



# Great Lakes Update

## Lake Superior Outflow Regulation

The natural outflow from Lake Superior is through the St. Marys River into Lake Huron (Figure 1). In the vicinity of the cities of Sault Ste. Marie, Michigan and Ontario the river drops nearly twenty feet in less than a mile. This reach of the river is known as the St. Marys Rapids. Although the rapids represent a hindrance to navigation, the twenty foot drop also represents a tremendous source of potential energy, which can be turned into renewable electricity.



**Figure 1: The St. Marys River near Sault Ste. Marie, Michigan and Ontario**

In the last 200 plus years, the St. Marys River has undergone many physical changes intended to harness its energy and to allow for safe passage of all types of vessels, including large freighters. A combination of these changes made it possible to control the flow in the river and thus the outflow from Lake Superior.

### Changes in the River

The natural flow of the St. Marys River was first disturbed by man in 1797 when the Northwest Fur Company built a thirty-seven foot long lock in one of the small natural canals on the Canadian side of the rapids. The first use of water to produce mechanical power began in 1822 when a raceway and sawmill were built by the U.S. Army at Sault Ste. Marie, Michigan.

The International Railroad Bridge, built in 1887, was the first modification in the river to significantly affect the flow of water in the river. The piers placed in the river to support the bridge deck restricted a critical section of the river, essentially reducing the flow. Additional construction of larger navigation locks and the development of hydroelectric power plants also altered the outflow capacity of the river.

To adjust for the changes in channel capacity, work on a sixteen gate dam began in 1901. Completed in 1921, the Compensating Works allows complete control of Lake Superior's outflow. The almost 1,000 foot long structure spans the international boundary (Figure 2). Gates one through eight are owned by Brookfield Renewable Power of Canada, with gates nine through sixteen owned by the U.S. Government.

In response to fishery interests, remedial works were placed in the rapids along the Canadian shore to enhance and protect the sport fishery in

the river. The Fishery Remedial Works, built in 1985, include a 2,800 foot long dike designed to retain a flow of water approximately equal to the natural conditions existing prior to any structure. Water is provided to the remedial works through the first gate on the Canadian side of the Compensating Works.



**Figure 2: The Compensating Works, Railroad Bridge, International Bridge and the Fishery Remedial Works**

Today, water from Lake Superior passes through a number of structures adjacent to the St. Marys Rapids. Hydroelectric power plants on both sides of the international boundary produce electricity to benefit the region. Navigation locks allow safe passage of both commercial and recreational vessels between Lake Huron and Lake Superior.

### **Regulation History**

The outflow from Lake Superior was first subject to some degree of artificial control as a result of the Rivers and Harbors Act of 1902. This act required the U.S. Secretary of War to approve operation of the early U.S. power canal diversions. The approval included restrictions on power diversions when the level of Lake Superior rose or fell outside of specified limits.

The International Boundary Waters Treaty of 1909 placed jurisdiction of Lake Superior Regulation in the hands of the International Joint Commission (IJC). The IJC's original Order of

Approval dated May 26 and 27, 1914, set the conditions for the control and operation of the structures in the St. Marys River. The Order states that the works be operated so as to maintain the level of Lake Superior as near as possible, within a specified range and in such manner as not to interfere with navigation. It also provided safeguards against extremely high water levels in the harbor below the works. Over the years, the Order has been amended several times to keep up with changing physical changes of the system and to reflect changing philosophies on outflow regulation.

The original Order also calls for a plan of regulation to determine the outflow from Lake Superior consistent with certain conditions and criteria. Since 1916, seven different plans have been used. The plans used up until 1973 determined outflows based only on the water levels of Lake Superior and the St. Marys River and certain maximum and minimum flow limits. With record high water levels occurring in 1973, an experimental regulation plan was introduced. This plan, known as SO-901, incorporated the concept of trying to balance the levels of Lake Superior and Lake Michigan-Huron. Plan SO-901 was used until 1979.

The philosophy of systemic regulation was incorporated when the Order of Approval was amended on October 3, 1979. At that time a new regulation plan was initiated, Plan 1977. Plan 1977 used many of the concepts of Plan SO-901, and added an outflow forecast to smooth the operation of the plan.

1990 saw another revision to the regulation plan. Changes were not dramatic, but were made to bring the plan up to date and to improve its operational efficiency. The revised plan, Plan 1977-A is the current plan used to regulate the outflow of Lake Superior. Plan 1977-A, like its predecessor, is designed to meet the conditions and criteria set forth in the Order of Approval,

while operating within certain restrictions of the existing structures and the river system.

It should be noted that during periods of extreme high or low levels on the Great Lakes, the IJC has occasionally applied its discretionary authority and has set outflows which deviate from the prescribed regulation plan.

**Regulation Conditions, Criteria and Limits**

The original Order of Approval was amended by a Supplemental Order dated October 3, 1979. The amendment sets the following conditions for regulating the outflow from Lake Superior.

“...maintain the monthly mean level of Lake Superior as nearly as may be within its recorded range of stage below elevation [603.22 feet (IGLD 1985)]; provide no greater probability of exceeding elevation [603.22 feet] that would have occurred using the 1955 Modified Rule of 1949; and ... maintain the levels of Lakes Superior and Michigan-Huron at the same relative position within their recorded ranges of stage and with respect to their mean monthly levels, ... in such a manner as not to interfere with navigation.”

In addition to the conditions, the Order states that the operations of the control structures shall be in accordance with a plan of regulation consistent with these criteria:

- (a) Maintain the level of Lake Superior between 603.2 and 599.6 feet (IGLD 1985) when tested with water supplies of the past (1900 – 1976)
- (b) Maintain the water level below the locks at or below 583.8 ft (IGLD 1985), when outflows are greater than those that would have occurred under the discharge conditions prior to 1887

- (c) When Lake Superior’s level is below 601.7 feet (IGLD 1985), maintain the outflow at or below those that would have occurred under the discharge conditions prior to 1887

The criteria only address conditions on Lake Superior and on the St. Marys River immediately below the rapids. No limits or requirements are stipulated for levels on Lake Michigan-Huron.

Plan 1977-A takes into account certain outflow limitations not specified in the Order of Approval. These limitations reflect the realities of the physical system and the local interests on the St. Marys River. These limits are:

- Maximum Lake Superior outflow is limited to the capacity of the 16-gate Compensating Works, plus 82,000 cfs through the power plants and locks.
- Maximum winter outflow is 85,000 cfs
- Minimum outflow for all months is 55,000 cfs
- Maximum change in outflow from month to month is +/- 30,000 cfs

**Balancing the Lakes**

Plan 1977-A’s central theme is the relationship between the water levels of Lakes Superior and Michigan-Huron. The relationship takes into consideration the lakes’ historic range of levels and differences in their size. The outflow is determined based on the relationship.

The fundamental goal of the balancing relationship is to make the water stored in the two lakes (represented by water level) proportionally the same. If the the level of Lake Superior at the beginning of the month is proportionally greater than that of Lake Michigan-Huron, the

relationship will call for a Lake Superior outflow greater than average. Conversely, if the beginning of month water level of Lake Michigan-Huron is relatively higher, then the resulting outflow would be below average.

### **Distribution of Flow**

The releases from Lake Superior are determined near the beginning of each month and must fulfill the requirements of the Order of Approval. The outflow allocation must adhere to the following order of priority, 1) Navigation, 2) Fisheries and 3) Hydropower

The navigation requirements relate to the water needed to operate the navigation locks. To meet the requirements of the fishery, a minimum of one half gate open is maintained in the Compensating Works to maintain flow in the main section of the rapids. 530 cfs of flow is also released through Gate No. 1 of the Compensating works, providing water to the Fishery Remedial Works. Remaining water is used by the hydropower companies up to the capacity of the plants. Any remaining water is passed through the Compensating Works by opening more gates up to the maximum of sixteen.

Water is allocated equally for hydropower generation on each side of the border. On the U.S. side the needs of the U.S. Government power plant are met first. This plant produces the energy needed to operate the locks. Any surplus is sold to the local utility. The Cloverland Electric Cooperative is allocated the remaining share of water. On the Canadian side, Brookfield Renewable Power is the sole user.

### **International Lake Superior Board of Control**

The 1914 Order of Approval established the International Lake Superior Board of Control, which oversees the maintenance and operation of the Compensating Works, power canals and other

structures on the St. Marys River to meet Lake Superior outflow guidelines outlined in the Order. The Board has two members, one each from the United States and Canada. The U.S. Army Corps of Engineers and Environment Canada provide technical support to the Board.

More information on the Lake Superior Board of Control can be found at:

<http://www.lre.usace.army.mil/IJC/Superior/index.shtml>

### **Future Regulation**

The IJC's International Upper Great Lakes Study (IUGLS) is approaching the end of the fourth of its five years. As part of its mission, the IUGLS is looking at potential new regulation plans for Lake Superior water levels, as well as the impacts on Lakes Michigan-Huron, St. Clair, and Erie. This work is being done in consultation with a number of broad interest groups, including commercial navigation, hydropower, ecosystems, recreational boating, coastal zone interests, and municipal and industrial uses.

Future regulation plans may also encompass some form of adaptive management, which would shorten the time between iterations of new or altered regulation plans in order to keep up with changing basin conditions. Public meetings are expected to be held in the summer of 2011 around the Great Lakes to describe study progress and draft regulation plan alternatives. Further information on the study is available at <http://www.iugls.org/>.