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US Army Corps of Engineers
Detroit District

Great Lakes Update

2010 Annual Summary

While 2010 saw an increase from 2009 of traffic and movement of cargo on the Great Lakes, levels of Lake Superior and Lake Michigan-Huron remained below their historical averages during the year continuing the trend of the last decade. Lake Superior remains in its longest stretch of below average levels, while Lake Michigan-Huron continues its second longest stretch. Only the period from 1930 to 1942 was a longer stretch of below average water levels on Lake Michigan-Huron. Both lakes began 2010 higher than their 2009 water levels, but dry conditions in the spring allowed levels to fall lower than the previous year.

Hydrology

Figure 1 shows the snow water equivalent (SWE) across the Lake Superior basin during mid March. The National Weather Service conducts snow surveys using low flying aircraft over the northern Great Lakes. The amount of water contained in the snowpack can vary throughout the year and makes up a significant part of the seasonal rise of Lake Superior. The SWE shown in Figure 1 is 75% of average. Rainfall during the spring is also a large component of the seasonal rises of Lake Superior and Lake Michigan-Huron. The spring of 2010 was very dry across both basins. Figure 2 shows the March, April and May total precipitation compared to average.

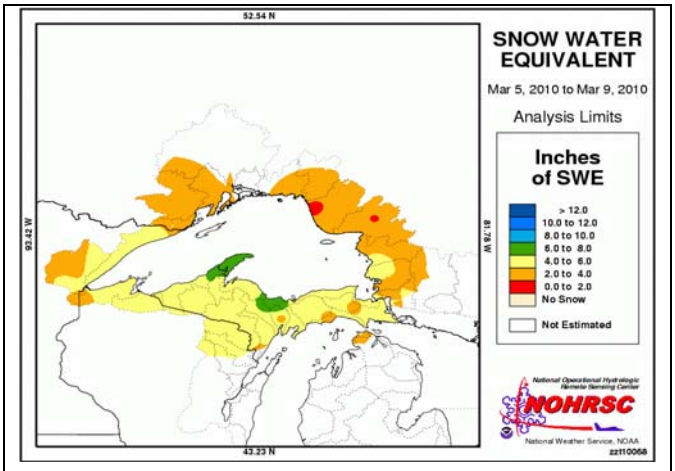

Figure 1: 2010 Snow Water Equivalent

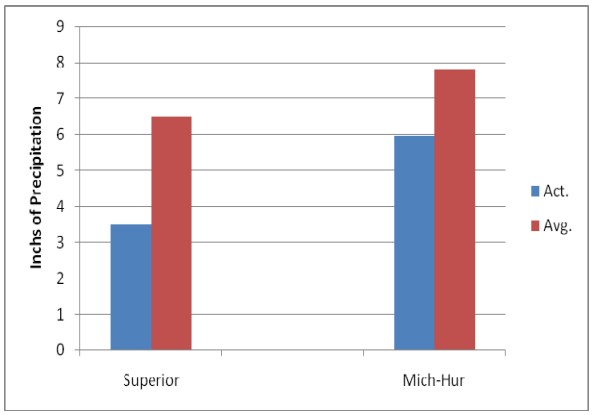

Figure 2: Spring 2010 Precipitation

The lower than average snow water equivalent and spring precipitation combined, led to smaller than average seasonal rises on lakes Superior and Michigan-Huron. Lake Superior's rise was 6 inches, while Lake Michigan-Huron rose 7 inches. On average the lakes both rise 12 inches during the spring and summer

Lakes St Clair, Erie and Ontario were also below their levels of last year throughout most of 2010. Lake St. Clair and Lake Erie were also below average for the entire year. Lake Ontario reached average conditions in late summer.

Ice cover on the Great Lakes was generally lower during the winter of 2009-2010 than the winter of 2008-2009. Figures 3 and 4 show ice thickness near the beginning of March, which is on average the time of peak ice cover on the lakes. The winter of 2008-2009 was much colder than last winter, and allowed the thick ice cover to form. A solid ice cover will limit evaporation from the lakes.

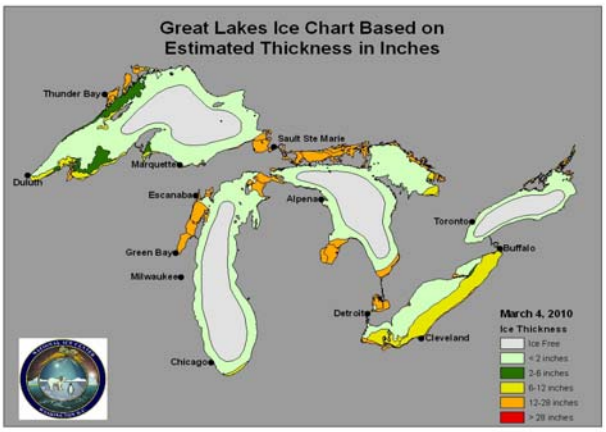

Figure 3: Great Lakes Ice Cover – March 4, 2010

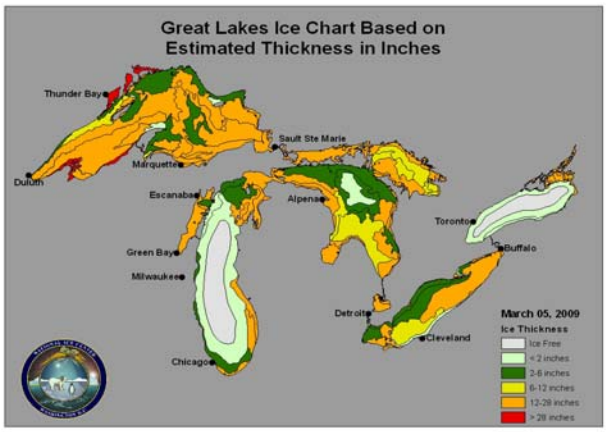

Figure 4: Great Lakes Ice Cover – March 5, 2009

Ice Jams

Significant ice jams formed on the St. Clair River in both February and March, as large amounts of ice were forced into the river from southern Lake Huron. The February event caused the water level of Lake St. Clair to drop about a foot and a half. Navigation impacts during the February event were small as most carriers were in winter lay-up. The March event had a significant impact on navigation, causing many delays as both the U.S. and Canadian Coast Guards escorted vessels traversing the St. Clair River.

Forecast

The latest *Monthly Bulletin of Lake Levels for the Great Lakes* continues to show below average water level conditions on Lake Superior and Lake Michigan-Huron through June of 2011. Lake levels in January through June of 2011 are also expected to remain below conditions of 2010. However, even with very dry conditions during the rest of the winter and early spring, water levels on Lake Superior and Lake Michigan-Huron are expected to remain above record lows.

Water levels on Lake St. Clair, Lake Erie and Lake Ontario are also forecasted to remain below average through June of 2011. With wetter than average conditions this winter, water levels on Lakes St. Clair Erie and Lake Ontario may near their respective long-term average levels.

Water Levels

The "*Monthly Bulletin of Lake Levels for the Great Lakes*" displays water levels on the Great Lakes for the years 2009 and 2010. The following discussion is based on monthly mean levels.

Lake Superior levels started 2010 at 601.08 feet, about 5 inches below its January long-term average (LTA). Levels peaked in September at 601.11 feet, about 13 inches below its September LTA. Lake Superior normally peaks in August or September. Lake Superior levels ended the year at 600.66 feet, about 13 inches below its December LTA.

Lakes Michigan-Huron began the year at 577.92 feet, about 6 inches below its January LTA. The lakes peaked at their normal time in July at 578.28 feet, about 13 inches below the July LTA. The year ended with the level at 577.00, about 19 inches below the December LTA.

Lake St. Clair levels started the year at 573.23 feet, about 5 inches below its January LTA. Levels peaked in July, at 574.41 feet, about 5 inches below the July LTA. Levels ended the year at 573.23 feet, about 7 inches below the December LTA.

Lake Erie began 2010 at 570.83 feet, slightly above its January LTA. Levels peaked in June, at 571.92 feet, slightly above its June LTA. Levels ended the year at 570.41 feet, about 5 inches lower than the December LTA.

Lake Ontario started the year at 244.46 feet, about 2 inches lower than its January LTA. Levels peaked in July at 245.96 feet, about 1/2 inch below the July LTA. The year ended with the level at 244.52 feet, which is near the December LTA.

Lake Superior Regulation

During 2010 Lake Superior water levels ranged from 5 to 14 inches below LTA. Outflows continued to be set by the International Lake Superior Board of Control (Board) using Regulation Plan 1977-A. The Board is a bi-national body that reports to the International Joint Commission (IJC) on boundary water management issues including including Lake Superior outflows. Flow changes resulting from monthly Lake Superior regulation are accomplished by varying the amount of water allocated to hydropower production and, when necessary, opening or closing gates in the Compensating Works at the head of the St. Marys Rapids.

Overall, water supplies to Lake Superior were below average for 2010. Precipitation in June, August, September and November was above average, while the remainder of the months received below average precipitation. Preliminary 2010 Lake Superior basin precipitation was 26.80 inches, or 3.65 inches below the annual average of 30.45 inches.

A one-half gate open setting was maintained during 2010 in the Compensating Works in order to maintain minimum flow requirements in the St. Marys Rapids and to support spawning in the fishery. To facilitate the refurbishment of Canadian Gates No. 1 and No. 2, Gates 7, 8, 9 and 10 were closed and Gates 11, 12, 13 and 14 were opened on June 15 to 8 inches each in order to maintain the one-half gate open equivalent. The gates were returned to the original setting on November 30, 2010.

Flow variations due to peaking and ponding operations by the hydropower plants at Sault Ste. Marie, Michigan and Ontario cause St. Marys River water levels downstream from the plants to fluctuate. When Lake Superior levels and outflows are below average, these fluctuations can be of concern to commercial navigation. When water levels at the U.S. Slip Gauge fall below 577.72 feet (IGLD 1985) ponding by the hydropower entities is suspended on weekends and holidays with an 8-hour window of peak flow required for each weekend and holiday day. Water levels were high enough that starting with the March 25, 2010 opening of the Soo Locks ponding was allowed on weekends and holidays by the Board for the entire 2010 shipping season.

Outflows were 76% of average in 2010, ranging from a low of 54.4 tcfs in September and October to a high of 70.6 tcfs in January. Figure 3 compares the monthly Lake Superior outflows in 2010 to long–term average flows for the 1900-2008 period of record.

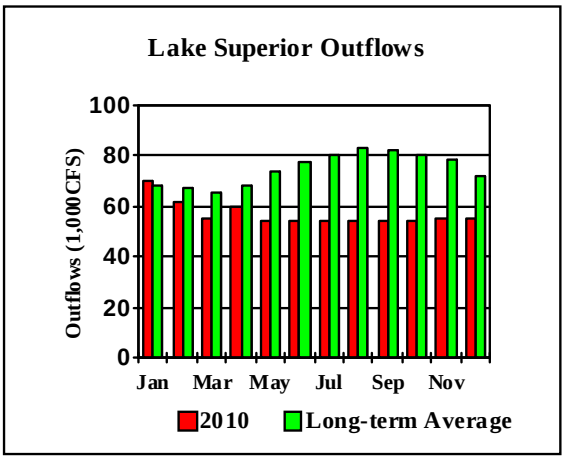

Figure 3: Lake Superior Outflows

Lake Ontario Regulation

At the end of November 2009 Lake Ontario's level was at 249.32 feet, 2.4 inches below its LTA. Accumulated outflow deviations from Plan 1958-D for 2009 were equivalent to 0.08 inches of water stored on the lake relative to Plan 1958-D. The Board decided to continue the current strategy and follow the outflows prescribed by the regulation plan with flow adjustments consistent with the winter operations guidance of the "Operational Guides for Plan 1958-D" and past practice.

During the first half of December 2009 outflows were as specified by Plan 1958-D, but varied later in the month to moderate a decline in downstream levels and to assist in formation of a smooth ice cover in the Beauharnois Canal. As part of normal operations, the Board reduces the Lake Ontario outflow to promote the formation of a smooth, stable ice cover on the St. Lawrence River at the beginning of the ice season. Flow reductions are typically done during each winter, usually after the closing of the

Seaway navigation season. A rough ice cover increases water flow resistance and the resultant weak ice cover increases the potential for ice jams and outflow regulation problems during the winter. Ice formation in the Beauharnois Canal near Montreal began on December 23, 2009. A warm spell soon melted some ice, but ice cover reformed on December 29th.

The outflows also varied from those specified by Plan 1958-D in the last week of December 2009 due to the calculation of the "I" limit. This limit in Plan 1958-D can only be determined after the fact, and an estimate must be used in determining the actual flow. The "I" limit of Plan 1958-D limits Lake Ontario outflows such that the flow from Lake St Louis is no more than 280,000 cfs. This limit was incorporated into Plan 1958-D to assist the ice formation process on Lake St. Louis for a planned (but not constructed) power plant at the outlet of that lake.

The water supply to Lake Ontario was above average in December. By the end of the month the level had risen 0.8 inches to 244.39 feet, but was 2.4 inches below its LTA. The lake usually rises 0.4 inches in December. By the end of the month outflow deviations were equivalent to about 0.4 inches of water stored on Lake Ontario. Ice cover upstream of the Moses-Saunders Dam began developing on January 10th, reaching upstream to Morrisburg.

On January 13th the Board reviewed conditions in the Lake Ontario-St. Lawrence river system and decided to continue releasing outflows in accordance with Plan 1958-D as much as possible. Adjustments to assist in stable ice cover formation, avoidance of extreme downstream water levels, or to meet critical hydropower and navigation needs would be made as the Board deemed necessary. Any water retained on the lake would be released later as the opportunity arose. A mid-month mild spell loosened ice in the Beauharnois Canal causing increased stress on the ice booms. Flow was reduced to prevent the booms from breaking. Cold weather the last few days of January allowed for the ice cover to reform. During January, in response to melting snow Lake Ontario's water level rose 2.8 inches to 244.65 feet, 0.8 inches below its LTA and 8.7 inches below its year ago level.

Flow during early February was below Plan to assist with ice formation in the International Section of the Seaway, but was increased on February 5th due to concern about ice bridging at Iroquois. By February 10th deviations due to under-discharges for ice management were equivalent to 1.5 inches of water on the lake relative to the Plan. The Board agreed to vary outflows as needed to facilitate ice management and to discharge any water stored on the lake as opportunities arose over the February/March time period.

Flows less than those specified by Plan 1958-D were approved to avoid flooding on Lake St. Louis or for other unforeseen critical restrictions. Over-discharges would be permitted as necessary to allow incoming vessels to reach the Port of Montreal, or to meet critical hydropower needs. By March 12th all water stored on Lake Ontario had been released through outflows above the plan-specified amounts and the lake was at its plan-specified level. All ice booms in the International Section were removed by March 16th. The Montreal-lake Ontario section of the Seaway opened March 25th.

By the end of March, Lake Ontario had risen 4.7 inches to 244.85 feet, 5.5 inches below its LTA and 13.8 inches below its year ago level. On average the lake rises 5.9 inches during March. The Ottawa River freshet was lower than average, reducing the need to lower Lake Ontario outflows to prevent downstream flooding. Water supplies in April were very dry and levels only rose slightly during the month. At its April 20th meeting the Board decided to continue with plan-specified outflows as much as possible. During April, Lake Ontario rose only 0.4 inches to 244.91 feet. On average the lake rises 7.9 inches in April. The last time the lake was this low in April was in 1999 when the level was 245.01 feet.

In May, June and July the Board continued with its April strategy to release plan-specified flows but permitting over-discharges as necessary to maintain Lake St. Louis levels above 67.9 feet until May 27th and above 67.6 feet thereafter to facilitate vessel navigation. Should any over-discharges be required, flows less than those specified by Plan 1958-D would be released as opportunities arose, to offset the over-discharges, with the provision that outflows below plan flow not be made unless the Lake St. Louis level was above 68.2 feet. Adjustments would be made to avoid extreme downstream levels, or to meet critical hydropower and navigation needs.

In June a record 6.3 inches of precipitation fell on the Lake Ontario basin and 4.9 inches of precipitation fell on the Lake Erie basin. July followed with 3.5 inches of precipitation on the Lake Ontario basin and 4.5 inches on the Lake Erie basin. By July 25th Lake Ontario had risen to its seasonal peak of 246.09 feet, 14.2 inches below the upper water level criterion. By the end of July Lake Ontario's level was 246.03 feet, 1.2 inches above its LTA and 4.3 inches below its year ago level.

By the end of July Lake Ontario was at its LTA, while the rest of the Great Lakes were lower than their year ago and LTA levels. As per Board strategy, Lake Ontario outflows were below Plan 1958-D flows for the first thirteen days in August in order to restore water to Lake Ontario. By August 13th, all water previously removed from Lake Ontario resulting from flow increases earlier in May and June to aid navigation, was restored through outflows less than plan-specified amounts, and Lake Ontario was at its plan-specified level. Lake Ontario outflows were as specified by Plan 1958-D for the remainder of August. By the end of August Lake Ontario had fallen to 245.47 ft, 0.4 inches above average, 4.7 inches below its year ago level, and had fallen 6.3 inches compared to the beginning of the month. On average, Lake Ontario's level falls 5.9 inches during August. No net accumulated outflow deviations from Plan 1958-D occurred in August.

During September, October and November, Lake Ontario outflows were as specified by Plan 1958-D. Following heavy rainfall at the end of September levels in the St. Lawrence River near Montreal rose sharply, reaching near record highs. By the end of November Lake Ontario's level was at 244.35 feet, 2 inches below its LTA. Since August the lake had fallen about 13.4 inches.

On December 8th, the Board decided to continue to release Plan 1958-D specified outflows. However, consistent with the winter operations guidance of the "Operational Guides for Plan 1958-D" and past practice, flow variations either below or above those of Plan 1958-D could be made as necessary to form and maintain a stable ice cover in the river in late December and/or January.

At the end of December flows greater than as specified by Plan 1958-D were released in order to moderate an expected decline in levels in the Montreal area and to maintain efficient water use at the hydropower plants.

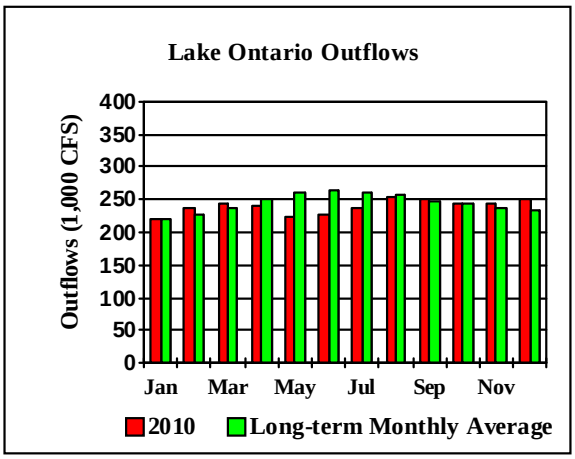

Figure 4: Lake Ontario Outflows

Figure 4 above compares 2010 Lake Ontario outflows with period of record (1900-1999) monthly LTA outflows. Further information on ISLRBC activities can be found at:

http://www.ijc.org/conseil_board/islrbc/en/main_accueil.htm.

Public Concerns

Lower than average water levels and their causes were a continuing concern throughout 2010. Lakes Superior and Michigan-Huron water levels were lower than in 2009 causing some concern to shipping. The economy showed some improvement as evidenced by the increased volume of goods being transported on the lakes. Potential impacts due to climate change and variability, commercial bottling of water, regulatory practices, concern about erosion in the St. Clair River and control of invasive species continued to draw public attention.

International Upper Great Lakes Study

The International Upper Great Lakes Study (IUGLS) began in 2007 to investigate the possible factors responsible for recent declining upper Great Lakes levels (Phase 1) and to formulate alternative plans for Lake Superior outflow regulation with the goal of providing benefits to existing and emerging interests (Phase 2). On December 15, 2009, the final Phase 1 Report was released describing the investigations by dozens of scientists from U.S. and Canadian government and non-government agencies and universities around the Great Lakes. They found that over the last four decades, the conveyance of the St. Clair River has changed due to man-made factors. However, they also determined that the declining lake levels were due primarily to climatic variability and glacial isostatic rebound.

During 2010 emphasis has shifted to Phase 2. This phase is being conducted by scientists within six technical work groups (TWG) - coastal processes, commercial navigation, hydropower, municipal & industrial water uses, recreational boating, and ecosystems, which are selecting performance indicators to aid in the formulation of alternative plans. There are also four integration TWGs - plan formulation and evaluation, hydroclimatic, adaptive management and information management.

The performance indicators used to devise improved Lake Superior regulation plans are based on:

- for coastal processes – flooding, erosion, low water impacts and shore protection structure ownership costs;
- for commercial navigation – Great Lakes transportation costs;
- for hydropower – maximizing power production and the value of power, flow stability and ice formation;
- for water uses – operating costs of facilities impacted by water levels and pumping costs;
- for recreational boating – marina slips, boat launches and tourism; and,
- for ecosystems – indicators related to various species at selected sites around the Great Lakes.

These performance indicators will be used by the Plan Formulation and Evaluation TWG in a shared vision planning framework to arrive at alternative plans. Interest input from "circles of influence" forums will also be considered in plan development.

Recognizing that improvements to the existing plan for Lake Superior regulation, Plan 1977-A, will be small considering a historic database and that in the upper Great Lakes, the outflow control is at the outlet of the upper most lake in the system, the Study Board has developed an approach that considers the acceptable range of water levels for a given interest or sector and how those water level ranges may change in response to future climate variability. This approach uses coping zones to determine how acceptable a particular range is to an interest. Zone A includes water levels within which an interest can thrive, Zone B represents a range within which an interest will begin to experience difficulties, and Zone C levels are those that would result in long-term catastrophic impacts which may result in, for example, the elimination of a ecological species or major disruption of an industry.

The Study Board has also considered the uncertainties associated with future hydroclimatic conditions and climate variability. The Hydroclimatic TWG was a key group during the first phase of the Study and will be essential in Phase 2 as various hydrologic scenarios are developed to test alternative regulation plan performance. Scenarios will be based on historic supplies, stochastically-generated supplies (likely 50,000 years or more of possible supply sequences, allowing testing of plans under extended droughts and wet periods) and climate change possibilities from the work of the Intergovernmental Panel on Climate Change (IPCC). Regional climate models for both comparative analyses and the development of climate change scenarios will be utilized.

The coping zones and the hydrology that will be considered will help formulate an adaptive management strategy that could be implemented beyond the Study's completion date in March 2012. Investigations are underway to determine future monitoring of conditions and to identify Great Lakes agencies that could partner with the IJC to implement such strategies.

More information about the Study can be found on its Web Site at www.iugls.org.

Working Group develops potential approach for regulation of Lake Ontario and St. Lawrence River

During 2010, the Lake Ontario-St. Lawrence River Working Group identified and began to develop a potential new approach for managing the outflow of Lake Ontario through the Moses-Saunders dam. The approach would modify how levels and flows are currently managed in order to achieve environmental and other improvements for the overall benefit of the basin. Among other things, the approach could include: a new Order of Approval providing a framework for regulation; a new regulation plan for managing levels and flows; an adaptive management strategy to monitor and assess conditions and refine the plan as needed; revisions to the structure and operations of the control board; and beneficial management practices to enhance the overall benefits from this approach.

The current approach to regulating the Lake Ontario-St. Lawrence River system has been in place for more than 50 years. During that time, natural water supplies to the system have been higher and lower than the range of supplies the current regulation plan was designed to accommodate. Water use has changed and the technology available for regulating levels and flows has advanced. A built-in process for making adjustments in response to any significant impacts from climate change is also needed. Discussions by the Working Group have taken into account the five-year International Lake Ontario-St. Lawrence River Study, completed in 2006, and comments from stakeholders across the system.

The Working Group is an ad hoc group made up of senior representatives of the federal governments of Canada and the United States, the governments of Quebec, Ontario and New York, and the International Joint Commission (IJC). Its purpose is to provide advice to the IJC on the future regulation of water levels and flows in the Lake Ontario-St. Lawrence River system. The IJC will consider the Working Group's advice, and will seek public comment and the concurrence of the two federal governments on any proposal it makes to change the current approach to regulation.

The IJC approved the construction and operation of the Moses-Saunders Dam, located at Massena, New York and Cornwall, Ontario under the Boundary Waters Treaty of 1909. Regulation of the flow of water through the dam affects levels and flows on Lake Ontario and the St. Lawrence River downstream to Trois-Rivières, Quebec. The International Joint Commission prevents and resolves disputes between the United States and Canada under the treaty and pursues the common good of both countries as an independent and objective advisor to the two governments.

Meetings with the Public

The International Lake Superior Board of Control held its annual public meeting on June 9, 2010 at Sault College in Sault Ste. Marie, Ontario.

The International Niagara Board of Control met with the public on September 15, 2010 in Niagara Falls, New York.

The International St. Lawrence River Board of Control held two public teleconferences to inform the public on water level conditions and Board activities. The first public teleconference was hosted on March 16th from Rochester, New York and Montreal, Quebec, while the second was hosted on September 21st from Cornwall, Ontario and Oswego, New York.

More information on the above Boards of Control can be found at:

http://www.ijc.org/en/boards/boards_conseils.htm

Commercial Navigation

The Soo Locks opened the 2010-2011 shipping season on March 25, 2010 as scheduled and will close on January 15, 2011. The 2009 – 2010 shipping season saw a total of 53.35 million short tons (MST) pass through the locks down 32% from the 2008 – 2009 season's 78.47 MST.

Through November 2010, the estimated total tonnage passing through the Soo Locks at Sault Ste. Marie, MI was about 65.37 MST up 41.11% from the comparable 2009 tonnage of about 46.33 MST. U.S. and Canadian vessels carried 47.63 MST and 15.10 MST of cargo respectively, as compared to respective 2009 tonnages of 31.34 MST and 13.31 MST. Foreign flagged vessels carried about 2.65 MST, up from the 2009 tonnage of 1.67 MST.

An estimated total of 9,155 vessels had transited the locks through November as compared to 6,613 vessels the previous year. Cargo vessels totaled 3,875 compared to 2,641 in 2009. There were 2,411 U.S. flagged vessels, 1,161 Canadian flagged vessels and 303 foreign flagged vessels (ocean going or "salties"). Other vessels transiting the locks such as pleasure craft, tour boats, Coast Guard and scientific research vessels numbered 5,280. The U.S. Locks will close on January 15, 2011 and reopen on March 25, 2011.

Due to a mechanical failure the Canadian Lock at Sault Ste. Marie, Ontario was closed on October 15, 2009. It has remained closed throughout the 2010 shipping season to allow for repairs and upgrades to the site infrastructure. The Canadian Lock is expected to reopen in 2011.

Preliminary figures through November 2010 indicate the tonnage passing through the Lake Ontario-Montreal section of the St. Lawrence Seaway was up about 27.85% from 2009 at about 23.16 million metric tons (MMT). Vessel traffic was up about 8.04% from 2009 at 2,312 (combined lake and ocean) vessels.

Preliminary data on the type of cargo transiting the Seaway through November 2010 include iron ore up 87.82% to about 6.481 MMT; iron and steel up 40.03% to about 1.072 MMT; grain up 12.22% to about 7.686 MMT; coal up 24.53% to 0.854 MMT; general cargo up 45.88% to about 1.279 MMT; and petroleum products up 1.52% to about 1.118 MMT. For additional details on Seaway activities visit their website on the Internet at http://www.greatlakes-seaway.com/. The St. Lawrence Seaway Development Corporation provided this data.

New Lock

A new "Poe-sized" lock is proposed to replace the existing Davis and Sabin Locks at the Soo Locks complex at Sault Ste. Marie, MI. The purpose of this project is to provide for more efficient movement of waterborne commerce. The Water Resources Development Act of 2007 directs that construction of the new lock shall be at Federal expense. This authorization eliminates the need for the eight Great Lakes States to cost share in the project. In FY 2010 the two ongoing construction contracts, one for the cofferdam construction and one to deepen the downstream approach channel, were completed.

In FY 2011 design continues on the plans and specifications for the guide walls/upstream channel excavation and the lock chamber. Additional contracting will take place utilizing funds as provided without committing the Federal Government to future appropriations.

2010 Great Lakes Updates

2009 Annual Summary, Vol. No. 178, January 2010.

Ice Jams on the St. Clair River, Vol. No. 179, April 2010.

Low Snow = Low Levels, Vol. No. 180, July 2010.

Lake Superior Outflow Regulation, Vol. No. 181, October, 2010.

Past Great Lakes Update articles are available at: http://www.lre.usace.army.mil/greatlakes/hh/newsandinformation/pastupdatearticles/

General Notes

All elevations shown in this article are referenced to the IGLD 1985 datum. Information about the Great Lakes water levels, outflows, and weather is available at: http://www.lre.usace.army.mil/glhh