summer 1993. The flood that occurred on that system breached hundreds of levees, flooded thousands of acres of farmland, demolished countless homes and devastated whole towns, some of which may never be rebuilt. The extensive channeling, diking and control structures throughout that system could not stop the extraordinary damage that occurred. The Commission encourages all governments to review recent events in the Mississippi River basin to see whether there are useful lessons that can be learned about how to deal with the effects of fluctuating water levels.

The Study Board determined that the five-lake regulation plan that would provide the greatest compression in the levels of Lakes Michigan, Huron and Erie would

reduce the range of fluctuations of those lakes to 30 centimetres (approximately one foot) above and below the long-term average level. The usual range of fluctuation of these lakes is about one metre (approximately three feet) above and below the long-term average. This plan, if implemented, would result in benefits to shore property owners on the middle three lakes in the form of reduced flooding and erosion damages and reduced shore protection costs. However, the plan would increase the flooding and erosion damages to riparians on Lake Ontario and the St. Lawrence River, even with major mitigation works. There would also be benefits and losses to other interests throughout the system. The Study Board was not able to find a regulation plan that would distribute the impacts evenly among regions or among interests. While some regions and interests would benefit, others would have increased damages.

Five-lake regulation would permanently alter all of the remaining natural cycles of levels and flows in the lakes and rivers of the Great Lakes-St. Lawrence River System. The environmental implications of this are still largely unknown. From its assessments, however, the Study Board estimated that the potential environmental impacts would be highly adverse on Lakes Michigan, Huron and Erie, as well as on the St. Lawrence River. Environmental impacts on Lake Ontario would also be adverse, although not as severe. The Study Board advised that major environmental assessments would be required if such a plan were ever to be considered further.

The Study Board concluded that, although five-lake regulation is feasible from an engineering standpoint, it is neither economically efficient nor environmentally acceptable. In the Study Board's judgment, the economic evaluation of five-lake regulation demonstrated that its dollar costs would exceed any potential benefit. It also concluded that it is unlikely that such a plan would be acceptable from a public policy perspective. Based on its own review, the Commission concurs with the Study Board's conclusions.

The International Joint Commission recommends that no further consideration be given to five-lake regulation.

For some of the same reasons, the Study Board also concluded that regulation of Lake Erie in combination with Lakes Superior and Ontario (i.e., three-lake regulation) would not be economically feasible or environmentally acceptable. The Study Board's analysis shows economic losses for the plans it examined and adverse environmental impacts in all areas except Lake Superior. Because of the serious concerns about the quality of the available shoreline damage data discussed earlier in this report, the Study Board took steps to ensure that it was not understating the potential benefits of further regulation. The Study Board developed what it termed a "maximum plausible estimate" based on a risk analysis technique for estimating flood damage reduction and a tripling of the erosion benefits based on the results of limited site specific studies. Using this alternative approach did not alter the Study Board's conclusion about the economic feasibility of three-lake regulation.

Both of the Study Board's approaches included the cost of extensive engineering works to mitigate impacts of modified levels and flows in the St. Lawrence River caused by changes in upstream regulation. Most of the mitigation works occur in the portion of the river between Montreal and Trois Rivières, Québec. The preliminary cost estimates for these works greatly overshadow the estimated benefits derived from the additional regulation.

The Commission notes that members of the riparian community have questioned the benefit and cost analyses of the Study Board and the data upon which those analyses are based. Those questions will remain at least until the quality of the database is improved. The Commission's concerns about the quality of the database were discussed in an earlier section and additional comments appear later in this report. At the same time, the Commission does not wish to encourage unrealistic expectations regarding the viability of three-lake regulation. Further, the Commission wishes to reiterate that the Study Board, despite a determined effort, was unable to identify a scenario for three-lake regulation that was sufficiently feasible economically and environmentally to warrant further detailed analysis. Nevertheless, while the Commission agrees that no further analysis is warranted at this time, the Commission notes the many uncertainties concerning both future water levels and the complex relationships between water levels and potential impacts.

In light of the above considerations, the International Joint Commission does not believe that the case has been made for three-lake regulation. Furthermore, the Commission does not believe that such a case could be made in the near term.

Changes to Existing Regulation

The Study Board also examined the existing regulation plans for Lakes Superior and Ontario to determine whether they could be made more responsive to the needs and desires of the users without jeopardizing the benefits and protection already provided under the Orders of Approval issued by the Commission over the past years. The Study Board also examined possible changes that would call for operations outside of the requirements of the Orders. The results appear as recommendations numbered four through eight of the Study Board's final report and are summarized in Appendix D of this report.

The International Joint Commission will review the Study Board's recommendations on changes to existing regulation. In carrying out this review the Commission wishes to emphasize that it is bound by the "rules or principles" set forth in Article VIII of the Boundary Waters Treaty of 1909.

Other Hydraulic Measures

The effect of artificial infilling on the discharge capacity of the Niagara River was also examined. Initial recommendations on this issue were made to the Federal Governments in the Commission's 1988 *Interim Report on the 1985-86 High Water Levels in the Great Lakes-St. Lawrence River Basin*. Further evaluations during the final phase studies support the initial conclusion that a number of obstructions placed in the river have had a significant effect on the flow capacity of the river and the level of Lake Erie. In addition, there is a long-outstanding concern about two small fills on the Canadian side upstream of the Peace Bridge which have contributed slightly to raising the lake level. The Commission has suggested in the past that removal or modification of some of the existing obstructions, particularly those in the vicinity of the Peace Bridge, should be considered.

The International Joint Commission recommends that governments take appropriate steps to ensure that effective controls are in place concerning actions on one side of the boundary that affect water levels and flows on the other side, particularly with respect to activities that constrict the capacity of the connecting channels.

Shore Protection

Another key objective of the studies carried out under the Reference was to evaluate land use and shoreline management measures as an alternative or, in appropriate cases, a companion measure to water level regulation. Studies in the final phase indicate that, regardless of whether there is any further regulation of lake levels, high levels of damage to shore properties and shore installations will continue to occur unless preventive action is taken. In its investigations, the Study Board found two types of measures that have been used successfully at various locations in the basin to prevent high water from eroding or flooding shore property, namely structural or nonstructural shoreline protection and raising the elevation of the land itself.

Shore protection is only one component of a comprehensive approach to shoreline management. Other possible measures involving restrictions on the use of and construction on shoreline property are discussed below under "Measures to Ensure that Human Presence and Behaviour in the Coastal Zone are Appropriate."

Structural varieties of shore protection that the Study Board found to be successful in the Great Lakes-St. Lawrence River System include:

- a. dikes and levees to protect against flooding;
- b. various types of stone, concrete, timber and steel walls installed along the shoreline or protruding into the water to protect against erosion from wind and wave action, currents and fluctuating levels.

Nonstructural varieties of shore protection that the Study Board found to be effective include:

- a. building up beaches;
- b. vegetation to stabilize shorelines, particularly steep shorelines;
- c. protective sand dunes.

The Study Board concluded that structural shore protection may be the only appropriate land-based alternative for intensely developed shoreline areas such as major towns and cities where there is little likelihood of land acquisition by governments or relocation of structures. However, the Study Board reported that the majority of privately constructed shore protection structures fail within ten years of construction. Any government incentive programs, such as loans, grants and tax incentives, that encourage the construction or upgrading of shore protection structures should include provisions for technical inspection, approval of plans and enforcement.

The Commission notes that some shore protection works may have the potential not only to transfer damages among riparians but also to adversely affect the environment and natural habitats. This potential should be considered when such works are proposed. If shore property owners undertake shore protection work, it is also

important that they take a long-term view and recognize that the problems these works are designed to address will likely return in the future.

Many riparians have not been exposed to the variety of shoreline management options available. It is the Commission's view that riparians should be required to consider the feasibility of the alternatives to shore protection discussed in the following two sections when applying for assistance to protect their properties.

The International Joint Commission recommends that, as part of a comprehensive shoreline management program, governments consider shore protection measures only where other alternatives alone are not appropriate.

Measures to Ensure that Human Presence and Behaviour in the Coastal Zone Are Appropriate

The Study Board also investigated a variety of land use and management measures to help adapt shoreline activities to large fluctuations in water levels. All of the measures recommended by the Study Board have been used successfully at various times and places around the basin. The measures examined include:

- a. erosion/recession setback requirements;
- b. relocation of dwellings;
- c. flood elevation and protection requirements;
- d. shoreline alteration requirements;
- e. real estate disclosure requirements;
- f. acquisition of high-risk undeveloped land, developed land and habitat areas;
- g. hazard insurance (used in the United States only).

Although none of these measures would completely eliminate shoreline damage, they do offer practical and effective solutions to specific shoreline problems if undertaken in harmony with conditions unique to the site. It is likely that these measures would provide effective solutions to erosion and flooding problems at many locations.

The Commission notes the hesitancy of riparian property owners to accept further government intervention in what they see as their right to unencumbered ownership, use and enjoyment of the shoreline. However, given the present high degree of shoreline development, particularly in the United States, and the anticipation that development will continue in the future, any solution to fluctuating water levels problems will be costly, in either financial or social terms or both. It would be unrealistic and unfair to expect the general public to pay a disproportionately high price to protect those who live on the shoreline.

It was not possible within the current studies to examine the water-level related problems of all the sites around the basin and assess the relative applicability and effectiveness of various measures at each site so that alternative use and management programs could be developed. Only if such an assessment were completed would it be possible to estimate the costs and benefits of such programs.

The International Joint Commission strongly recommends that governments aggressively promote the use of shoreline land use and management measures, including those described in this report, as the principal component of a strategy to alleviate the adverse consequences of fluctuating water levels. The Commission further suggests that flexibility in the choice and management of shoreline land use and management measures on the part of the responsible jurisdictions may be a key element in the success of such programs.

Measures to Help Ensure that Public Expectations and Attitudes Concerning Living on the Shoreline are Realistic

Information Center

Over the past several years there have been a number of proposals, some now implemented, for public information centers on a number of Great Lakes topics, including a pollution prevention center, a clearinghouse on acid rain and crisis water levels information centers. It is probable that others will be proposed for emerging issues such as climate change. The Commission is convinced that there is merit in establishing one information center and/or network that would provide all agencies and the public with "one-stop" access to information on Great Lakes issues. An ongoing information center involving a network of affiliated organizations would be a useful way to disseminate coordinated information in a targeted manner, and to address the difficulty experienced by many in obtaining consistent information, especially during crisis periods. The information center should dedicate staff resources to the levels issue on an ongoing basis so that it becomes established as a useful point of contact and has the capability to communicate proactively during noncrisis as well as crisis periods.

The International Joint Commission recommends that the Federal Governments establish an information center as a binational effort, and that the information center be assigned the responsibilities of communicating with the public and facilitating communication between the public and governments on a wide range of issues related to the Great Lakes-St. Lawrence River Ecosystem.

The International Joint Commission further recommends that this information center be linked to larger units within the government agencies, which would provide information resources and staff support, particularly during water level crisis periods.

Visibility, Transparency and Accessibility of the Regulation Process

Over the past few years, the Commission has been considering ways to ensure that its boards of control are more accessible to the public. The three Great Lakes boards of control are the International St. Lawrence River Board of Control, the International Niagara Board of Control and the International Lake Superior Board of Control. At present, each board is asked to hold one public meeting each year at a location within the region directly affected by its actions. The meetings are organized to inform the public of the Board's responsibilities and actions and to receive public views and comments. In addition, board members and associates have appeared at public hearings at the request of elected officials, usually during periods of crisis.

The International Joint Commission will examine several proposals to improve the visibility, transparency and accessibility of the regulation process.

Development of Improved Operational and Management Tools

Studies under the Reference identified a number of other areas in which data gathering efforts, information storage, interpretation and communication could be improved to aid in the ongoing management of the Great Lakes-St. Lawrence River System. These include procedures for calculating, forecasting and regulating levels and flows as well as improving the quality of water level information provided to the public.

The International Joint Commission recommends that governments take action to improve information bases and analytical techniques in the following ways:

- a. remedy deficiencies in the precipitation and snowpack network;**
- b. undertake efforts to improve long-range precipitation and temperature forecasts;**
- c. develop new technologies, such as satellite, airborne and ground-based radar to monitor lake evaporation, over-lake precipitation and basinwide snow conditions;**
- d. continue work to upgrade models used for simulation, forecasting and regulation in order to formulate a comprehensive water supply and routing model that includes the whole basin through Trois Rivières, Québec;**
- e. continue efforts to improve the forecasting and statistical information available to all users throughout the system to make decisions and couple these efforts with an upgraded systemwide supply and routing model;**
- f. implement the efforts referenced in Chapter 8 of the Study Board's final report to improve the quality and communication of information to the public;**
- g. initiate efforts to standardize hazard mapping methodologies across the Great Lakes-St. Lawrence River region and develop procedures for allowing broad access to such maps for general use.**

The Commission will itself be considering those proposals which have implications for its own areas of responsibility.

In addition, the Commission has been developing risk analysis techniques and geographic information system technology for application in its work under the Great Lakes Water Quality Agreement; the Commission supports the development of these technologies for application in management of water levels issues.

The International Joint Commission recommends that cooperative binational coordination and planning of geographic information system development and use be considered to increase the usability of information stored in geographic information systems related to the Great Lakes-St. Lawrence River System, and that national and international standards for data transfer be established.

The International Joint Commission further recommends that the following data elements be incorporated into geographic information system databases:

- a. all land use information for the entire shoreline;
- b. all hazard areas along the Great Lakes-St. Lawrence River System;
- c. all coastal wetlands.

In view of all of the data and information needs and gaps identified during the study, the Commission recommends that a binational mechanism or mechanisms be established to acquire and maintain improved data and information bases for the various hydraulic, hydrometeorologic, socioeconomic and environmental data and information.

A useful first step would be for the Federal Governments to consider formalizing the functions of the **Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data** (Coordinating Committee). Historically, the Coordinating Committee has served an important function in coordinating the binational collection and use of water level and flow data. As a result of the Coordinating Committee's work, internationally coordinated data are available for all the Great Lakes. The Coordinating Committee has also provided coordinated data on diversions and other important technical issues.

The Commission also wishes to point out that climate change over the next 50 or so years could have a significant effect on water supplies and therefore levels and flows in the Great Lakes-St. Lawrence River System. The Commission encourages the Federal Governments to continue their efforts to identify and understand global climate change as it relates to water supplies, levels and flows in the Great Lakes-St. Lawrence River Basin.

The International Joint Commission recommends that efforts continue to develop a binational assessment of the potential impacts of climate change on the Great Lakes-St. Lawrence River System.

Measures to Plan for and Manage Water Levels Crises

The Commission recommended several crisis actions in its initial letter reports to the Federal Governments on November 14, 1986 and December 10, 1986 (see Appendix B). Additional technical information on possible crisis measures that could be implemented within approximately one year was contained in the Commission's 1988 report to the Federal Governments entitled *Interim Report on 1985-86 High Water Levels in the Great Lakes-St. Lawrence River Basin* (see Appendix B). Significant physical effects were identified and direct project costs were estimated where possible. The Commission directed the Study Board to further evaluate and propose possible crisis measures.

The Study Board attempted to formulate a systemwide crisis action plan consisting of coordinated manipulations of the diversions at Long Lac and Ogoki on Lake Superior, Lake Michigan at Chicago and the Welland Canal between Lakes Erie and Ontario, as well as deviations from the regulation plans for Lakes Superior and Ontario, an ice boom at the head of the St. Clair River and additional flow through the Black Rock Lock in the Niagara River. Because available information was inadequate in several

important areas, the Study Board had difficulty assessing the socioeconomic and environmental effects of many of the potential measures inside and outside of the Great Lakes-St. Lawrence River Basin. Despite this shortcoming, the Study Board concluded that the redistribution of benefits and impacts resulting from the measures might not be acceptable to all interests and it recommended that further evaluation be made of the potential impacts of using the diversions and other hydraulic measures discussed above.

The International Joint Commission recommends that before definitive conclusions are reached regarding the use of the diversions at Long Lac, Ogoki, Lake Michigan at Chicago, the Welland Canal and the Black Rock Lock in the Niagara River as crisis relief measures, the potential impacts within and outside of the Great Lakes-St. Lawrence River Basin be determined.

The Study Board also recommended emergency actions that the Commission might take within its existing areas of responsibility. These measures include deviations from the existing regulation plans for Lakes Superior and Ontario.

The International Joint Commission will review the Study Board's recommendations on possible deviations from the regulation plans for Lakes Superior and Ontario. In considering what action is appropriate for it to take, the Commission will observe the "rules or principles" set forth in Article VIII of the Boundary Waters Treaty of 1909.

Work done by the Study Board also confirms the appropriateness and viability of a number of possible emergency planning and land-based crisis measures. These measures include storm and water level forecasting and warning systems, temporary sandbagging and other forms of shore protection, and temporary land and water use restrictions. Many Great Lakes communities currently practice some of these measures.

The most critical land-based crisis response is preparedness. The extraordinarily high water levels that occurred on Lake Ontario in spring 1993, as well as the record floods that occurred on the Mississippi River at about the same time, serve as timely reminders of the need for contingency planning to reduce the impacts of extreme fluctuations in water levels caused by the unpredictable vagaries of nature. These events demonstrate once again that there will be high levels in the future, possibly higher than have been experienced before; low levels will also continue to occur, possibly lower than have been experienced before. They also demonstrate that a significant improvement in managing crisis situations would be obtained by the continued acquisition and improvement of the information bases discussed in earlier sections of this report.

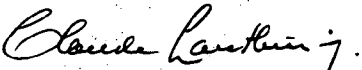
The International Joint Commission recommends that the Federal Governments, in cooperation with state, provincial and local governments initiate comprehensive, coordinated emergency preparedness planning for water level crises, using the following measures:

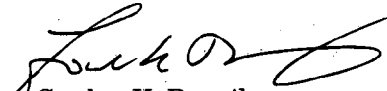
- a. intensified storm and water-level forecasting, warning, monitoring and public information/updating mechanisms;**

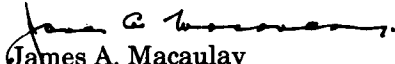
- b. clear delineation of responsibilities and lines of communication between federal, state, provincial and local governments, and other involved agencies and groups;**
- c. temporary emergency sandbagging and other temporary shore protection alternatives;**
- d. temporary land and water use restrictions;**
- e. assessment of environmental impacts of proposed actions.**


The International Joint Commission further recommends that post-crisis action reports be prepared that include comprehensive assessments of the impacts of the measures taken in order to evaluate the effectiveness of emergency preparedness plans and to recommend areas for improvement.

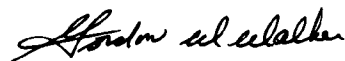
Signed this 15th day of December 1993 as the International Joint Commission's report to the Governments of Canada and the United States in response to the August 1, 1986 Reference on methods of alleviating the adverse consequences of fluctuating water levels in the Great Lakes-St. Lawrence River Basin.


Claude Lanthier, ing.
Chairman


Gordon K. Durnil
Chairman


James A. Macaulay
Commissioner


Hilary P. Cleveland
Commissioner


Gordon W. Walker, Q.C.
Commissioner


Robert F. Goodwin
Commissioner

APPENDIX A

Text of the August 1, 1986 Reference to the International Joint Commission

I have the honour to inform you that the Governments of Canada and the United States of America, pursuant to Article IX of the Boundary Waters Treaty of 1909, have agreed to request the Commission to examine and report upon methods of alleviating the adverse consequences of fluctuating water levels in the Great Lakes-St. Lawrence River Basin. In doing so, the Governments acknowledge previous Commission reports on regulation of Great Lakes levels, which have encouraged appropriate jurisdictions to institute improved shoreline management practices.

The Governments note that the previous reports were based upon recorded water supplies which have subsequently been exceeded, that economic conditions have changed, and that improved analytical techniques may now be available. The Governments conclude, therefore, that further investigation is now required to revise previous reports and develop appropriate methods to alleviate the adverse consequences of fluctuating water levels.

Accordingly, the Commission, building upon previous studies, should:

1. propose and evaluate measures which governments could take, under crisis conditions, to alleviate problems created by high and low lake levels;
2. review its previous lake regulation studies and revise their engineering, economic and environmental evaluations;
3. examine past, present and potential future changes in land use and management practices along the shorelines of the Great Lakes, their connecting channels and the St. Lawrence River;
4. determine, to the maximum extent practicable, the socio-economic costs and benefits of alternative land use and shoreline management practices and compare these with the revised costs and benefits of lake regulation schemes;
5. investigate any feasible methods of improving the outflow capacity of connecting channels and the St. Lawrence River;
6. develop an information program which could be carried out by responsible governmental agencies to better inform the public on lake level fluctuations; and
7. consider any other matters that the Commission deems relevant to the purpose of this study.

The Commission is requested to examine the effects both within and outside the basin of the measures it considers on:

- (1) domestic water supply and sanitation;
- (2) navigation;
- (3) water supply for power generation, industrial and commercial purposes;

-
- (4) agriculture;
 - (5) shore property, both public and private;
 - (6) flood control;
 - (7) fish, wildlife and other environmental aspects;
 - (8) recreation and tourism; and
 - (9) such other effects and implications which the Commission may deem appropriate and relevant.

Whenever appropriate, the Commission is encouraged to use improved analytical techniques which would best represent the changing conditions and socio-economic values in the Great Lakes region. In order to assess the viability of lake level regulation, the Commission should take into account changes in land use practices induced by actions which previously have affected levels in the Great Lakes basin.

In the event that the Commission's investigations show that new or altered works or other regulatory measures appear to be economically and environmentally practicable, it shall determine the full costs and benefits of such works or measures and indicate how the various interests on either side of the boundary would be affected thereby. In addition, the Commission shall determine the need for and costs of remedial or compensatory works or measures to offset costs to the interests which may be adversely affected by any proposed regulatory measures.

In conducting its investigations and in preparing its report the Commission shall use data which is available now or which is developed during the course of its study. In addition, the Commission shall seek the assistance, as required, of specially qualified personnel in Canada and the United States. The Governments, subject to their applicable laws and regulations, shall make available, or as necessary, seek the authorization and appropriation of funds required to provide promptly to the Commission the resources needed to discharge its reference obligations within the specified time period. The Commission shall develop, as soon as practicable, study cost projections for the information of Governments.

The Commission, subject to the availability of adequate appropriations, should proceed with the studies as expeditiously as practicable and present its final report to Governments no later than May 1, 1989. The Governments also request that an interim report, focusing on measures to alleviate the present crisis, be submitted no later than one year from the date the Commission's study board actively begins its work.

APPENDIX B

Previous International Joint Commission Reports under the Reference

1. Text of letter of November 14, 1986 to Federal Governments
2. Text of letter of December 10, 1986 to Federal Governments
3. Summary of conclusions and recommendations from *Interim Report on 1985-86 High Water Levels in the Great Lakes-St. Lawrence River Basin*, October 1988

1. Text of letter of November 14, 1986 to Federal Governments

As Governments are well aware Great Lakes water levels continue to be extremely high. As the fall storm season approaches, there is general agreement that with the current levels on the lakes, the potential for a possible emergency and extensive damage is high. In addition, it is expected that high water levels will be with us for an extended period of time. As a result of this serious and worsening situation, the Commission has decided to respond with this initial report under the Governmental Reference dated August 1, 1986.

To the Commission's knowledge there is at present no comprehensive effort to identify Great Lakes shoreline areas which are particularly vulnerable to storm surge activity. The Commission believes there is a need to improve advanced tracking and warning systems, and the forecasting and communication of information regarding the predicted impact of storm-related wave action. Existing programs such as the hurricane watch directed by the National Oceanic and Atmospheric Administration, and the forecasting services of the Atmospheric Environment Service, might well be used as models to expand upon.

In summary, the Commission believes there is an urgent need to improve both existing information about areas at risk and existing storm related predictive capacity in the Great Lakes Basin; and there is a need to communicate this information effectively to shoreline interests. The Commission also believes that evaluations of existing emergency and information dissemination programs may well show that additional resources need to be devoted to the problem. Accordingly:

1. The Commission recommends that Governments immediately act to improve early storm and storm surge forecasting and warning programs for the Great Lakes Basin. Further;
2. The Commission recommends that Governments act immediately to ensure that pre and post-storm emergency relief measures currently available through agencies of the respective federal governments, Great Lakes jurisdictions and others are adequate for dealing with the current state of emergency.

In 1985 the Commission recognized the impending danger of the high lake levels and organized and participated in public meetings and briefings whenever possible. Representatives of various federal agencies and Great Lakes jurisdictions were often members of briefing teams. These initiatives, in conjunction with a Commission sponsored information exchange between the Great Lakes Basin States and the Province of Ontario in April 1986, were useful in the necessary process of information exchange. Further, Environment Canada has been the focus of a Canadian federal effort to coordinate current actions with respect to the high water level problem and to disseminate information to the general public. These are welcome initiatives, but the Commission concludes that the extent of the current crisis necessitates increased coordination at all levels of Government, especially with regard to planning, coordinating, and implementing pre and post-storm emergency relief measures. Accordingly:

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3. The Commission recommends that Governments formally designate a federal lead agency in each country to facilitate coordination between and among federal agencies and the large number of affected agencies and groups within the Provinces of Ontario and Québec and the eight Great Lakes Basin States. The Commission believes the designation of federal lead agencies would facilitate binational cooperation in the important areas of information dissemination and program development.

The Commission notes that a process has begun to remove the barge stuck on the International Peace Bridge in the Niagara River. Nevertheless the barge is still in place and continues to raise the level of Lake Erie. Accordingly:

4. The Commission urges Governments to continue to expedite removal of the barge.

In addition to the above measures, in its Diversions and Consumptive Uses report the Commission recommended that steps be taken to improve coastal zone management practices as a way to reduce Great Lakes flood and erosion damage. Accordingly, the possibility of implementing emergency measures to inhibit or prevent further shoreline development in areas likely to be affected by water levels and storm surges could be called to the attention of relevant jurisdictions.

The Commission, with the assistance of its Boards, itself has initiated certain actions. Specifically:

1. The Commission has directed its International Lake Superior Board of Control to retain the remaining one inch of emergency storage on Lake Superior as a result of Commission actions during 1985, and to follow Plan 1977 until further notice. As a result of this storage, Lakes Michigan-Huron, St. Clair and Erie are approximately .04 ft, .04 ft and .03 ft lower than they otherwise would be at this time.
2. To date, Commission directed criterion (k) operations and other deviations from Plan 1958-D have resulted in an overdischarge from Lake Ontario corresponding to an approximate 2 1/2 foot reduction in the level of Lake Ontario as compared to what it otherwise would be. The Commission continues to review St. Lawrence River flow limitations.
3. The Commission's Great Lakes Water Quality Board has alerted agencies of Great Lakes jurisdictions to the potential dangers posed by the current unprecedented high water level situation for dredge and other waste disposal sites which are situated near or on the shorelines of the lakes. It warned of the possibility of erosion or storm damage to the sites releasing pollutants to the Great Lakes. Further, the Board has advised responsible agencies to ensure that all potentially vulnerable dredge and waste disposal sites are identified and, if necessary, that contingency plans for their protection are developed.

In addition to the above recommendations, the Commission is reviewing measures that are technically feasible, utilizing existing facilities, some of which could lower levels on some lakes or, taken all together, could lower levels on all the lakes. The reduction in levels would be small initially although further reductions would occur over the next few years. Most of these measures carry with them the potential for a redistribution of benefits and costs, some of which were addressed in previous Commission reports but which the Commission has not had an opportunity to revise in light of any changed conditions or improved analytical techniques. They are being re-examined as a matter of priority but a complete analysis of all these measures will not be available within a year.

1. The Ogoki and Long Lac diversions could be shut down. Past experience with these measures was reviewed in the Commission's Great Lakes Diversions and Consumptive Uses report.
2. The Chicago Diversion could be increased to the maximum extent. In its Great Lakes Diversions and Consumptive Uses report the Commission noted that the Lake Michigan Diversion at Chicago (Chicago Diversion) could at times be increased by a change in operation of existing facilities.
3. Welland Canal flows could be maximized.
4. Timely closing and opening of navigation in the St. Lawrence River could be undertaken to maximize outflows through the river. While Lake Ontario levels have not to date been setting record monthly levels, under certain supply conditions Lake Ontario could begin setting monthly record levels as early as January, 1987. Flows can be increased following the end of navigation, but prior to ice formation. The Commission notes the importance of forming a solid ice cover on the St. Lawrence River during the winter so that maximum winter outflows from Lake Ontario can be achieved. Retention of an undisturbed ice cover on the St. Lawrence River and the connecting channels, until natural spring break-up, facilitates increased outflows.

Since April of 1986 the Commission and its International St. Lawrence River Board of Control have been discussing with the Seaway Entities scenarios which could assist in maximizing Lakes Ontario outflows. These discussions continue.

5. The Commission notes that consideration of interests in the St. Lawrence River can result in constraints on outflows from Lake Ontario. Consideration could be given to an examination of measures that could be undertaken, in appropriate situations, to make possible increased St. Lawrence River flows, taking into account all interests concerned.
6. Recently the Commission inquired of the U.S. Army Corps of Engineers as to the feasibility of employing existing valves on the miter gates of the Black Rock Lock to flow additional water. The Corps has responded that these valves could be employed to discharge an additional 1,000 cfs

through the Black Rock Canal facility. Also, the Corps reported that the lock filling mechanism could be operated on a test basis to increase Lake Erie outflows by an additional 300 cfs. Both of these measures could be taken.

7. The Commission notes that ice jams can and have taken place in the connecting channels with consequent flooding. Under certain conditions winter navigation can contribute to such problems. Accordingly, given current high levels in the connecting channels, winter navigation in the connecting channels could be curtailed or eliminated, thereby reducing the potential for ice jams which can cause flow retardation with consequent shoreline flooding.

The Commission will submit further reports as appropriate.

2. Text of letter of December 10, 1986 to Federal Governments

In its initial report of November 14, 1986, the Commission recommended certain measures which could be initiated immediately to improve the ability of Governments to foresee oncoming crises and prepare to deal with them, and outlined actions which have been initiated by the Commission itself. The Commission then went on to enumerate certain measures that are technically feasible, utilizing existing facilities, and which might be implemented immediately to deal with the present crisis. Before setting out the specific list, the Commission pointed out that we have not yet had an opportunity to review and revise the benefit and cost implications of these measures, as was requested in the August 1, 1986 Reference, and went on to say:

“They are being re-examined as a matter of priority but a complete analysis of all these measures will not be available within a year.”

The Commission did not intend by this statement to suggest or imply that action by Governments with respect to these measures should be precluded until the full evaluation process is ultimately finalized.

The Commission believes it is its duty, given the extent of the current crisis, and consistent with its responsibility under the Reference, to report to Governments on measures to alleviate the present crisis, and that the measures in the letter warrant the consideration of Governments even in advance of completion of the full evaluation process.

3. Summary of conclusions and recommendations from *Interim Report on 1985-86 High Water Levels in the Great Lakes-St. Lawrence River Basin, October, 1988*

1. Governments should initiate immediately broad but systematic discussions on their use of Great Lakes water, as called for in the Commission's January 1985 report on Great Lakes Diversions and Consumptive Uses.
2. As part of their consultations on this report, Governments should develop coordinated, emergency management plans for both high and low water conditions, beginning with the information provided in our initial report (letters of November 14 and December 10, 1986) and the findings of the Task Force.
3. All levels of government in Canada and the United States act to further discourage the construction of new, damage-prone buildings or facilities on the Great Lakes shoreline pending completion of the comprehensive study.
4. Governments enact measures necessary to insure that further encroachment does not occur in the connecting channels of the Great Lakes.
5. Governments continue the public information and technical activities emphasized during the recent high water crisis pending completion of the comprehensive study.

APPENDIX C

Text of Conclusions and Recommendations from the First Phase Project Management Team report "Living With the Lakes: Challenges and Opportunities", July 1989

[Note: The term "Phase II" used in the Project Management Team's final report refers to the final phase of the study]

The call to deal with the Great Lakes-St. Lawrence River Basin from the perspective of a total system has been voiced for more than a decade. This study has for the first time explicitly attempted to organize an inquiry into water levels and flows which takes into account the full range of components of both the natural and human phenomena of the Basin. These include hydrological and ecological as well as political and economic aspects. Not only have the changes in water levels been studied and the impacts of the action of water on the shoreline, but how humans respond to and adapt to changes in the environment and what system of governance is needed in the Basin.

This system approach is a conceptual reorientation from the problem-specific analyses of the past. Even though it has been recognized in previous studies that the issues associated with fluctuating water levels cannot be adequately addressed as single or discrete problems and even though the term ecosystem and holistic approach have become a part of the vocabulary for discussing Great Lakes-St. Lawrence River Basin issues, it is far from easy to conceive of and carry out a systems analysis of the issue of fluctuating water levels and flows in the Basin. The very attempt to channel into the inquiry the thinking of specialists from widely different disciplines and non-governmental agencies, and a range of involved groups has emphasized the difficulty of developing a comprehensive approach. Phase I of the Study evidences the various degrees of success in this attempt; the lessons learned will direct the work of Phase II.

Not only do the water levels and flows themselves constantly change, but human positions, values and institutions are also in a continuous process of adaptation, sometimes to the water levels and flows, sometimes to stimuli outside the Basin, sometimes to their own varying needs and circumstances. So, too, in this Study, we have had to take as a starting point the assumptions of the participants and allow the discussions to move as freely as possible toward the comprehensive level of a systems analysis. Change and adaptation were as much part of our process as they are basic to the system we were studying. For, there is no simple, enduring solution for dealing with what has been called "adverse consequences" in the Reference. The systems approach requires that complexity and change be wedded to the need for an organized process of decision-making and implementation over the long-term.

Water levels issues take place in the context of many other natural, political, social, economic and technological factors and possible solutions and courses of action must be sensitive to and consistent with these factors. Political concerns, such as national sovereignty and economic well-being, ecological concerns, such as water quality, natural issues, such as climate change and wildlife habitat protection, and large-scale economic and social changes are interwoven into the fabric of the development of the region. Any

measure or set of measures designed to deal with Basin issues has to anticipate a range of considerations (hydrological, geomorphological, ecological, economic, land use, demographic, political and legal) or they may actually increase the problem they are meant to resolve. Awareness of the total geographical area is necessary in discussing any course of action for the Basin. What seems a desirable action in one part of the system may have negative results on another. The systems approach emphasized that the wholeness of the system has to be foremost in our minds.

Not only space but consciousness of time is essential to systems analysis. Solutions must be designed to answer not only the problems of today but also future contingencies, no matter how uncertain our predictions of the future may be.

At this juncture in the Study, we are convinced that for purposes of managing the water levels issues over a long time frame, it is necessary that a broad planning approach be developed, which will include:

- the development of bi-national agreement on principles designed to provide broad guidelines for future decisions in regard to water levels issues.
- the development of an overall strategy for deploying measures. It is important that both the needs of the entire Basin as well as the circumstances of specific locales be encompassed.
- the development of a framework for an effective governance system, including considerations for the appropriate role of interests and the public.

We intend to carry out these three tasks in Phase II of the Study. One of the tools we shall develop for these purposes will be a set of policy models, relating to issues of hydrology, the effectiveness of measures, and the activities and sensitivities of interests. These models will be designed for use by policy makers or interests themselves in exploring the impacts of various positions and possible actions.

Since state and provincial governments have direct shoreline authority and their participation is vital to the management of the water levels issues, these jurisdictions should be involved in the process of arriving at agreement on goals and objectives and in developing an overall strategy for the region regarding water levels issues.

Whatever decisions are made in the future concerning the water levels and flows in the Great Lakes-St. Lawrence River Basin, they will have to take into account, work around, and build on decisions that have been made in the past and which affect the day-to-day life of the Basin. Moreover, natural changes will continue to be major factors in the future as they have in the past and must be taken into account. Even without significant changes in regional water supply or lake outlet conditions, lake levels are going to continue to vary, and it is possible that they will vary beyond the recordings in the 20th century. The probability or possibility of these occurrences of extreme levels cannot be quantified precisely; they have to be taken into account when projecting impacts of various courses of action.

Similarly, climate change especially if it causes persistent trends in water supply to the lakes over a period of several years, can have a considerable effect on lake levels. It is not possible to tell from existing recorded data, however, whether a long-term change is establishing itself or not; we will only be able to see whether a new pattern is being established by looking back at the records. We will, therefore, have to continue to deal with uncertainty as part and parcel of the process of decision-making. Prediction will always be based on incomplete, perhaps even inaccurate knowledge. Climate change, like prediction of extreme levels, is a factor which has to be noted, but which cannot be assigned an exact importance. Furthermore, in the issues of the Basin as a whole, the climate change phenomena may have much more impact in social, technological, political and economic areas than in the issues associated directly with the fluctuations of water levels and flows.

A great deal of discussion in Phase I of the study centred on the two issues which attract the most attention in controversies regarding water levels: full control and regulation of the lakes and protection and restoration of the environment. At the extreme, advocates of full control and advocates of environmental integrity have often found themselves diametrically opposed on what courses of action should be taken in the Basin in regard to water levels. The two positions may be simply stated as maximum human involvement as opposed to minimum human involvement. They are often seen, however, as an older way of thinking, characterized by faith in technology and engineering and the human ability to solve any problems, and a newer emphasis on the necessity for human activities to accommodate themselves to natural processes.

The mandate of the study was to examine ways of alleviating the adverse consequences of the fluctuating water levels and both of these extreme positions as well as a spectrum of variations had to be examined. The possible positions or courses of actions between the extremes engender less ardent support, but they may well be the ones which yield practical and acceptable ways of dealing with the fluctuating water levels issue. In this phase of the study these various courses of action (measures) were looked at and given a preliminary testing, but in outlining these courses of action certain, what may be called cautionary considerations had to be made. At first reading, these considerations seem to be almost too obvious to mention, but their importance for finding a way of dealing with the issue of water levels and flows cannot be over-emphasized.

The first of these considerations is that any course of action taken to resolve issues in regard to fluctuating water levels and flows leads to disagreements over how the system is to be used and managed and how costs, benefits and access are to be allocated. These conflicts centre on the different perceptions and needs of interests, on impacts on the natural ecology and on concerns for health and productivity. We are, therefore, not talking about a solution or a course of action, with which everyone will agree, but about a set of measures managed over a long time, which satisfies the most critical concerns. Those concerns will be looked at from the point of view of the entire Basin, but they will encompass the needs of individual communities and localized situations. The message is clear, however, for those holding extreme positions, prepare to compromise.

The second obvious, but often overlooked consideration is that full regulation designed to reduce the range of historic fluctuations on all of the lakes would further exacerbate the extreme flow variations in the connecting rivers and in the St. Lawrence river, unless provisions were made for the diversion of large quantities of water into or out of the Basin at the critical time. In effect, this exigency places a practical limitation on the extent of possible control, even if full regulation were implemented.

The third point that needs to be emphasized is that at this stage in the present study there seems no reason to modify the conclusions presented in previous studies in regard to the likelihood of full regulation being implemented. The current understanding of the technical merit, socio-economic rationale and government policy support for full regulation all make the implementation of such a proposal unlikely in the foreseeable future. The conclusion, that full regulation is not the preferred course of action at this time, does not arise because of the realities of the present economic and political situation. Historically, efforts to deal with the problems of water levels tended to focus on structural measures; in fact, few resources have been directed toward the vast array of potential, alternate measures. Engineering solutions alone are applicable to relatively few of the gamut of problems and a restricted number of local conditions. The adoption of combinations of measures is seen, therefore, as achieving better overall results when focused on specific, localized areas. Beyond consideration of historic approaches and technological factors, the present economic and political situation has to be taken into account. Cost estimates for full regulation and its associated accommodations for the rest of the system are extremely high, and the net economic benefits of water level regulation are not clear. And, not least, in both countries increased awareness and concern for the environment has meant that no mega-projects can go forward without passing through strict environmental assessment procedures which can take years to complete.

On the environmental side, a great deal of attention has been given over the past years to the function and importance of the wetlands in the Basin. Fluctuating water levels are a natural process which are important for the maintenance and replenishment of wetlands. Although the exact impact of fluctuating water levels on wetlands is not known, it is clear that the alternating seasonal and periodic extreme fluctuations are basic to the productivity of the natural habitats. The wetlands, in turn, provide a rich and varied habitat for fish, plant, and wildlife species and play an important role in modulating flows and cycling matter and energy throughout the Great Lakes-St. Lawrence River Basin. They also play a role as a buffer of fluctuations and storms. With the loss of over one-half of the wetlands in the Basin, mostly in this century, there is concern about any plan which might compromise the remaining wetlands in the Basin.

And, lastly, there are major changes in socio-economic structures, which reflect much larger changes in values, technology, organizational behaviour and world markets and demographics. Here too, our knowledge is not sufficient to give definitive answers to all questions, but the growing demands for a better understanding of the interrelatedness of these changes will have to be met before the impacts of possible courses of action can be thoroughly evaluated.

We have to deal with uncertainty as an unavoidable condition for decision-making, always recognizing that as full a range of considerations and as much reliable information as possible have to be brought to bear on the issue. For example, it is possible that a measure or set of measures, if all conditions are not taken into account, may actually increase the very problem they were intended to resolve. It is, therefore, critical that any measure or set of measures designed to address the issue of fluctuating water levels in the Basin be examined in the light of a full range of considerations. At the same time, it is important that long-term strategies for dealing with significant deviations in levels, such as those that may be caused by the "greenhouse effect", be developed along with an improved capability for estimating the probabilities of certain levels.

All these cautionary considerations are based on incomplete knowledge, and, perhaps, it is partially because of the incompleteness of our understanding that there is resistance to proceeding with measures which may have unforeseen impacts and which may not be reversible. It is certain that these considerations are, however, not to be disregarded in trying to weigh the merits of the various courses of action available to governments.

Even though there is a perception among certain interests that structural works are necessary and appropriate, the Study to this point does not support such a conclusion. Based on our findings, we feel strongly that full regulation should be recognized as unlikely to be implemented by governments in the near future and that combinations of measures of all types should be vigorously pursued in study and implementation.

RECOMMENDATION: It is recommended that the federal governments not undertake commitments toward planning, funding, or constructing major public works to control levels and flows in the Great Lakes-St. Lawrence River Basin watershed until there is more consultation with interests and a more comprehensive evaluation of the impacts of such works on the environment.

In surveying opinion in the Basin, members of the study groups discovered that there were misperceptions, inaccurate information and lack of clarity concerning both the natural processes and the impacts of human activities. These shortcomings make discussion of possible measures difficult if not impossible. As we move into Phase II of this study, there are a number of points which need to be cleared up.

First, land use, consumptive water uses, and other human interventions have a minimal influence on fluctuation of lake and flow levels. For example, current regulation of levels has very little effect on much of the system, except for Lake Ontario and the Upper St. Lawrence River system and to lesser extent for Lake Superior. The greatest impact of regulation is in the trade-offs between levels and flows. Water held back in sustained dry periods to maintain lake levels results in lower river flows and, conversely, excessive discharges made to lower lake levels during sustained wet periods result in higher river flows. Present, limited regulation criteria have historically been designed to provide benefits for commercial navigation and power. However, the socio-economic structure and land use patterns and values have changed significantly in the

past 10–15 years, and setting new objectives, even for the limited regulation of levels now in effect, is difficult. Knowledge of the present objectives is very limited among interests and this engenders many suspicions and unrealistic expectations toward the International Joint Commission. This situation makes present operation more difficult and does not serve as a useful guide in developing future plans. It is clear, however, that present objectives of regulation are in need of thorough review.

The causes of shoreline erosion are also widely misunderstood. Although water level fluctuation can be important for some shore types, for many other types fluctuations have little influence over the long-term rate of recession (erosion). Much more important to shoreline dynamics are storms. Shoreline erosion and flood damages can be further exacerbated in local areas by the presence of high water levels and geological characteristics of the shoreline. This can be seen most clearly on Lake Erie, which, as a result of its shallow depth and orientation to westerly storms, has the most extreme short-term, lake level variation due to storm conditions and the highest shore erosion rates of any of the Great Lakes because of its shoreline characteristics. Although much work has already been done and there is wide consensus on various processes, we need more knowledge about erosion in specific locations, as well as about wetland rejuvenation and the creation and alteration of near-shore depositional features as a function of water levels fluctuations.

A third occasion for misunderstanding identified by some participants in the study involved the very idea of an “adverse consequence”. Adverse for whom? If what is adverse for one interest is beneficial for another, is it still adverse? It has been argued that human activity in the Basin represents investments, in which a decision is made to benefit from locating there. Benefits vary, but all can be weighed against the costs and the level of risk that is comfortable. These investment decisions are made on the basis of information available. The issue, then, may not be whether or by how much an interest “suffers adverse consequences”, but how does the interest benefit from lake services, how are the costs factored in and why does the interest petition governments for action. All investments are based on expectations of probable future benefits and costs, and, these in turn are based on information the interest has on what he or she may expect from government. Many interests, for example, believe that they have the right to expect certain levels and flows and certain actions by government. These beliefs are often erroneous and it is incumbent upon government to articulate, perhaps even to review, the current status of those rights. However, when an interest petitions governments for assistance, it is usually a result of the interest either not having expected the magnitude of water level changes or not having the resilience to respond to the changes. Apart from the question of the reliability of and responsibility for information, the central issue in this approach is who bears the costs of the consequences of changing water levels — the investor, the customer, the general taxpayer, the environment? Managing levels, therefore, means managing the process of allocating costs, benefits, and risks across groups. Not only were past planning processes of government often more appropriate for designing and evaluating individual projects than for managing the ecosystem, they also were poorly conceived in regard to informing investment decisions, informing the political

positions of interests and informing governments about interests' positions. In the light of this problem, we think action can be taken in this area immediately.

One of the areas, in which participants of this study found a need for the articulation of specific information, was in the operational objectives regarding lake level control. The knowledge of most interests regarding the existing operational objectives for Lake Ontario and Lake Superior levels is very limited and therefore engenders suspicion and unrealistic expectations toward the International Joint Commission. Clear enunciation of these objectives would do a great deal to promote more reasonable expectations among concerned interests. Along with articulation of objectives, the existing hydrological and hydraulic models could be accommodated to deal with scenarios ranging from existing controls to total Basin regulation, including a review of existing regulation plans for 1958-D and 1977 for Lake Ontario and Lake Superior respectively.

RECOMMENDATION: It is recommended that the International Joint Commission communicate its operational objective regarding Lake Ontario and Lake Superior levels so as to promote reasonable expectations among concerned interests.

In addition to misperceptions and misunderstandings on the one side, there are real inadequacies in the performance of government in providing information to interests in the Basin. This situation has been noted many times in previous reports and steps have been taken to improve the situation. Information provided by governments, however, is still inadequate and poorly and unequally distributed. Some interests, such as commercial and industrial enterprises, have access to reliable information; others may not know what information is available or where to obtain it, and, in many cases, when they do get information it is often not in a format useful to their decision-making. Information related to water levels made available by government also seems to follow an "issue-attention cycle". The problem is compounded by the uncoordinated multitude of governmental and non-governmental sources of information throughout the Basin, and by the fact that there are apparent inconsistencies in policies, authority, programmes, and implementation structures of federal and other levels of governmental departments and agencies.

In addition to more accurate and available information, there is a perceived need for different kinds of information presented in different formats. It is clear that the ways by which information is made available must vary according to the user. Informed risk-taking begins with reliable information. Information is in many instances a two-way process, in which public response and involvement are critical to future decision-making.

Certain areas, in which more knowledge is needed, have already been identified in this phase of the Study. For example, the geomorphological susceptibility of different segments of the shoreline to short-term and longer-term water level fluctuations, storm patterns, and wave and wind action need further analysis. This type of information can be used to map vulnerability tiers using a geographic information system covering the shoreline throughout the Basin. We also believe that our knowledge of the basis of the relationship between water levels, interests, and environmental processes needs improvement. By concentrating on the specific vulnerabilities (e.g.

damage potential) and the benefits of fluctuations in relation to interests and wetlands and environmental processes, knowledge can be gained that will enhance and refine the capabilities of the Geographic Information System being developed jointly by both countries.

In the realm of human activities, there is a range of areas of analysis which require our attention in Phase II. We do not know in enough depth many basic socio-economic aspects of the Basin. Urbanization, the growth of leisure and recreational activities, changes in the industrial base of contemporary North American society, changing demographics of population concentrations, investment patterns and government policy development are areas of direct concern for a systems approach to the problems of the Basin. Large as these areas of study are, they will have to be de-limited and focused in order to be of use in the future decisions which will be made by governments in both countries.

During the course of this study, our preliminary investigation on governmental decisions in regard to management of water related issues indicated that Canada and the United States agree on a wide range of principles and goals, but have not yet articulated them clearly. Until these principles and goals are publicly stated by the federal governments, it is difficult for other levels of government to develop plans and programmes for the Basin and for interests to make informed decisions.

RECOMMENDATION: It is recommended that the federal governments issue a statement on federal policy goals regarding water issues.

One of the products of Phase II of this Study will be an improved public information programme, which will assure interests of equal access and ability to use information. We also intend in Phase II to carry out further in-depth surveys and analyses of interests to understand better the location and economic investments of interest sub-classes. It is hoped that these surveys and analyses will further help to explain the different sensitivities of the interests to fluctuating water levels, as well as identify better the type and timing of information needs for responsible decision-making.

In some areas, Phase I of the Study has only begun to uncover the problems which have to be dealt with in addressing the water levels issue. One of the areas is the interconnection of water quality and water quantity. It is known, for example, that fluctuations in levels and flows can affect the quality of water in localized areas, as seen in the impact of low levels on the concentration of pollutants or of high levels on urban sewer infrastructures or cottage septic units. It is not clear, however, what the importance of this relationship is or the degree of impact water levels have on water quality basin-wide.

If we are to carry out a successful systems analysis of the Great Lakes-St. Lawrence River Basin, we have to understand better the nature and interrelatedness of human activities. Population changes, new investment decisions, industrial re-configurations and developments and government policy are interrelated with the natural environment. We feel that the first steps have been taken in this phase of the Study, but much remains to be done.

The attempt to adopt a systems perspective on the issue of water level fluctuations had in many ways raised as many questions as it has answered. A wide range of exploration and inquiry has been encouraged in this first phase of the Study; it remains for Phase II to pull these investigations together. Some parts of the inquiry will prove fruitful; some will end in a cul-de-sac.

Appropriate as these new and modified systems investigations were for the formation of the coherent overall approach, it was felt there had to be an ongoing process of distilling basic premises and criteria from the investigations in order to test, in a practical way, their relevance for the process of decision-making. During the latter part of Phase I, an attempt was made to summarize and categorize the possible courses of action (measures) which could be entertained by governments, and to develop a method of evaluating those measures by assessing their impacts throughout the system as a whole. For the first time in studies on the water levels issue, a list of possible measures related to this issue was drawn up and, if we set aside emergency measures and combinations of measures, four basic categories or types of measures were identified — Public Investment in Control and Diversion Works, Public Investment to Direct Land and Water Use to Adapt to Fluctuating Levels, Direct Public Regulation of Land and Water Use, and Public Programmes to Influence Indirectly Land and Water Use or the Effects of Fluctuating Levels. These include over a hundred specific measures. This first attempt to bring together a wide array of measures will have to be tested in the context of government and public acceptability.

Phase I of the Study produced a process in preliminary form for evaluating the relative acceptability of the measures and combinations of measures by subjecting them to an assessment based on certain core criteria. Evaluative criteria were exercised in a structured framework to assess the impacts of measures on interests and on the natural environment and to establish the range and combinations of measures and the goals and values which will shape and determine future evaluative processes. The evaluation was carried out to test it as an analytical tool for governments, but it has the potential to be used as a mechanism for engaging public participation and involvement.

In Phase II of this Study, the comprehensiveness of the list of measures and the process of evaluation will have to be reviewed and developed. The first run-through is, however, completed and it is now possible to see the strengths and weaknesses of the present approach and some of the implications for the development of future evaluative methods. These investigations will have to be explicitly related to the development of an overall strategy. There will always be a need for specific attention to local situations, but these must be assessed in the context of an overall strategy for the Basin. The challenge will be to give full consideration to basin-wide issues while focusing on local exigencies.

At the completion of Phase I of this study, our understanding of the extent of the problem is now much clearer, but the magnitude of the task has not been reduced. Even at this early stage in our investigations, we can see clearly that there are certain actions which should be taken immediately. These include a moratorium on all major public works related to control of levels and flows, the clear articulation of the operational

objectives for Lake Ontario and Lake Superior, and the articulation of federal policy goals regarding water levels issues.

The work carried out in Phase II will have to be more closely directed to yield specific results, and projects which are ongoing will have to be brought to completion. The major challenges have, however, been identified and there seems every reason to believe that the final product will be instrumental in reshaping in a major way future thinking and actions concerning the water level fluctuations in the Great Lakes-St. Lawrence River Basin.

APPENDIX D

Summary of Levels Reference Study Board Recommendations

GUIDING PRINCIPLES

1. The Board recommends that federal, state and provincial governments adopt the eleven Guiding Principles (below) and that these principles be used as guidelines for the management of issues related to water levels and flows within the Great Lakes-St. Lawrence River System.

The Board is not recommending changes in the Boundary Waters Treaty of 1909 but is suggesting that the International Joint Commission use these guiding principles within the limits of the Treaty.

- a. Existing and future beneficial uses will be considered, and the fundamental character of the Great Lakes-St. Lawrence River System will not be adversely affected.
- b. Actions approved or taken will be environmentally sustainable and respect the integrity of the Great Lakes-St. Lawrence River System ecosystem.
- c. Actions approved or taken will be beneficial to the Great Lakes-St. Lawrence River System and not result in undue hardship to any particular group.
- d. Coordinated management of the System needs to respect and accommodate the dynamic nature of the entire Great Lakes-St. Lawrence River System.
- e. Reduction of damage to existing development from fluctuating water levels in the Great Lakes-St. Lawrence River System will be based on the use of both non-structural and structural measures at various locations throughout the Basin.
- f. Prevention of damage to future development from fluctuating water levels in the Great Lakes-St. Lawrence River System will include the implementation of land use measures to discourage construction in areas subject to damage from fluctuating water levels and storms.
- g. Management of the Great Lakes-St. Lawrence River System will be done in full awareness of the potential for reduced water supply as a result of climate change.
- h. Decision-making with respect to the management of the Great Lakes-St. Lawrence River System will be open, respecting the full range of interests affected by any decisions and facilitating wide participation in the policy process.
- i. Management of the Great Lakes-St. Lawrence River System will be based on coordination of actions relating to levels and flows.
- j. Management of the Great Lakes-St. Lawrence River System will be based on continued improvement in the collection of data and the

understanding of the processes and impacts of fluctuating water levels and flows.

- k. Management of the Great Lakes-St. Lawrence River System requires ongoing communications and public awareness.

MEASURES — LAKE LEVEL REGULATION

2. The Board recommends that Governments give no further consideration to five-lake regulation.
3. The Board recommends that Governments give no further consideration to three-lake regulation.
4. The Board recommends that the regulation plans of Lakes Superior and Ontario be modified to achieve water levels and flows similar to those described in Measure 1.21 (in the Final Report).
5. The Board recommends that the Orders of Approval for the Regulation of Lake Superior be reviewed to determine if the current criteria are consistent with the current uses and needs of the users and interests of the System.
6. The Board recommends that the International Lake Superior Board of Control be authorized to use its discretion in regulating the outflows from Lake Superior subject to conditions similar to those which authorize discretionary action by the International St. Lawrence River Board of Control.
7. The Board recommends that the criteria of the Orders of Approval for the Regulation of Lake Ontario be revised to better reflect the current needs of the users and interests of the System. In particular, the Board recommends that Criterion (d) of these orders be amended as follows:

Criterion (d): The regulated outflow from Lake Ontario during the annual flood discharge from the Ottawa River shall not be greater than would have occurred assuming supplies from the past as adjusted. *When Lake Ontario levels and supply allow, consideration should be given to reducing outflows from Lake Ontario during the annual flood discharge from the Ottawa River.*

8. The Board recommends that the Orders of Approval for the Regulation of Lake Ontario be modified by adding the following criteria:

Criterion (): Consistent with other requirements, the outflow of Lake Ontario shall be regulated to minimize the occurrence of low water levels on Lake Ontario and the St. Lawrence downstream as far as Trois Rivières during the recreational boating season.

Criteria should be added that consider the environmental interest on Lake Ontario and the St. Lawrence River downstream as far as Trois Rivières.

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9. The Board recommends initiating negotiations for the purpose of removing fills upstream of the International Railway Bridge on the Niagara River and lowering the mean level of Lake Erie by 0.03 to 0.06 metre (0.1 to 0.2 foot).
 10. The Board further recommends that Nicholl's Marine be the first priority for fill removal.

MEASURES — LAND USE AND SHORELINE MANAGEMENT

11. The Board recommends that any comprehensive approach to managing adverse impacts of fluctuating water levels be multi-objective in focus and coordinated in application.
12. The Board recommends that consideration be given to establishing multi-level government funding of \$10 to \$20 million per year for planning and implementing land use and shoreline management projects. A possible funding cost-sharing formula might be 1/3 federal, 1/3 provincial/state, and 1/3 local.
13. The Board recommends that areas requiring land use and shoreline management measures be prioritized through a comprehensive shoreline management program in developed and undeveloped areas.
14. The Board recommends that consideration be given to implementing remedial measures when appropriate to the local conditions. The following measures are recommended for implementation, as appropriate:
 - Relocation of structures from hazard areas.
 - Flood proofing of existing structures.
 - Non-structural shore protection.
 - Structural shore protection, where other alternatives are not appropriate, only if well-designed and engineered, and only if impacts are not shifted to adjacent areas.
15. The Board recommends that the following preventive land use and shoreline management measures be implemented and applied consistently and uniformly around the Great Lakes and St. Lawrence River:
 - Erosion setbacks that include minimum requirements for a 30 year erosion zone for movable structures and a 60 to 100 year erosion zone for permanent structures plus an adequate distance to assure a stable slope. A provision for variance should be included for areas where the slope has been, or is proposed to be, stabilized by a well-engineered structure.
 - Flood setbacks and elevation requirements that include minimum requirements for a 1% flood risk line plus allowance for wave uprush and freeboard.

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- Shoreline alteration requirements established in the context of a comprehensive plan. The environmental, updrift and downdrift impacts of shoreline alterations must be considered, along with hydraulic impacts on the connecting channels.
 - Regulations in Canada to control fills and other obstructions in connecting channels. The most effective means of achieving this would be through amendment of the International Rivers Improvement Act.
 - Real estate disclosure requirements where the seller should be required to disclose to prospective buyers that the property is within a mapped or known flood or erosion hazard area. The buyer should sign an acknowledgment that he or she has been informed of the risk.
16. The Board recommends that acquisition of undeveloped and developed land and habitat protection areas be considered in areas where it is appropriate.
17. The Board recommends that where hazard insurance exists or is implemented in the future that the following elements be included.
- A hazard insurance program should use historic shoreline change methods coupled with recession rate studies to identify and map long-term erosion hazards on flood insurance rate maps.
 - A hazard insurance program should encourage community-based erosion management by establishing setbacks for new construction.
 - The program should deny subsidized flood insurance for new or substantially improved construction within the erosion hazard zone and should require that any structure substantially damaged during a storm be reconstructed landward of the hazard zone. The program should also deny subsidized insurance for recurring claims.
 - A hazard insurance program should provide eligibility for mitigation assistance when the aggregate of damage claims exceed 50% of the fair market value of the insured property and provide mitigation assistance for structures imminently threatened by erosion with an emphasis on relocation of structures out of the hazard area, not demolition.

EMERGENCY PREPAREDNESS

18. The Board recommends that the two federal governments, in cooperation with provincial and state governments, begin preparation of a joint and cooperative Emergency Operations Plan for the Great Lakes-St. Lawrence River as soon as possible.

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19. The Board recommends as a priority that investigations continue into methods of alleviating high or low water crises on the lower St. Lawrence River and that investigations continue into avoiding increased damage as a result of crisis actions taken upstream.
 20. The Board further recommends that the following be implemented in the near future:
 - The authority necessary for deviation from the Lake Superior Regulation Plan during an emergency, similar to the authority to deviate that exists for Lake Ontario.
 - The installation of an ice boom at the head of the St. Clair River to reduce the risk of ice jams and flooding.
 - An increase in the flow capacity of the Black Rock Lock, so the flow through the lock may be increased in emergency situations by an additional 340 cms (12,000 cfs).
 - The manipulation of the four major Great Lakes diversions; Long Lac, Ogoki, Lake Michigan at Chicago, and the Welland Canal during crisis situations when conditions permit.
 21. The Board recommends that prior to implementing the manipulations of diversions, the potential impacts within and outside the Great Lakes-St. Lawrence River System of changes to the Long Lac, Ogoki and Lake Michigan at Chicago diversions be determined.
 22. The Board recommends post-crises action reports be done to evaluate the effectiveness of emergency preparedness plans and to recommend areas for improvement.
 23. The Board recommends that comprehensive emergency preparedness planning be undertaken immediately at the provincial, state and local government levels. The preparations should include public information programs, stockpiling of emergency materials, active monitoring of water levels and flows, and identifying areas where community-based shore protection can be implemented immediately.

INSTITUTIONS

24. The Board recommends that the membership of the Lake Superior Board of Control be expanded to include representation from citizens, the states and provinces.
25. The Board recommends that the membership of the International St. Lawrence River Board of Control be expanded to include citizen representation from Lake Ontario, the upper St. Lawrence River and the lower St. Lawrence River.
26. The Board recommends that the functions of the Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data be formalized and that the Committee report to the Commission.

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27. The Board recommends that a Great Lakes-St. Lawrence River Advisory Board be created to coordinate, review, and provide assistance to the Commission on issues relating to the water levels and flows of the Great Lakes and St. Lawrence River.

COMMUNICATIONS

28. The Board recommends that a Great Lakes-St. Lawrence Water Level Communications Clearinghouse be established as a bi-national effort by the United States and Canadian Governments, with the responsibility to communicate with the public, to facilitate communication between the public and governments, and to facilitate coordination of agency communication activities related to the water levels and flows of the Great Lakes and St. Lawrence River.
29. The Board recommends that the Clearinghouse be established under major federal agencies such as Environment Canada and the United States Army Corps of Engineers, which already have significant responsibilities in this area, and that it be linked to larger units within these agencies to act as information resources and provide staff support in water level crisis periods.
30. The Board recommends that the Clearinghouse establish and coordinate a network of agencies and groups that communicate about water level issues.

MANAGEMENT AND OPERATIONAL IMPROVEMENTS

31. The Board recommends that action be taken to improve the information base used to manage the Great Lakes-St. Lawrence River resource in the following ways:
- That the identified deficiencies in the precipitation and snowpack network be remedied.
 - That a risk analysis model be developed that takes into account uncertainties of water supply to Lake Ontario, storm surge on Lake Ontario, variations of tributary inflows to the St. Lawrence River downstream of Cornwall and updated stage-damage data in the Lake Ontario-St. Lawrence River system to assist in equitably managing outflows during high- and low-water supply periods. If discretionary authority is provided to the Lake Superior Board of Control, as recommended elsewhere in this report, this model should be implemented for Lake Superior as well.
 - That efforts be made to improve long-range precipitation and temperature forecasts.
 - That new technologies such as satellite, airborne and ground-based radar be developed for use in the monitoring of lake evaporation, overlake precipitation and basin-wide snow conditions.
 - That work continue on upgrading models used for simulation, forecasting and regulation to formulate a comprehensive water

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- supply and routing model that includes the whole basin through Trois Rivières, Québec.
- That efforts continue to improve forecasting and statistical information be continued, so that all users throughout the system can make better decisions and that this be coupled with an upgraded system-wide supply and routing model.
 - That the efforts referenced in Chapter 8 to improve communication be implemented.
32. The Board recommends that efforts be initiated to standardize hazard mapping methodologies across the Great Lakes -St. Lawrence River region and that efforts continue to identify and map all flood and erosion hazard areas in the system.
 33. The Board further recommends that procedures be developed for allowing broad access to such maps for general use.
 34. The Board recommends that long-term monitoring of shoreline erosion and bluff recession be undertaken and that future erosion damage assessments consider, or be based on, information and methodologies developed under this study to improve these approaches.
 35. The Board recommends that the United States and Canadian land use mapping systems be updated on a periodic basis and that they be designed and developed cooperatively to promote uniformity.
 36. The Board recommends that a potential damage sample survey be undertaken in the future to improve flood damage estimates.
 37. The Board further recommends that the first priority for the potential damage sample survey be Lake Ontario and the St. Lawrence River.
 38. The Board recommends that a comprehensive wetlands inventory be completed and that long-term assessments of the effects on wetlands of variations in levels and flows be continued.
 39. The Board recommends that refinement of Global Climate Models be continued to improve their predictive capability and use as a planning tool.
 40. The Board further recommends that efforts continue to develop a bi-national assessment of the potential impacts of climate change on the Great Lakes-St. Lawrence River Basin System and to coordinate a response to the expected climate changes.
 41. The Board recommends that the following data elements be incorporated into Geographic Information System databases:
 - All land use information for the entire shoreline.
 - All hazard areas along the Great Lakes-St. Lawrence River.
 - All coastal wetlands.

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42. The Board further recommends that cooperative bi-national coordination and planning of Geographic Information System development and use be considered to increase the usability of the information stored in Geographic Information Systems relating to the Great Lakes-St. Lawrence River System, and that national and international standards for data transfer be established.

APPENDIX E

Additional Citizens Advisory Committee Recommendations

In addition to supporting the above Study Board recommendations, the Citizens Advisory Committee also recommends:

1. The Citizens Advisory Committee recommends examination of the practice of adjusting releases in the St. Lawrence River to provide adequate water to Montreal Harbour when large container ships are in port, and to allow for equitable apportionment of water, both upstream and downstream of Cornwall, for recreational boating at other times during the fall season. This would involve consultation among all affected parties. The Citizens Advisory Committee believes that such a practice may provide greater overall benefits to both shipping and recreational boating interests in the St. Lawrence River.
2. The Citizens Advisory Committee recommends that the International Joint Commission provide for continued citizen involvement in the Great Lakes-St. Lawrence River water levels issue, by including citizen representatives at the policy decision level (not day-to-day operation) of the management of Great Lakes-St. Lawrence levels and flows through whatever structures and institutions are operative.
3. The Citizens Advisory Committee recommends that the International Joint Commission appoint citizen members to future Study Boards on other issues as well as fluctuating water levels, and direct those Study Boards and committees to involve citizens directly as full members of working committees and task groups as well.
4. The Citizens Advisory Committee recommends that the International Joint Commission consider creating a single public involvement, citizens advisory function which would encompass the entire Great Lakes-St. Lawrence River Basin Ecosystem, both water quality and water quantity aspects.
5. The Citizens Advisory Committee recommends that, considering the time requirements and the responsibility associated with the type of involvement which Citizens Advisory Committee members had in the Levels Reference Study, future such efforts should make provisions for: 1) modest honoraria to partially compensate nongovernmental representatives for time away from work and family; and 2) the designation of an alternate to attend meetings when the member cannot attend.
6. The Citizens Advisory Committee recommends that, with respect to citizen involvement in the ongoing management of Great Lakes-St. Lawrence River water levels and flows, individuals should be appointed for three year terms, with a limit to one renewal, so as to ensure turnover in committee membership.

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7. The Citizens Advisory Committee recommends that, following completion of the Levels Reference Study, all Study papers and documents be archived permanently at a location to be designated in both the United States and Canada.

APPENDIX F

Text of Articles III, IV, VIII of Boundary Waters Treaty of 1909

ARTICLE III

It is agreed that, in addition to the uses, obstructions, and diversions heretofore permitted or hereafter provided for by special agreement between the Parties hereto, no further or other uses or obstructions or diversions, whether temporary or permanent, of boundary waters on either side of the line, affecting the natural level or flow of boundary waters on the other side of the line shall be made except by authority of the United States or the Dominion of Canada within their respective jurisdictions and with the approval, as hereinafter provided, of a joint commission, to be known as the International Joint Commission.

The foregoing provisions are not intended to limit or interfere with the existing rights of the Government of the United States on the one side and the Government of the Dominion of Canada on the other, to undertake and carry on governmental works in boundary waters for the deepening of channels, the construction of breakwaters, the improvement of harbours, and other governmental works for the benefit of commerce and navigation, provided that such works are wholly on its own side of the line and do not materially affect the level or flow of the boundary waters on the other, nor are such provisions intended to interfere with the ordinary use of such waters for domestic and sanitary purposes.

ARTICLE IV

The High Contracting Parties agree that, except in cases provided for by special agreement between them, they will not permit the construction or maintenance on their respective sides of the boundary of any remedial or protective works or any dams or other obstructions in waters flowing from boundary waters or in waters at a lower level than the boundary in rivers flowing across the boundary, the effect of which is to raise the natural level of waters on the other side of the boundary unless the construction or maintenance thereof is approved by the aforesaid International Joint Commission.

It is further agreed that the waters herein defined as 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.

ARTICLE VIII

This International Joint Commission shall have jurisdiction over and shall pass upon all cases involving the use or obstruction or diversion of the waters with respect to which under Article III and IV of this treaty the approval of this Commission is required, and in passing upon such cases the Commission shall be governed by the following rules or principles which are adopted by the High Contracting Parties for this purpose:

The High Contracting Parties shall have each on its own side of the boundary, equal and similar rights in the use of the waters hereinbefore defined as boundary waters.

The following order of precedence shall be observed among the various uses enumerated hereinafter for these waters, and no use shall be permitted which tends materially to conflict with or restrain any other use which is given preference over it in this order of precedence:

- (1) Uses for domestic and sanitary purposes;
- (2) Uses for navigation, including the service of canals for the purposes of navigation;
- (3) Uses for power and irrigation purposes.

The foregoing provisions shall not apply to or disturb any existing uses of boundary waters on either side of the boundary.

The requirement for an equal division may in the discretion of the Commission be suspended in cases of temporary diversions along boundary waters at points where such equal division can not be made advantageously on account of local conditions, and where such diversion does not diminish elsewhere the amount available for use on the other side.

The Commission in its discretion may make its approval in any case conditional upon the construction of remedial or protective works to compensate so far as possible for the particular use or diversion proposed, and in such cases may require that suitable and adequate provision, approved by the Commission, be made for the protection and indemnity against injury of any interests on either side of the boundary.

In any cases involving the elevations of the natural level of waters on either side of the line as a result of the construction or maintenance on the other side of remedial or protective works or dams or other obstructions in boundary waters or in waters flowing therefrom or in waters below the boundary in rivers flowing across the boundary, the Commission shall require, as a condition of its approval thereof, that suitable and adequate provision, approved by it, be made for the protection and indemnity of all interests on the other side of the line which may be injured thereby.

The majority of the Commissioners shall have power to render a decision. In case the Commission is evenly divided upon any question or matter presented to it for decision, separate reports shall be made by the Commissioners on each side to their own Government. The High Contracting Parties shall thereupon endeavour to agree upon an adjustment of the question or matter of difference, and if an agreement is reached between them, it shall be reduced to writing in the form of a protocol, and shall be communicated to the Commissioners, who shall take such further proceedings as may be necessary to carry out such agreement.

APPENDIX G

List of Persons Who Appeared at the International Joint Commission's Public Hearing on the Final Report of the Levels Reference Study Board Held in Windsor, Ontario, on Saturday, September 11, 1993

D. McCracken	International Great Lakes Coalition, Sarnia, Ontario
B. Andresen	International Great Lakes Coalition, South Haven, Michigan
T. Yonker	Great Lakes United, Buffalo, New York
M. Walker	North Shore Coalition, Lowbanks, Ontario
J. Menegon	North Shore Coalition, Hamilton, Ontario
L. Lehmann	International Great Lakes Coalition, Geneva, Ohio
J.P. Nash	East Shore Coalition, Amherstburg, Ontario
R. Ozanne	Citizen, Two Rivers, Wisconsin
W.J. Somerville	International Great Lakes Coalition, Williamston, Michigan
J. Milauckas	International Great Lakes Coalition, Saugatuck, Michigan
A. Chase	International Great Lakes Coalition, Oostburg, Wisconsin
J.K. Hoffman	Great Lakes Commission, Ann Arbor, Michigan
N. Thurber	Citizen, Portage, Indiana
S. Hazen	International Great Lakes Coalition, Port Rowan, Ontario
T. Bojanowski	Citizen, Geneva-on-the-Lake, Ohio
A. Bojanowski	Citizen, Geneva-on-the-Lake, Ohio
F. Lenard	Citizen, Port Stanley, Ontario
D. Thurber	Citizen, LaSalle, Michigan
C. Sasfy	Citizen, Maumee, Ohio