1.0 Introduction

The water levels and outflows of the Great Lakes are continuously changing in response to the climate of the Great Lakes basin and, to some extent, are influenced by man-made factors. How the levels and outflows change can have significant impacts on the Great Lakes ecosystem and the people who live and work there.

Hydropower development on the St. Marys River, the outlet channel of Lake Superior, took place in the early part of the Twentieth Century following approval by the International Joint Commission (IJC). The operation of these structures is governed by the criteria and requirements specified by the IJC, and this led to the regulation of the outflows of Lake Superior. Supplementary orders have been issued and different regulation plans have been used to reflect changing conditions and requirements since the IJC first issued its Orders in 1914. However, as the needs of the interests continue to evolve and our concern with global climate change grows, questions arise whether the current method of operation could be improved to better meet their needs.

The St. Clair River, Lake St. Clair and Detroit River form the connecting channel between Lake Huron and Lake Erie. The natural regime of this river system has been disturbed by human activities which include sand and gravel mining, dredging for navigation, and shoreline infilling and hardening. These activities affect erosion and deposition of materials in the river and thereby, its ability to transport water from Lake Huron to Lake Erie. There is growing concern that these physical changes may have increased the flow carrying capacity of the St. Clair River. Both high and low water conditions greatly affect riparian communities, recreational boating and tourism, commercial navigation, a number of species and the ecosystems in which they live, and a number of other economic and social interests. A recent report has indicated that there may be on-going changes in the St. Clair River, primarily as a result of human activities, that may be significantly contributing to the lowering of the levels of Lakes Michigan and Huron. Other recent reports have suggested significant lowering of lake levels may result from climate change.

This document describes the studies that are needed to investigate improvements to the regulation of the outflow of Lake Superior given the impacts regulation may have on water levels, flows, and consequently affected resources throughout the upper Great Lakes system. It also describes the studies that are needed to closely examine the physical processes driving current Great Lakes water level conditions, and possible ongoing changes in the St. Clair River and their impacts on river flow and Lakes Michigan and Huron levels. These two issues are interrelated in that the outflow of Lakes Michigan-Huron, through the St. Clair River, plays a direct role in determining lake level, which in turn affects the regulated outflow from Lake Superior and the regulation objectives of the IJC Orders. Depending on the nature and extent of the possible St. Clair River changes and impacts reviewed during the course of the study, potential remediation measures would also be investigated. Remediation measures could include structural and non-structural approaches.

There are many related Great Lakes initiatives underway such as the Great Lakes Regional Collaboration, Annex 2001 and updates to the Great Lakes Water Quality Agreement. While they have their distinct and separate purposes, coordination will be required to share information and ensure compatibility. The possible consequences of climate change on water levels and flows will be examined as well.

The study will be carried out in the context of Articles III and VIII of the 1909 Boundary Waters Treaty and the IJC's alerting responsibilities in the same manner as conducted for the IJC's *Plan of Study for Criteria Review in the Orders of Approval for Regulation of Lake Ontario – St. Lawrence River Levels and Flows.* The review of the IJC's criteria and Lake Superior outflow regulation is a part of the IJC's on-going responsibility to ensure that the works authorized in boundary waters continue to be operated in a manner that best meet the needs of the resources in the Great Lakes system.

This document outlines the overall organization of the study, including a preliminary estimate of the cost and a schedule of major activities. Chapter 1 provides a general overview of the purposes and objectives of the study, its scope, and the general approach to managing and undertaking activities. Chapter 1 also contains background information on the hydrology of the upper Great Lakes basin, and Lake Superior outflow regulation. Chapter 2 describes the study tasks that are required to further our understanding of the past and possible on-going physical changes in the river system and how these changes affect water levels and outflows of the upper Great Lakes. Chapter 3 describes the tasks for evaluating possible improvements to Lake Superior outflow regulation to meet contemporary and emerging needs of the interests including conditions resulting from climate change. Chapter 4 describes the relationships between water levels and flows and the various resources, and the study tasks that are needed to evaluate the impacts of management options on those resources. Chapter 5 proposes an organizational structure to facilitate study management and organization of activities to carry out the study. Supporting and background information may be found in the annexes.

This revised Plan of Study (POS) has been prepared by the current Upper Lakes Plan of Study Revision Team and has built upon the work previously carried out in 2001-2002. This document supersedes that report entitled: "Upper Great Lakes Plan of Study for Review of the Regulation of the Outflows from Lake Superior" prepared for the IJC by the Upper Great Lakes Plan of Study Team, January 2002.

1.1 Background

1.1.1 Directive for Revised Plan of Study

In January 2002, a binational team established by the IJC prepared a plan of study to review the regulation of the outflows from Lake Superior. The purpose of the study was to determine whether changes to the IJC's Orders of Approval or Lake Superior outflow regulation plan were warranted to meet contemporary and emerging needs of the interests in the upper Great Lakes system from Lake Superior downstream through

Lake Erie, including the environment. This plan of study was forwarded to the two Governments in March 2002 and has not yet been funded.

In May 2005, the IJC established a new team (Upper Lakes Plan of Study Revision Team) to revise the 2002 Plan of Study, directing that three additional purposes be included. Annex 1 of this document contains the IJC's Directive to the Upper Great Lakes "Plan of Study" Revision Team. One added purpose is to examine, during the early part of the study, past and on-going physical changes in the St. Clair River and their impacts on the river flow and water levels of the upper Great Lakes. A second is to take into consideration the lessons learned from the five-year International Lake Ontario – St. Lawrence River Study, which was nearing its completion. Lastly, the IJC directed that the new team streamline the existing Plan of Study. The 2005 Directive retains the main purpose of the 2001 Directive concerning Lake Superior outflow regulation. The conduct of this study is dependent on the Canadian and United States governments providing funding.

1.1.2 Great Lakes Hydrology/Water Balance

The upper Great Lakes (Figure 1) form a system of large natural reservoirs connected by rather short channels, given the size of the basins. The total basin area (measured above Cornwall, Ontario and Massena, New York) is about 774,000 square kilometres (299,000 square miles). Table 1 provides information on the sizes of the Great Lakes and their drainage basins. Lake Superior, which is the most upstream of the Great Lakes, flows into Lake Huron through the St. Marys River. Lake Michigan also flows into Lake Huron through the Straits of Mackinac. The straits are wide and deep enabling both Lake Michigan's and Lake Huron's water levels to stand at the same elevation and respond hydraulically as one lake. Thus, the two lakes are also referred to as Lakes Michigan-Huron. From Lake Huron, water flows into Lake Erie via the St. Clair River, Lake St. Clair and the Detroit River. Lake Erie then flows into Lake Ontario through the Niagara River and the Welland Canal. Lake Ontario, in turn, flows into the St. Lawrence River which connects with the Gulf of St. Lawrence. Figure 2 shows the general water surface profile of the Great Lakes – St. Lawrence River System.

A rock ledge in the St. Marys Rapids of the St. Marys River acted as a natural submerged weir, controlling the outflows of Lake Superior. The hydropower development and construction of the St. Marys River Compensating Works in the early part of the Twentieth Century altered this part of the river, enabling humans to regulate the outflow from Lake Superior. The rate of water flow in the St. Clair – Detroit River system depends mainly on the level of Lakes Michigan-Huron and, to some extent, also Lake Erie's level. Other factors affecting this system's flow rate are aquatic growth in the river in summer and ice conditions in winter. Physical changes in the St. Clair and Detroit Rivers can have significant impacts on water flows of the river and Lakes Michigan-Huron water level. The flow of the Niagara River depends on Lake Erie's level at its outlet. Hydropower operations at Niagara Falls have considerable water level impacts in the immediate river stretches both upstream and downstream of these facilities but insignificant impacts on Lake Erie's level.

Lake Ontario's outflows are regulated by a hydropower dam and other control works in the international reach of the St. Lawrence River. Lake Ontario levels cannot affect the upstream Great Lakes water levels due to the almost 100-metre (328-foot) drop in elevation between Lake Erie and Lake Ontario, most of it located at Niagara Falls and cascades in the Niagara River.

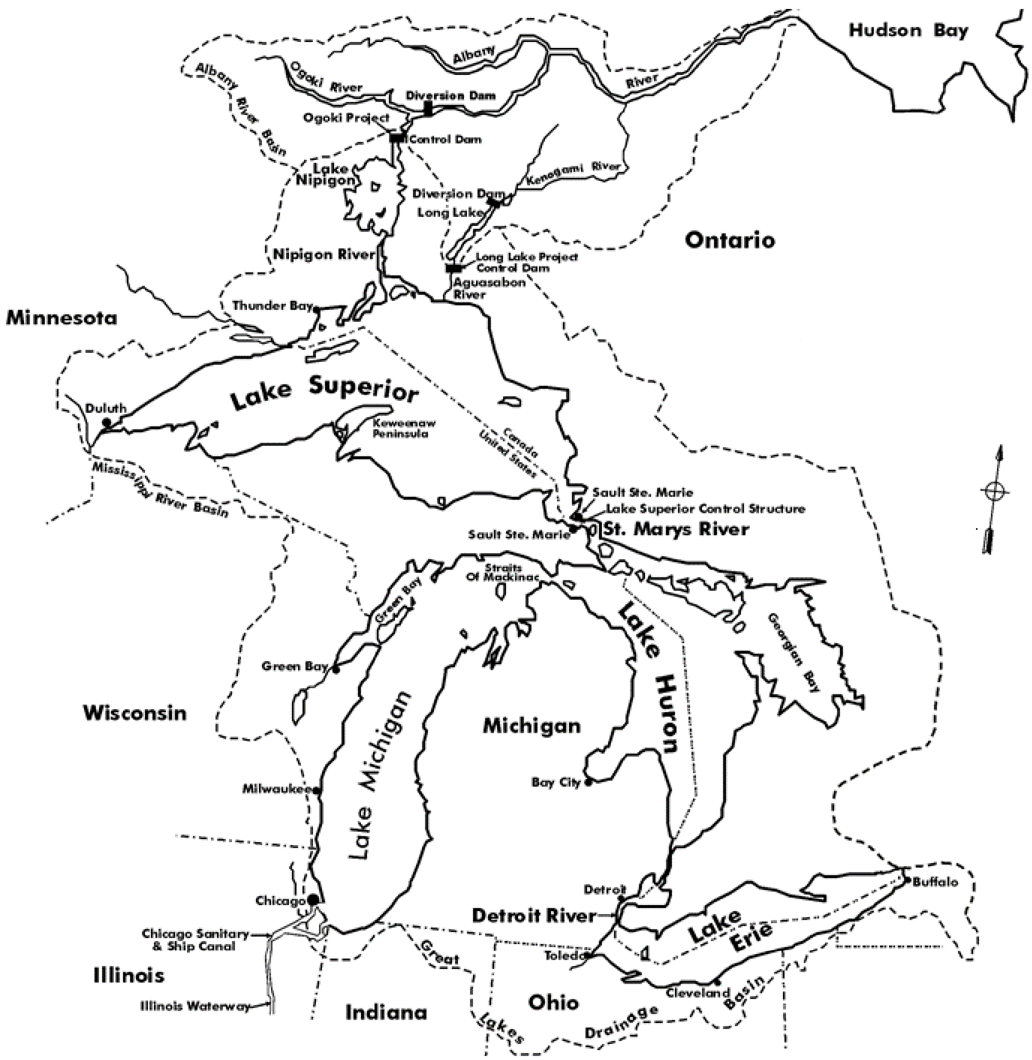


Figure 1 – Upper Great Lakes Basin

Table 1
Dimensions of the Great Lakes Basins

	Surface Area				Volume*		Max Depth*	
	Water		Land					
	km²	miles²	km²	miles²	km³	miles³	metres	feet
Lake Superior	82,100	31,700	127,700	49,300	12,100	2,900	405	1,330
St. Marys River	230	90	2,600	1,000				
Lake Michigan	57,800	22,300	118,000	45,600	4,920	1,180	281	923
Lake Huron	59,600	23,000	131,300	50,700	3,540	850	229	750
St. Clair River	55	21	3,300	1,270				
Lake St. Clair	1,110	430	12,430	4,800				
Detroit River	100	39	2,230	860				
Lake Erie	25,700	9,910	58,800	22,700	484	116	64	210
Niagara River	60	23	3,370	1,300				
Lake Ontario	18,960	7,340	60,600	23,400	1,640	393	244	802
St. Lawrence River To Cornwall/Massena	610	240	7,190	2,780				

*Measured when the lake's water level is at chart datum
Source: Coordinating Committee on Great Lakes Basin Hydraulic and Hydrologic Data, 1977

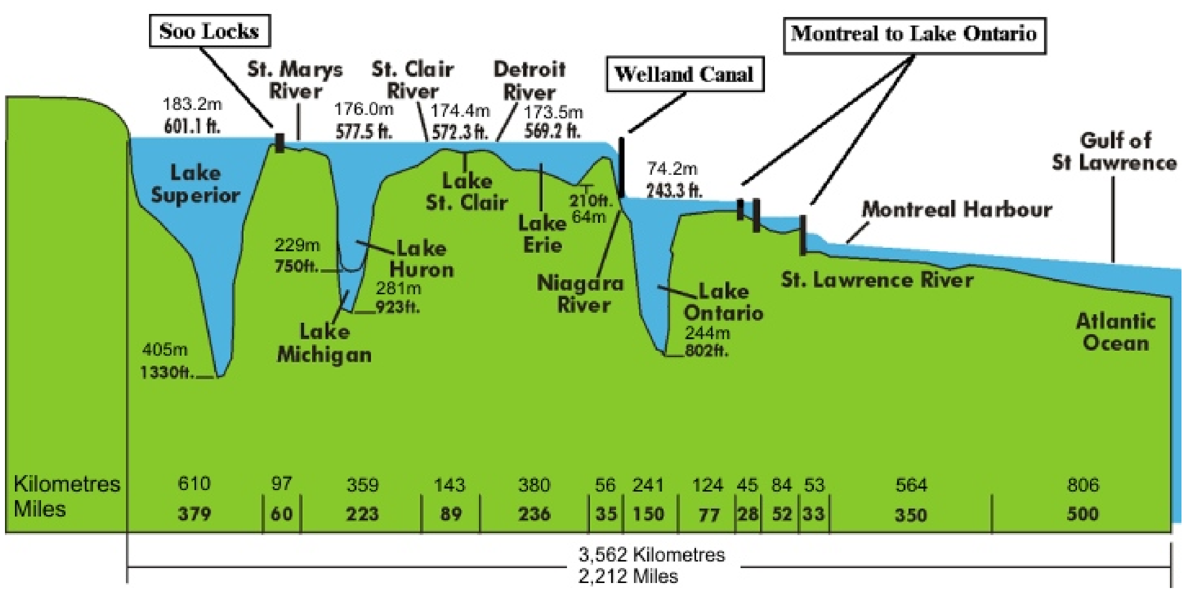


Figure 2 – Great Lakes St. Lawrence River Water Surface Profile

A lake's level rises and falls according to the amount of water entering and leaving the lake. Overlake precipitation, condensation at the lake's surface, surface runoff, inflows and groundwater flow provide water to the lake, while evaporation and outflow reduce the amount in storage. The term water supplies, calculated by analyzing water levels, outflows, other hydrological and meteorological data, comprise the net effect of these factors. Though not impacting on the quantity of the water in the system, ice and aquatic growth in the lake's outlet river generate flow resistance and thus affect the timing of the water flow from one lake to the next downstream. Human activities affecting levels and flows include dredging and infilling of rivers, water diversions, consumptive uses, and Lake Superior and Lake Ontario outflow regulation. Consumptive uses are water taken out and not returned to the lakes, such as water incorporated into manufactured products and exported out of the region, and the portion of water used for agricultural irrigation and other outdoor water consumption that is lost to evaporation.

Fluctuating water levels on the Great Lakes have been described as being of a long-term, seasonal, and short-term nature. Long-term fluctuations occur over periods of consecutive years as the result of climate variations affecting the region. Figure 3 shows plots of lake levels for the Great Lakes from 1918 through 2004. Prior to 1918, there were insufficient water level data and gauge stations to determine accurately the lake-wide average monthly mean lake levels. The plots show record low water levels occurred during sustained drought periods in the 1930s and 1960s. Record highs occurred during sustained wet periods in the early 1950s, in 1973, and in 1985-86. Water level trends can also reverse quickly, as demonstrated in the drop from very high to very low in a matter of about two years from 1986 to 1988 and again from 1997 to 1998.

Table 2 lists the long-term average and range of water level and outflow fluctuation for the period 1918-2004.

Seasonal fluctuations take place during the course of each year. Water levels rise in the spring in response to runoff from snowmelt and spring rainfall. The levels decline during late summer through the fall and winter due to reduced runoff from tributaries and increased evaporation from the lake. Owing to the timing of the water supply to Lake Superior, the level of that lake usually peaks in August or September, about a month or so later than the other downstream lakes.

One cause of short-term fluctuation is sustained high winds blowing over a lake producing a wind set-up or storm surge on the downwind shore of the lake. This results in lower water levels at the opposite shore of the lake. Superimposed on water level fluctuations are wind-induced waves. When the wind subsides, the water on the lake oscillates or sloshes (also called seiche) until it stabilizes again.

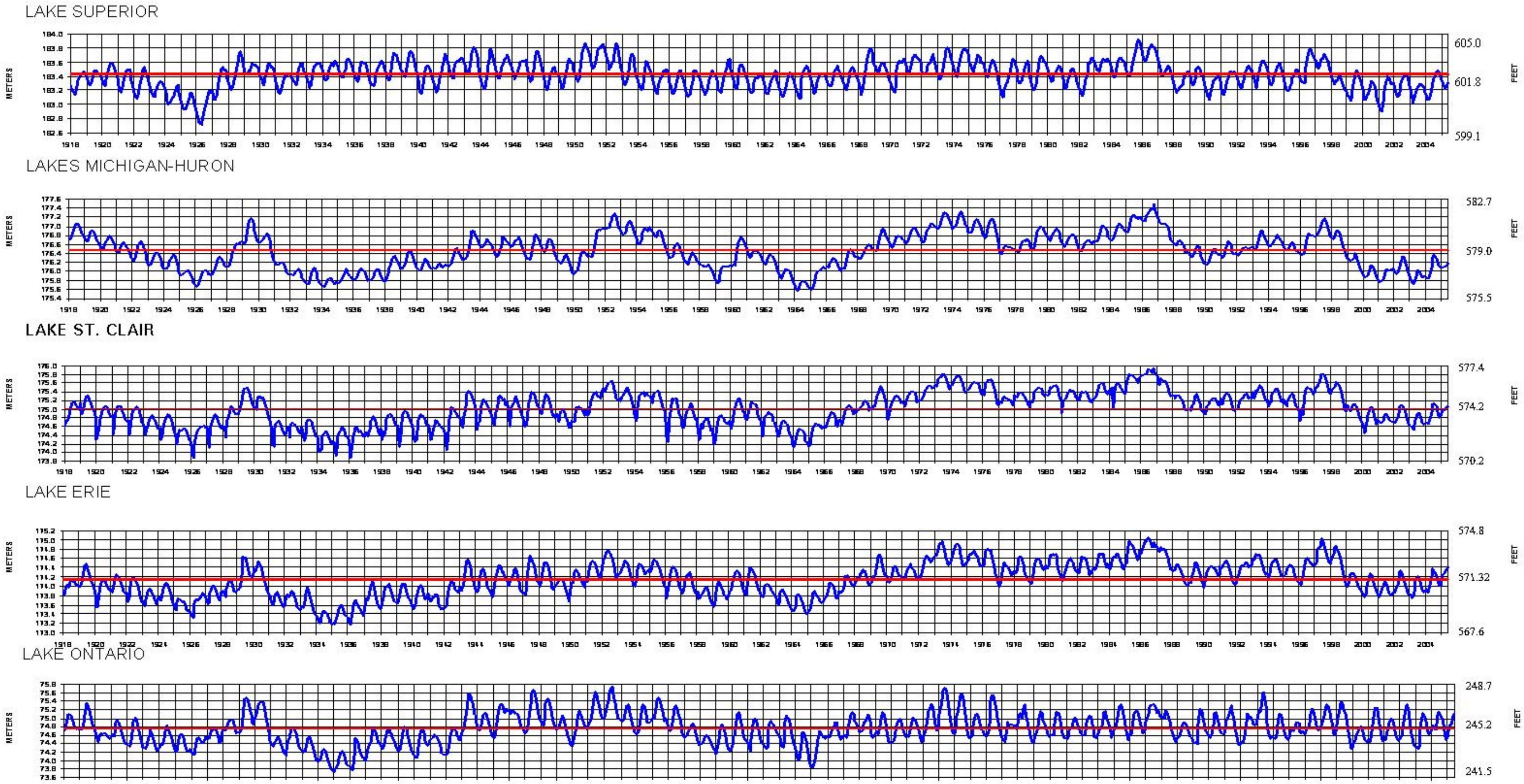
High or low lake levels and flows can persist for a considerable time after a change in the system, because of the large size of the Great Lakes and the limited flow capacities of their outlet rivers.

Table 2
Summary of Monthly Mean Water Levels and Outflows

	Water Levels, IGLD 1985 metres	Water Levels, IGLD 1985 feet	Outflows m^3/s	Outflows ft^3/s
Lake Superior				
Average	183.42	601.77	2130	75,200
Maximum	183.91	603.38	3600	127,100
Minimum	182.72	599.48	1160	41,000
Range	1.19	3.90	2440	86,200
Lakes Michigan-Huron				
Average	176.46	578.94	5170	182,600
Maximum	177.50	582.35	6740	238,000
Minimum	175.58	576.05	3000	105,900
Range	1.92	6.30	3740	132,100
Lake St. Clair				
Average	175.01	574.18	5330	188,200
Maximum	175.96	577.30	7080	250,000
Minimum	173.88	570.47	3170	111,900
Range	2.08	6.82	3910	138,100
Lake Erie				
Average	174.14	571.33	5930	209,400
Maximum	175.04	574.28	7820	276,200
Minimum	173.18	568.18	3340	118,000
Range	1.86	6.10	4480	158,200
Lake Ontario				
Average	74.75	245.24	6980	246,500
Maximum	75.76	248.56	10,010	353,500
Minimum	73.74	241.93	4360	154,000
Range	2.02	6.63	5650	199,500

(1) Water levels for each lake are calculated using recorded monthly values from a network of gauges on the lake for the period 1918-2004. Daily and instantaneous water levels at a location on the lake are significantly more extreme than the values shown.
(2) Source: Environment Canada, Great Lakes – St. Lawrence Regulation Office

Figure 3 - Great Lakes Hydrographs



Lake Superior's outflow channel has a limited ability to make rapid and significant changes to its level or to that of the downstream receiving lakes. This can be demonstrated in the following example. If the Lake Superior outflow as specified by the regulation plan for the month of August 2005 was increased by 20 percent, the maximum impact due to this deviation from the regulation plan would be about one centimetre (0.4 inch) lowering on Lake Superior, and about one centimetre (0.4 inch) raising on Lakes Michigan-Huron. The impact of this one-month outflow increase would be moderated by the storage capacity of Lakes Michigan-Huron resulting in lesser impact on Lake St. Clair, Lake Erie's level and its outflow to Lake Ontario. As a second example, if the monthly mean outflows were set at 10 percent more than those specified by the regulation plan for a period of twelve months, at the end of this period, the maximum lowering impact on Lake Superior would be about nine centimetres (3.5 inches). The maximum raising impacts under this scenario would be about four centimetres (1.6 inches) on Lakes Michigan-Huron, three centimetres (1.2 inches) on Lake St. Clair and two centimetres (0.8 inch) on Lake Erie. Whereas consistent Lake Superior outflow increases (or decreases) from the regulation plan over a period of time have a cumulated impact on that lake's level, the impacts of these same deviations on Lakes Michigan-Huron are not linear or completely cumulative. The open-channel flow characteristics of the St. Clair River respond to the rise (or fall) in the Lakes Michigan-Huron levels thus moderating the impacts of the changes in the outflow from Lake Superior. These responses are markedly different from that for Lake Ontario outflow regulation where the lake surface is much smaller. The long-term average Lake Ontario outflow is about 7,000 m^3/s (247,000 ft^3/s) and a change of 700 m^3/s (24,700 ft^3/s) or 10 percent for one month is equivalent to 9 centimetres (3.5 inches) of water depth on Lake Ontario.

Some insight into patterns of lake level change from decades to millennia have been offered by recent research of hindcasting water levels using shorelines on Lake Michigan (Baedke and Thompson, 2000) and Lake Superior (Johnston and others 2004). They suggest that there are natural long-term lake-level fluctuations that have persistently reoccurred during the last 3,500 years. Two patterns of lake-level change that are important for historical record interpretation have periods of around three decades and a century and-a-half.

There is a growing concern about climate change and the effects it may have on the water levels of the Great Lakes. Current research points to an increase in regional temperatures, and possibly increased frequencies of severe weather events. Results from most global modelling studies show a decrease in water supplies to the lakes, resulting in lower water levels and decreased outflows.

Although we tend to think of our land masses and their relative elevations as being stable over time, this is not the case in the Great Lakes region. The present system of Great Lakes was formed about 10,000 years ago when the last glaciers retreated. Glaciologists believe that during the last ice age the region beneath the glacier was depressed while the regions on the periphery bulged upward. After the glacier melted, the crust underneath the glacier started to rebound upward while the forebuldge began to subside to achieve its former equilibrium prior to the ice age. This view is supported by current satellite-based Global Positioning System (GPS) measurements which clearly show that the areas formerly beneath the glacier are rising and the forebuldge is subsiding in an absolute sense (relative to the geocentre); however, studies of historical beach ridges on Lakes Superior, Michigan, and Huron (for example, Baedke and Thompson, 2000) suggest that the dissipating forebuldge may be a more recent phenomenon. Although further work is required to resolve this difference, key to this effort is the fact that that the earth's crust in the Great Lakes region continues to move today, but at varying rates, affecting land-to-water relationships around individual lakes as well as the elevation differences and hydraulic relationships between lakes. Section 2.4.3 provides more detailed discussion on this phenomenon, formally referred to as glacial isostatic adjustment (or GIA), and describes study tasks to examine this issue, which increases the complexity in both understanding what change is ongoing within the basin and in estimating what impact this may have on the ability of the lakes to store water and for the channels to convey water from lake to lake.

1.1.3 Orders of Approval and Supplementary Orders

In 1914, the IJC issued Orders of Approval permitting Algoma Steel Corporation in Canada and the Michigan Northern Power Company in the United States to divert St. Marys River water for hydropower generation and to complete the construction of a 16-gate control structure (St. Marys River compensating works) above the St. Marys Rapids. The Orders specified a list of conditions to be met in the construction and operation of these works, and established the International Lake Superior Board of Control to oversee their operation. This led to the regulation of the outflows of Lake Superior.

The 1914 regulation criteria recognized three major interests, namely, riparian on Lake Superior, hydropower and commercial navigation. The criteria supplemented the simple order of precedence listing from among the various interests already laid out in Article VIII of the Boundary Waters Treaty of 1909, namely (1) uses for domestic and sanitary purposes, (2) uses for navigation, including the service of canals for the purpose of navigation, and (3) uses for hydropower and irrigation purposes.

Since 1914, the IJC has issued supplementary orders to meet the changing conditions and requirements in the upper Great Lakes system. The 1978 supplementary order permitted the redevelopment of the Canadian hydropower facilities at Sault Ste. Marie, Ontario. Environmental concerns were taken into consideration when the IJC issued supplementary orders in 1978 and 1985 focusing on the hydropower redevelopment and fishery in the St. Marys Rapids area.

An important part of the 1979 supplementary order, which is built into the current regulation plan, requires that the water levels of both Lake Superior and Lakes Michigan-Huron be taken into account in determining Lake Superior outflows. The objective of this more system-wide consideration when regulating is to provide benefits throughout the upper Great Lakes system.

1.1.4 Current Regulation Plan

Since 1916, seven different regulation plans have been used to determine Lake Superior outflows. The early generation of regulation plans considered only the level of Lake Superior in determining the outflow because they were designed to comply with the 1914 Order. During the study by the IJC's International Great Lakes Levels Board, which occurred from 1964 to 1973, an experimental plan was developed that used the concept of balancing of Lake Superior and Lakes Michigan-Huron levels. That plan, known as Plan SO-901, was used as a guide for Lake Superior outflow regulation during the mid-1970s.

In May 1977, the IJC requested that the International Lake Superior Board of Control prepare a revised regulation plan that provides benefits to interests throughout the Great Lakes system without undue detriment to Lake Superior interests. In September of that year, the Board submitted a report on the development and evaluation of Plan 1977, which was a refinement of Plan SO-901. Plan 1977 was officially adopted in October 1979. Further improvements led to the development of Plan 1977-A, which took effect in June 1990. Plan 1977-A is the regulation plan used currently.

Plan 1977-A specifies monthly average outflows with the objective of balancing the levels of Lakes Superior and Michigan-Huron taking into consideration their historical ranges. The plan has a number of outflow limitations to meet the regulation criteria and requirements of the IJC Orders. For example, one outflow limit serves to prevent excessive lowering of the levels of Lake Superior, while another prevents high water level conditions in the lower St. Marys River at Sault Ste. Marie. The regulation plan also has a limit on maximum allowable outflow in the winter to reduce the risk of ice jam and associated flooding in the lower St. Marys River.

The monthly Lake Superior outflow, as specified by Plan 1977-A, is first allocated to meet the needs of municipal - industrial water uses, operate the navigation locks and provide sufficient flow to maintain the aquatic habitat of the St Marys Rapids. The remainder of the flow, which is the majority, is allocated equally to the US and Canadian hydropower facilities to generate electricity. If the amount of water available for hydropower generation exceeds the capacities of the hydropower plants, the excess is released by opening gates at the 16-gate Compensating Works. To maintain aquatic habitiat, a minimum gate setting of one-half gate open, or its equivalent, is required at all times for the main rapids. In addition, Gate 1, at the north end of the structure, is set partially open to provide a continuous water flow for the fishery remedial works in accordance with the IJC requirement.

The International Lake Superior Board of Control constantly monitors the hydrological conditions of the upper Great Lakes basin. Each month, the Board determines Lake Superior's outflow according to Regulation Plan 1977-A. Under certain conditions, the IJC approves deviations from the regulation plan or changes to gate settings at the compensating works on the advice of the Board. These deviations may include flow changes to accommodate repairs at hydro facilities or the compensating works, support flow measurements, sea lamprey trapping that typically takes place in the summer, surveys or environmental studies of the rapids, or to deal with unusual water supply conditions.

To meet energy demand which fluctuates over the course of the day and week, hydropower plants typically conduct peaking and ponding operations. In peaking and ponding operations, higher flows pass through the plants during the daytime on weekdays when energy demand is high, which is then offset by lesser flows during the night and on weekends. These flow variations cause water levels to fluctuate downstream of the plants and in the lower St. Marys River. Peaking and ponding operations are carried out with the approval of the IJC.

1.1.5 Public Involvement

Extensive public involvement activities were carried out in the preparation of the 2002 Plan of Study and in the preparation of this revised POS. Annex 2 lists the activities carried out during the two exercises and a summary of these activities is presented below.

In May 2001, the IJC informed the governments and the public of its intention to develop a plan of study, and invited comments on the draft directive setting up the POS team. The IJC held public meetings during June and July 2001 in the upper Great Lakes basin to hear views and concerns, and solicit opinions on the proposed study. The draft plan of study was made available for peer review by a panel of experts in Canada and the United States, and for public review during October 2001. Another round of public meetings was held in October and November 2001 to receive public comments on the draft plan of study. The former team also conducted targeted consultation with First Nations and Native Americans, and with interest groups that included: ecosystem, hydropower, navigation, residential property owner associations and recreational boating.

To supplement the input collected during the 2001 public consultation process, the plan of study revision team sent letters in July 2005 to citizens and interest groups, First Nations and Native Americans, government agencies, industries and elected officials in both countries inviting them to provide comments and advice on the proposed study and to attend the public consultation meetings. Four public consultation meetings were held in September 2005, two in Canada and two in the United States. The team's efforts were posted on an internet web site to inform the public on progress of work, and to solicit public inputs and advice on the draft revised plan of study. Team members consulted with experts in governments and the academic community on current science and tools that could be of value for the study.

In both the 2001 and 2005 public consultations, there were overwhelming public support for a review of the Lake Superior outflow regulation. Numerous feedbacks from the public also support inclusion of the study of the St. Clair River. Many expressed concerns about the adverse effects of extreme low water levels on wetlands. Some raised concern that governments might rush into unwise actions, and urged that sufficient scientific investigations be conducted to understand the factors that are driving current low water levels prior to undertaking activities regarding their potential remediation.

1.1.6 Related Studies

1986 IJC Reference Study

The most recent major international study of Great Lakes water levels was conducted under the 1986 IJC reference and completed in 1993. That study identified some potential changes to the Lake Superior outflow regulation, for example modifying some of the outflow limits and exploring other techniques to balance water level conditions of Lake Superior with those of Lakes Michigan-Huron. Following the completion of the study, the Study Board recommended that the current IJC's Orders of Approval be reviewed to determine if the current regulation criteria are consistent with the current uses and needs of the users and interests of the upper Great Lakes system.

International Lake Ontario – St. Lawrence River Study

Another study that is of similar nature to the proposed Upper Lakes Study is the 5-year study to investigate improvements to Lake Ontario outflow regulation. This study was essentially completed by the Fall of 2005. During June and July 2005, the Plan of Study Revision Team consulted with the participants of the International Lake Ontario – St. Lawrence River Study on lessons learned from that study. The findings from these consultations that are applicable to the Upper Lakes Study are as follows:

Plan of Study

A well-thought-out plan of study is prerequisite to an effective and successful study. The plan must make clear its mandate, identify the issues and objectives, and next select requisite studies that help to answer the critical questions. In other words, how will the study results help society select an outflow regulation plan that is better than the one currently in use?

The plan of study should provide a description of how the Great Lakes system works, and what the impacts and limitations are of current or proposed Lake Superior outflow regulation. It should have a realistic definition of what the potential is for water level changes so as not to cause undue expectations.

Investigating improvements to Great Lakes water management takes time and resources. Too long a study however, risks high staff turnover.

Study Participants and Organization

It is important for all participants to clearly understand the purpose of the study and for the study board to provide clear and focused direction. It is strongly advised that all study participants be educated on Great Lakes hydrology and outflow regulation at an early stage in the overall process. The duties and responsibilities of all participants should be clearly defined. When scheduling and approving work tasks, study management should include a monitoring provision to ensure timely completion of the work and submission of written reports. Procedures should be in place to enable effective communications among the technical work groups and the study board.

The study organization of the International Lake Ontario – St. Lawrence River Study Board has worked well. Advisors on economic evaluations and basin-wide ecosystem planning are recommended at the early stage to help the study board decide on the focus and direction of the study.

Public Participation

Public participation is vital for the success of the study. The study must be proactive, searching out and engaging the public early, to provide opportunity for the public to participate in all aspects of the study. Public meetings, newsletters and a web site are essential elements of the study to maintain dialogue with the public and update the public on work progress. The Public Interest Advisory Group has proven to be valuable, providing not only direct inputs to the study but serving as a liaison between the study and stakeholders.

Establish an outreach team from the beginning of the study to map out a communication strategy template for the entire length of the study.

First Nations and Native Americans Participation

Efforts should be made to involve the First Nations and Native Americans in preparing the plan of study and the conduct of the study from the beginning. Their participation brings expertise to the study, and ensures that the water level issues and concerns of the native community are taken into consideration.

Study Approach

Given the complexity of the issues to be addressed in the proposed Upper Lakes Study, a proper sequencing of study tasks would be required. The initial work would scope out the physical limitations of the existing Lake Superior outflow regulation plan and potential changes, and would include a scoping exercise to identify priority and anticipated level of detail for evaluation. A team similar to the Plan Formulation and Evaluation Team is advised at the early stage to establish evaluation methods and guidelines on integrating study results for decision making. Also needed at an early stage are experts on economic and ecosystem evaluations. Early tasks would also define a study organization and expertise required for the study. This strategy aims to maintain the study focus and avoid needless costly scientific research and data collection.

Data, Science and Tools

Wherever possible, the data, science and tools used in the International Lake Ontario - St. Lawrence River Study and other studies would be adopted for analysis in the Upper Lakes Study. Additional data would be collected if they are determined to be essential to fill data gaps.

For example, vessel transit and cargo forecast data and evaluation methods are available from the International Lake Ontario – St. Lawrence River Study and other seaway studies. The methods for evaluating impacts of levels and flows on hydropower generation in the St. Lawrence River are also expected to be applicable, although changes would be required in the assumptions due to differences in energy marketing systems. The study of climate change has generated data for the Great Lakes basin. As the sciences in these issues continue to improve, some updating may be required for the Upper Lakes Study.

The general nature of the relationships between water levels and most interest groups such as coastal zone processes, hydropower, navigation and water uses are similar throughout much of the Great Lakes system, while some areas do have unique qualities. On the Great Lakes, there are many types of wetlands which, as a result of water level changes over the years and local settings, have evolved into what we see today. The water level requirements of wetlands are relatively more complex compared to other interest groups. Methods have been developed in the International Lake Ontario - St. Lawrence River Study to evaluate the impacts of alternative Lake Ontario regulation plans, and these would be considered for the Upper Lakes Study.

It is also recommended that peer review be conducted during the course of the study to ensure the credibility of the science. Some follow-up monitoring strategies may be advisable to verify whether the projected evaluation of impacts on the interest groups had been correctly reflected within the decision model.

In major studies of this scope and nature, new science, techniques and knowledge may be uncovered during the course of the study. Consideration should be given to developing mechanisms to ensure that governments are aware of these when making water management decisions for the Great Lakes.

Information Technology

The Upper Lakes Study should make appropriate use of information technology in public communication, the handling and storage of information, data and knowledge generated during the study.

1.2 Objectives

This plan of study is designed to fulfill the IJC's 2005 Directive. The two primary objectives are:

- To improve the operation of the structures controlling the outflows from Lake Superior, and to improve Lake Superior outflow regulation to meet contemporary and emerging needs of the interests including the environment in the upper Great Lakes system.
- To improve our knowledge of the physical process of the St. Clair River and use this knowledge for Great Lakes water management.

1.3 Scope

The geographic area of the Upper Lakes Study would encompass the upper Great Lakes basin from Lake Superior downstream through Lake Erie including Lake Michigan and Lake Huron, their interconnecting channels and the Niagara River.

The early part of the study will focus on the hydraulic, physical changes and sedimentation processes of the St. Clair - Detroit River system, and how past and possibly on-going physical changes affect river flows and water levels in the upper lakes system. If the impacts due to these changes are found to be significant and warrant remediation measures, the study would identify the nature of the remediation measures and their costs. In addition to analyzing existing data, new data to be collected includes bathymetry, water level and flow measurements to determine the present hydraulic regime, and sediment transport and core bed data for application of simulation models to study sedimentation processes. The study area includes the St. Clair River, Lake St. Clair and the Detroit River, as these water bodies form the connecting channel between Lake Huron and Lake Erie. The focus is the St. Clair River, with less detailed work needed on Lake St. Clair and the Detroit River. The study would also examine lower Lake Huron sedimentation processes and how they affect sedimentation processes in the St. Clair – Detroit River system.

The early part of the study would also include components of the Lake Superior regulation study which do not require additional data collection, and are not contingent upon decisions concerning evaluation methods and assumptions. These include reviewing existing outflow regulation criteria and technical aspects of the current regulation plan, and outflow capability of the control structures.

No structural modifications to the St. Marys River would be considered when investigating potential improvements to Lake Superior outflow regulation. The evaluation of existing and potential Lake Superior regulation plans may need to consider scenarios of potential structural modifications to the St. Clair River, should physical remediation works in that river be warranted. The testing of alternative Lake Superior outflow regulation plans will take into consideration climate variability and climate change as well.

No changes would be considered to the existing treaties or agreements between Canada and the United States concerning Great Lakes water levels. The review of the Orders of Approval governing Lake Superior outflow regulation will be carried out in the context of Articles III and VIII of the Boundary Waters Treaty and the Commission's alerting responsibilities in the same manner as conducted in the study to review the IJC Orders of Approval for hydropower developments in the St. Lawrence River and the regulation of the outflows of Lake Ontario.

1.4 Approach

The evaluation of options to improve Great Lakes water management requires an understanding of the wide range of water level and outflow issues. This study requires focused guiding principles, best available science and experts, and public participation. For an effective study, tasks must be conducted in proper sequence.

1.4.1 Guiding Principles

1. The investigation of water management options, including Lake Superior outflow regulation and St. Clair River investigations, will consider the needs of all the interests including ecosystem in the upper Great Lakes system and, in doing so, will balance benefits without undue detriment to any interest, region or lake.

2. All tasks proposed for the study must be compatible with the study objectives. The level of detail for evaluating alternative Lake Superior outflow regulation plans and other water management options would be dependent on the degree of impacts on water levels and flows.

3. Decision-making with respect to the development of water management options and evaluation methods will be transparent. Opportunity will be provided for meaningful participation of First Nations, Native Americans and the public in all aspects of the study to ensure their advice and concerns are considered and that all have the opportunity to contribute to the success of the study.

4. Credible and generally accepted science, current knowledge and state-of-the-art technologies for hydrological, hydraulic, economic and environmental evaluations are to be used in the study. New and innovative techniques are encouraged if they result in the provision of critical information for the decision making process that would have otherwise not been available. Peer review by independent experts would be conducted prior to adopting study methods and techniques, including major assumptions and overall approaches to be undertaken.

5. All technical reports funded through the study should be placed on the web site for public access and scrutiny.

6. Information technology will be used for public communications, while at the same time making provisions for providing information in conventional ways (for example,

paper format for reports) for the public who do not have access to computers or internet.

1.4.2 Organizational Period

The experience from the current International Lake Ontario - St. Lawrence River Study has shown it is important to lay the proper groundwork prior to initiating a full-blown study. An organization period spanning about six months is recommended. During this period, a small team would scope out the nature and extent of the hydrological, economic and environmental studies, including deciding on evaluation methods and assumptions. The team would also consider potential study participants from the public, government agencies and the academic community, and design a study organization with terms of references for study groups. It is recommended that this team consist of IJC staff, advisors and people who have the expertise and experience in setting up and conducting multi-disciplinary studies. Members of the Plan of Study Revision Team and the International Lake Ontario – St. Lawrence River Study could also provide valuable insight.

1.4.3 Evaluation Methodologies

To ensure a cost-effective study and the credibility of the science in the study, the organization team would consult with experts in governments and academia on appropriate scientific and engineering approaches to consider within the study. It is expected that some of the work from the International Lake Ontario - St Lawrence River Study will be useful for the Upper Lakes Study. These may include the data and methods used for commercial navigation and hydropower studies, hydrological studies including impacts of climate change, and techniques used for environmental evaluation. However, care should be exercised in adopting these methods as they reflect the state-of-knowledge at the time. Some updating of these methods and the data used to generate results are expected to be required for the Upper Lakes Study.

As discussed earlier, Lake Ontario outflow regulation has relatively much larger impacts on water levels and flows in the Lake Ontario and St. Lawrence River system than Lake Superior outflow regulation has on the upper Great Lakes system. This makes a scoping exercise essential to determine whether qualitative or detailed quantitative evaluations are sufficient. A hydrological and hydraulic team will be required throughout the study to determine the water levels and flows resulting from various water management options. It is expected that evaluation of the impacts of water management options will follow the general sequence as that in the International Lake Ontario - St. Lawrence River study, which are:

- identify the needs of the interest groups
- consider outcome of St. Clair River analyses and possible remediation options
- investigate changes to Lake Superior regulation plan
- generate water levels and flows under (1) existing regulation plan, (2) assuming pre-project St. Marys River hydraulic conditions, and (3) alternative regulation plans, assuming current climate and climate change scenarios
- evaluate impacts on the interest groups

- compile the evaluation results
- consider water management options and make recommendations

1.4.4 Timeline

The identification and evaluation of water management options that consider the complexity of the upper Great Lakes system and the relationships between water levels and interests requires a study that would span several years. Proper sequencing of study tasks having well-defined objectives is essential to conduct the study effectively in order to provide information for decision making. This study is envisioned to take five years and incorporates all necessary tasks to address the IJC's Directive.

Year 1 would initially focus on study organization and beginning work to study the physical aspects of the St. Clair – Detroit River system. It is expected that considerable effort will be required for analyzing historical data, detailed planning of the collection of new data and technical studies and selection and set-up of complex computer simulation models. In subsequent years, if the results from these studies show changes have occurred in the river and are continuing thus significantly impacting lake levels and flows, the work would include investigating remediation measures such as structural works in the river and non-structural measures.

Concurrent with beginning the St. Clair Study in Year 1 would be a review of the capabilities and limitations of Lake Superior outflow regulation considering climate variability and climate change, along with a preliminary review of the relationships between water levels and the interest groups. The results from these studies, along with the results from the St. Clair River study, will determine the level of detail in later years. Another essential task for Year 1 would be selection of the evaluation methodologies. Decisions on evaluation methods at an early stage are critical in guiding the direction of the scientific and economic studies thereby making the study focused and cost-effective. Detailed evaluation of the impacts on the various interest groups would be carried out in later years.

Throughout the entire study, public participation is a key element.

2.0 Physical Processes and Possible Ongoing Changes in the St. Clair River

2.1 Background

Following almost three decades of generally above average water levels, Lakes Michigan and Huron are now experiencing levels that are well below their long-term average for the 1918-2004 period-of-record. Although lower and more extensive periods of below average water levels have occurred in the past, questions have been raised about what may be the driving forces behind today's lower levels.

Such interest is not new to the waters of Lakes Michigan and Huron. In 1927, Horton and Grunsky published their major work on evaluating what they established to be the