# International Niagara Board of Control

# One Hundred Twenty Second Semi-Annual Progress Report

# to the

# International Joint Commission

**Covering the Period September 20, 2013 through March 25, 2014**

# EXECUTIVE SUMMARY

The level of Lake Erie began the reporting period with a September mean level equal to its 1918–2012 period-of-record, long-term average level for the month. The level of Lake Erie was near average throughout the entire reporting period. February's mean water level was 5 cm (2 inches) below average. Inflow to Lake Erie from the Detroit River remained below average throughout the reporting period (Section 2).

The level of the Chippawa-Grass Island Pool (CGIP) is regulated under the International Niagara Board of Control's 1993 Directive. The Power Entities–Ontario Power Generation (OPG) and the New York Power Authority (NYPA)–were able to comply with the Board's Directive at all times during the reporting period with one exception due to high flow and ice conditions. On January 7, 2014, the daily range for the CGIP level, as measured at the Material Dock gauge, exceeded the daily allowable range of 0.46 m (1.5 feet). The range was 0.55 m (1.8 feet) (Section 3).

A Falls flow violation occurred during the evening of January 18, 2014. Prior to the occurrence of the flow violation, ice breaking efforts were underway to clear significant volumes of heavy ice in the U.S. Ice Escape Channel. Those activities, combined with the onset of anchor ice below the International Niagara Control Works caused a constriction to flow through the open channel. Heavy accumulation of ice below Niagara Falls in the Maid-of-the Mist Pool also contributed to the restriction in flow to the Ashland Avenue gauge. Despite responsive actions taken by staff of the Niagara River Control Centre, the flow over Niagara Falls was 44 $m^3/s$ (1,554 cfs) below the Treaty requirement of 1,416 $m^3/s$ (50,000 cfs) for the hour of 8:00 p.m. (Section 5).

Regularly scheduled measurements were made during the reporting period at the Cableway section in the lower Niagara River to verify the 2009 Ashland Avenue gauge rating of the outflow from the Maid-of-the-Mist Pool below the Falls. However, high flow in the Niagara River due to high wind conditions on Lake Erie prevented the measurements of the low flows as planned. The results of the flow measurements that were taken are being analyzed and plans to measure the low flows are being made (Section 8).

Installation of the Lake Erie-Niagara River Ice Boom began on December 14 and was completed on December 20, 2013. Ice began to form on Lake Erie during the first week in December–about one week earlier than average–and was above average for all but two weeks near the start of the ice season through to the end of the reporting period. The ice cover on the lake peaked during the first week of March at about 98%, compared to the average for that point in time of around 53%. The extent of cover had reduced to about 88% by the end of the reporting period. Considering the large quantity of ice still present on the eastern portion of Lake Erie and in the Maid-of-the-Mist Pool below Niagara Falls, the ice boom opening will be delayed beyond April 1. (Section 10).

As a result of a high wind event that occurred on January 6-8, 2014, ice floes overtopped the Lake Erie–Niagara River ice boom for a period of approximately 50 hours. This resulted in an ice jam occurring in the East Channel of the Niagara River, causing water levels to rise to the point where, at 8:45 a.m. on January 7, 2014, the NYPA flood warning notification plan was executed. Post-event analysis indicated that the ice boom and other infrastructure performed as designed. As such, no modifications or reconfigurations of the ice boom, or installation of new infrastructure, are warranted. Field crews of the U.S. Army Corps of Engineers found no evidence of post-event flood damages. Although a local roadway was flooded for less than half a day, the water level readings at gauges in the affected area indicated that the damage level thresholds for residential and commercial property were not exceeded during this event. The Board believes that adequate procedures are in place to manage the threat of ice jams (Section 10).

The Board will hold its annual meeting with the public in August or September 2014 in the Niagara Falls, NY area (Section 12).

**COVER:** View of the Niagara River at Niagara Falls on January 30, 2014 showing the ice cover above and below the Falls.
(Photo by Mr. David Stevenson, Environment Canada)

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## INTERNET SITES

International Joint Commission
www.ijc.org

International Niagara Board of Control
http://ijc.org/en_/inbc
http://ijc.org/fr_/inbc

Lake Erie-Niagara River Ice Boom
www.iceboom.nypa.gov

# INTERNATIONAL NIAGARA BOARD OF CONTROL

Cincinnati, Ohio
Burlington, Ontario

March 25, 2014

International Joint Commission
Washington, D.C.
Ottawa, Ontario

Commissioners:

## 1. GENERAL

The International Niagara Board of Control (Board) was established by the International Joint Commission (IJC) in 1953. The Board provides advice to the IJC on matters related to the IJC's responsibilities for water levels and flows in the Niagara River. The Board's main duties are to ensure the operation of the Chippawa-Grass Island Pool (CGIP) upstream of Niagara Falls within the limits of its Directive and oversight of the operation of the Lake Erie-Niagara River Ice Boom at the outlet of Lake Erie. The Board also collaborates with the International Niagara Committee (INC), a body created by the 1950 Niagara Treaty to determine the amount of water available for Niagara Falls and hydroelectric power generation.

The Board is required to submit written reports to the IJC at its semi-annual meetings in April and October of each year. In accordance with this requirement, the Board submits its One Hundred Twenty Second Semi-Annual Progress Report, covering the reporting period September 20, 2013 to March 25, 2014.

All elevations in this report are referenced to the International Great Lakes Datum 1985 (IGLD 1985). Values provided are expressed in metric units, with approximate customary units (in parentheses) for information purposes only. The monthly Lake Erie water levels are based on a network of four gauges to better represent the average level of the lake.

## 2. BASIN CONDITIONS

The level of Lake Erie was close to average throughout the reporting period. It began the reporting period with a September mean level equal to its 1918–2012 period-of-record, long-term average level for the month. A near-average seasonal decline was experienced during the fall and early winter, with the lake falling by only 4 cm (1.6 inches) more than average on a monthly basis from September to December. The lake's level increased by 6 cm (2.4 inches) from December to January, compared to its average December to January increase of 1 cm (0.4 inches), but fell by 6 cm (2.4 inches) from January to February instead of remaining stable as it has on average over the period of record. The February mean water level was 5 cm (2 inches) below average. The lake's water level is forecasted to begin its seasonal rise during March. Recorded monthly water levels for the period September 2013 through February 2014 are shown in Table 1 and depicted graphically in Figure 1. The following paragraphs provide more detail on the main factors that led to the water level changes observed on Lake Erie during the reporting period.

Lake Erie receives water from both its local drainage basin and from the upstream lakes. The water supplied to a lake from its local drainage basin is referred to as its net basin supply (NBS). A lake's NBS is the sum of the amount of water the lake receives from precipitation falling directly on its surface and runoff (including snow melt) from its surrounding land area, minus the amount of water that evaporates from its surface. The sum of Lake Erie's NBS and its inflow from Lake Michigan–Huron via the St. Clair-Detroit Rivers system is its net total supply, or NTS.

Precipitation is a major contributor to NBS, both directly on the lake and through runoff due to rain and snowmelt. Recent precipitation data and departures from the long-term averages are shown in Table 2 and depicted graphically in Figure 2. Precipitation on the Lake Erie basin was below average during the months of September, November, January and February and above average during October and December. Much of December's precipitation fell in the form of rain on December 20-22, while January and February's

precipitation came in the form of snow. During the period September 2013 through February 2014, the basin received 42.6 cm (16.8 inches) of precipitation. This is approximately 4% above average for the period.

The recent NBS to Lake Erie is shown relative to average on a monthly basis in Figure 3. A negative NBS value indicates that more water left the lake during the month due to evaporation than entered it through precipitation and runoff. On Lake Erie, this typically happens from August through November. For the remainder of the year, combined precipitation and runoff are usually greater than the water lost to evaporation. During the reporting period, the lake's NBS was below average in September and above average from October to February. The above-average NBS in December and January was the result of precipitation that fell in the form of rain late in the month and subsequent runoff.

Inflow via the Detroit River is the major portion of Lake Erie's NTS, and is greatly influenced by the level of Lake Michigan–Huron. The level of Lake Michigan–Huron continued to be below average during the reporting period. The lake's outflow was also significantly reduced during January and February due to the impact of ice in the St. Clair and Detroit rivers. As a result, inflow to Lake Erie via the Detroit River was about 8% below the long-term average for the six-month period September 2013 through February 2014. However, it should be noted that the multiple methods used to estimate discharge in the both the St. Clair River and Detroit River all estimated the discharge of the St. Clair River to be greater than that of the Detroit River during January and nearly the same in February. This appears to have occurred without significant rise to Lake St. Clair, which suggests that the calculated discharge of the Detroit River may be questionable using the established methods during periods of significant ice. The monthly mean water level on Lake Michigan–Huron and the monthly mean flow in the Detroit River are provided in Figures 4 and 5, respectively.

The inflow from upstream combined with Lake Erie's NBS, resulted in above-average NTS in October and December and below-average NTS for the months of September, November, January and February. Of note, is that the lake's above-average NBS during

January combined with the below-average inflow from the Detroit River resulted in below, but near-average NTS for the month. Overall, Lake Erie's NTS was about 3% below average for September 2013 through February 2014. The recent NTS to Lake Erie is depicted relative to average in Figure 6.

Lake Erie discharges water to Lake Ontario through the Niagara River and the Welland Canal. The portion of the Lake Erie outflow that is diverted through the Welland Canal is relatively small–about 4 to 5% of the total Lake Erie outflow–and is used for navigation purposes through the canal and for the generation of electricity at Ontario Power Generations DeCew Falls hydroelectric plants. The major portion of the outflow from Lake Erie occurs through the Niagara River and depends on the level of the lake at its outlet. Generally speaking, above-average lake levels result in above-average outflow and below-average lake levels lead to below-average outflow. Flow is also influenced by ice in the river during the winter and aquatic plant growth in the river in the summer that can reduce the flow, and by seasonal trends in prevailing winds that on-average raise levels at the eastern end of the lake relative to levels at the western end and the lake's average level. Recent monthly outflow via the Niagara River is graphically depicted in Figure 7. The lake's near-average water level conditions from September 2013 through February 2014 resulted in Niagara River flow being close to average during those months.

The combination of Lake Erie's NTS and outflow resulted in the water level changes experienced on the lake over the reporting period. The lake's near-average NTS and outflow during September, October and November resulted in the lake's near-average decline during these months. The rain that fell in late December and the resultant runoff resulted in the lake's above-average NTS during December and a significant increase in its water level. Although the increase came too late in the month to have significant impact on the lake's December monthly mean level, it is reflected in its January level and larger-than-average December to January increase.

While it is not possible to predict with accuracy the supplies to the lakes for the coming months, using historical supplies and the current levels of the lakes, it is possible to make some estimate of water levels a few months out. The six-month water level forecast prepared at the beginning of March by the U.S. Army Corps of Engineers (USACE) and Environment Canada (EC) indicates that the level of Lake Erie is expected to remain near, but more likely below average, throughout the spring and summer, unless very high water supply conditions are experienced.

**TABLE 1 – MONTHLY AVERAGE LAKE ERIE WATER LEVELS**

(Based on a network of 4 water level gauges)
International Great Lakes Datum (1985)

| | Metres | | | Feet | | |
|---|---|---|---|---|---|---|
| Month | Recorded* 2013-2014 | Average 1918-2012 | Departure | Recorded* 2013-2014 | Average 1918-2012 | Departure |
| September | 174.16 | 174.16 | 0.00 | 571.39 | 571.39 | 0.00 |
| October | 174.07 | 174.06 | +0.01 | 571.10 | 571.06 | +0.04 |
| November | 173.97 | 173.99 | -0.02 | 570.77 | 570.83 | -0.06 |
| December | 173.94 | 173.98 | -0.04 | 570.67 | 570.80 | -0.13 |
| January | 174.00 | 173.99 | +0.01 | 570.87 | 570.83 | +0.04 |
| February | 173.94 | 173.99 | -0.05 | 570.67 | 570.83 | -0.16 |

* Provisional

**TABLE 2 – MONTHLY AVERAGE PRECIPITATION ON THE LAKE ERIE BASIN**

| | Centimetres | | | Inches | | | |
|---|---|---|---|---|---|---|---|
| Month | Recorded* 2013-2014 | Average 1900-2010 | Departure | Recorded* 2013-2014 | Average 1900-2010 | Departure | Departure (in percent) |
| September | 7.49 | 8.10 | -0.61 | 2.95 | 3.19 | -0.24 | -8 |
| October | 10.74 | 7.07 | 3.67 | 4.23 | 2.78 | 1.45 | 52 |
| November | 4.55 | 7.27 | -2.72 | 1.79 | 2.86 | -1.07 | -37 |
| December | 8.74 | 6.77 | 1.97 | 3.44 | 2.66 | 0.78 | 29 |
| January | 6.27 | 6.33 | -0.06 | 2.47 | 2.49 | -0.02 | -1 |
| February | 4.85 | 5.31 | -0.46 | 1.91 | 2.09 | -0.18 | -9 |

* Provisional

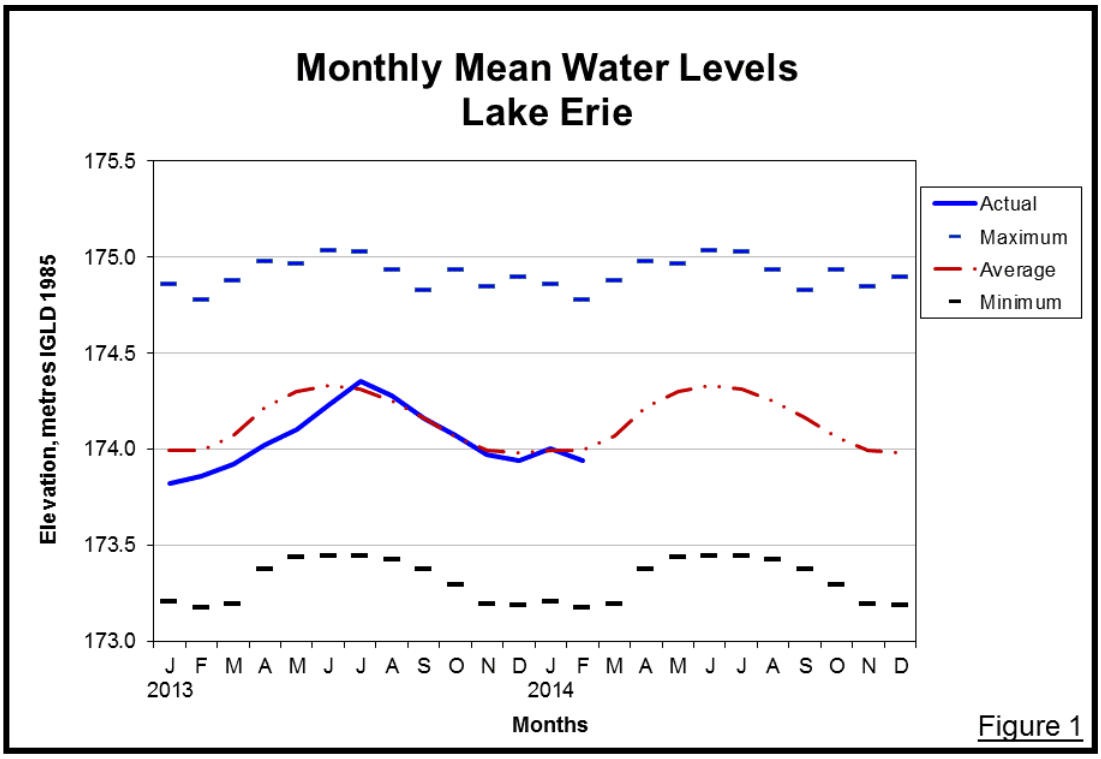


Figure 1

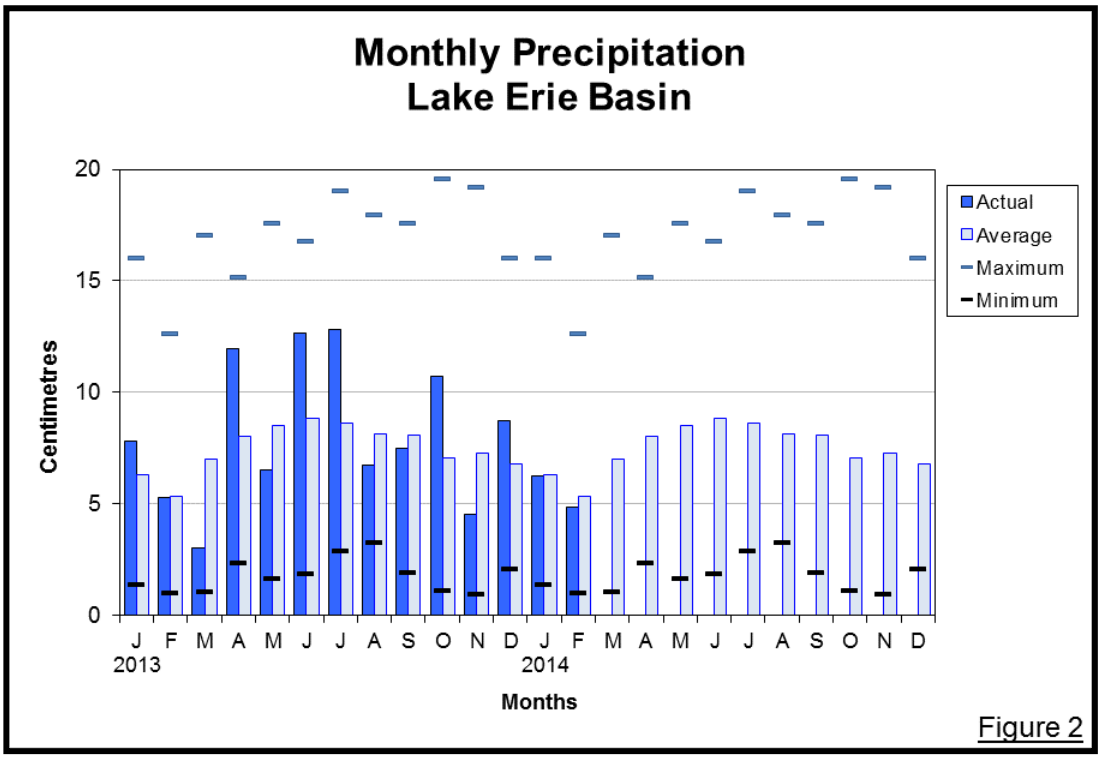


Figure 2

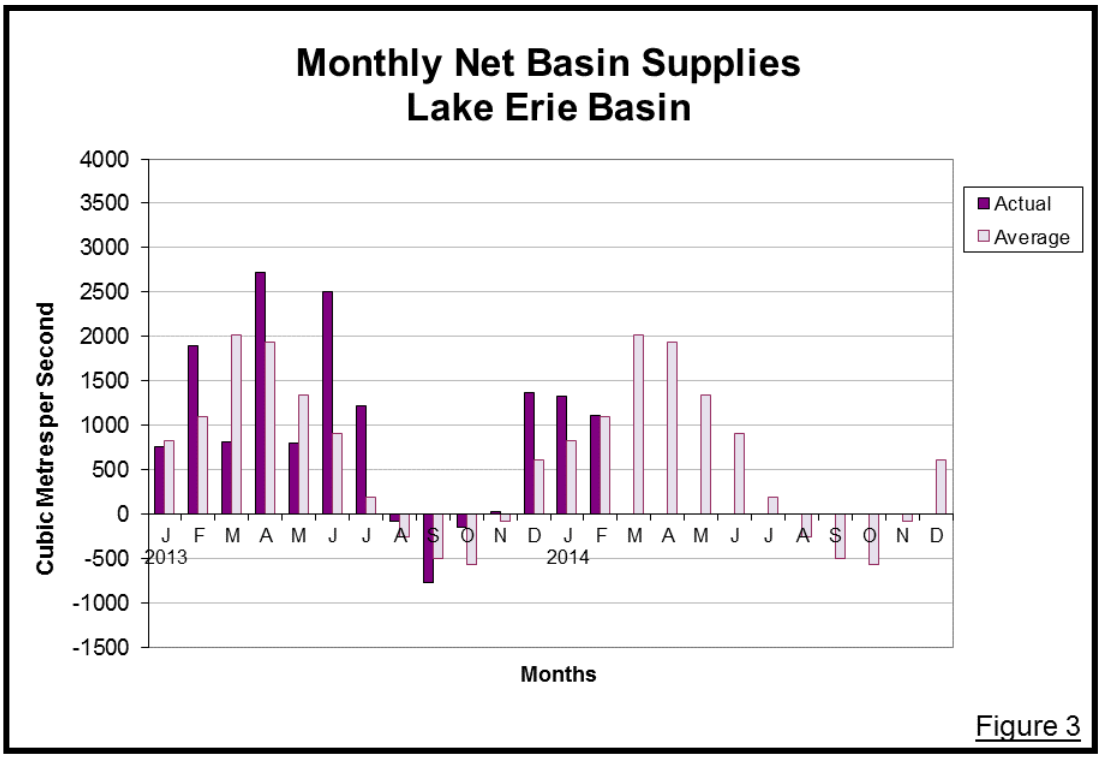


Figure 3

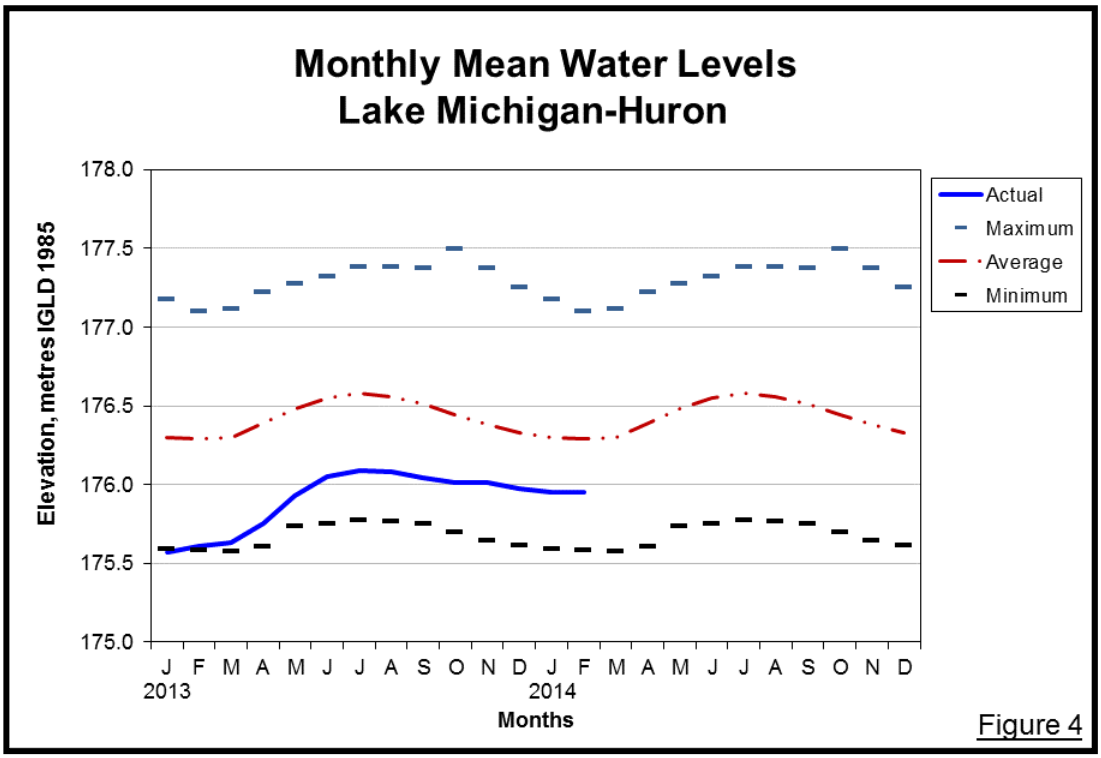


Figure 4

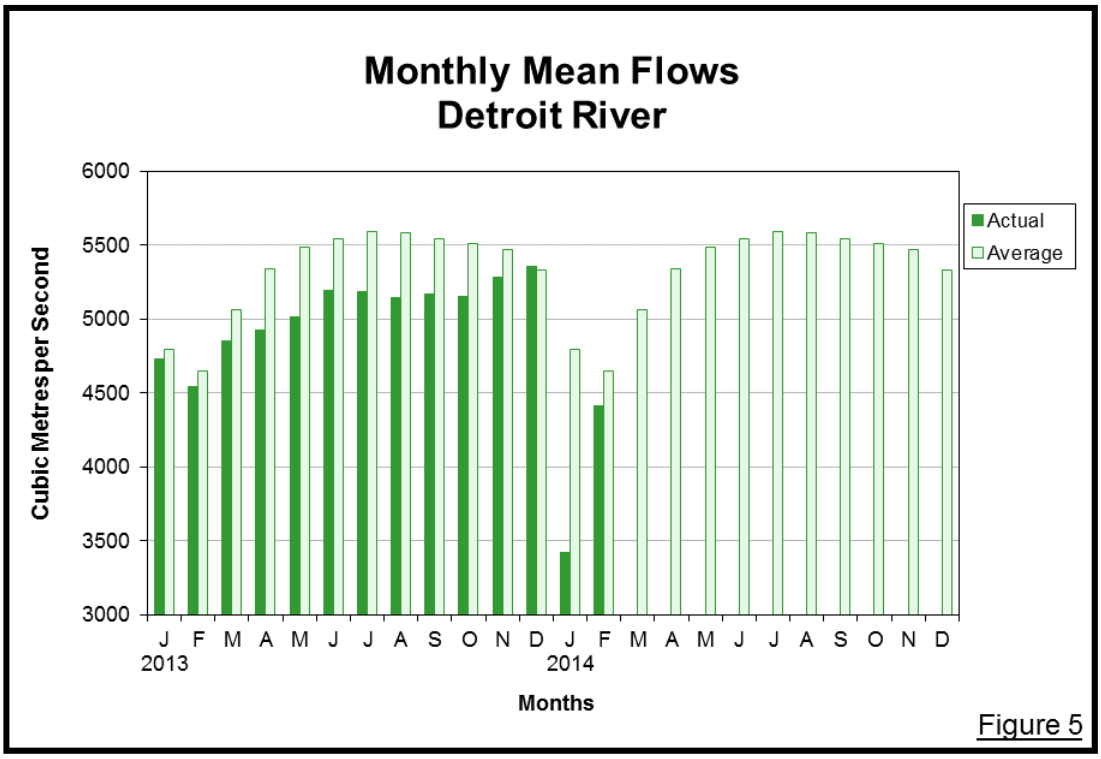


Figure 5

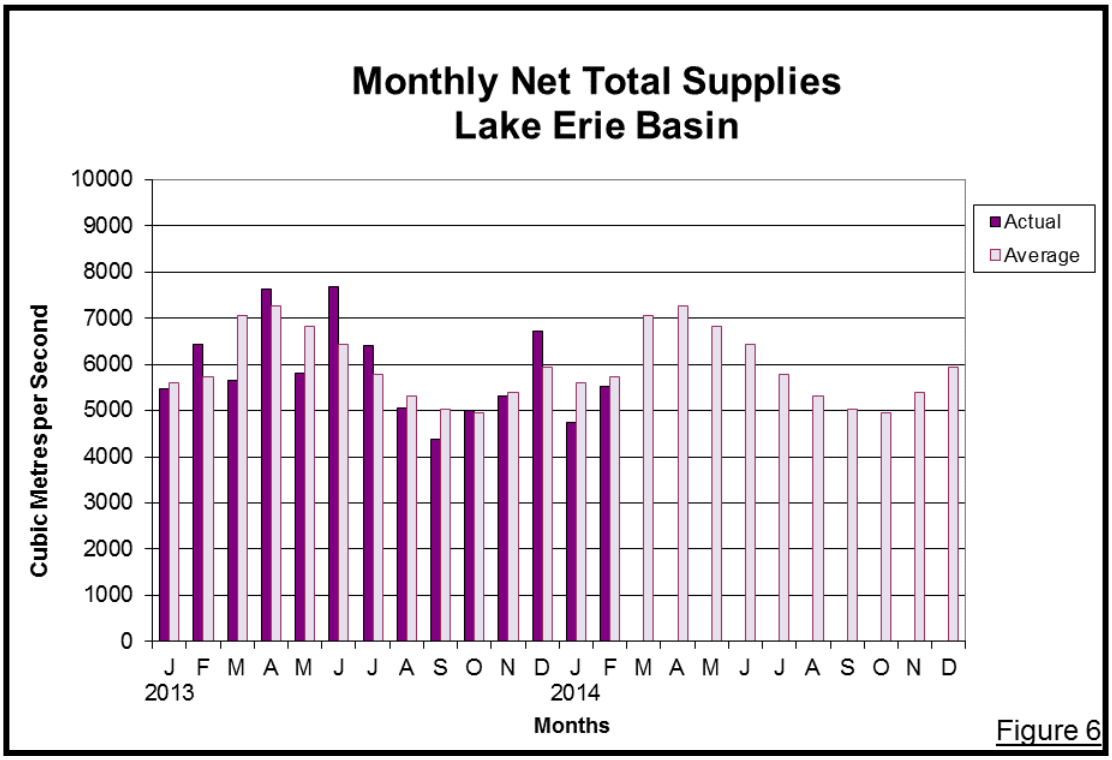


Figure 6

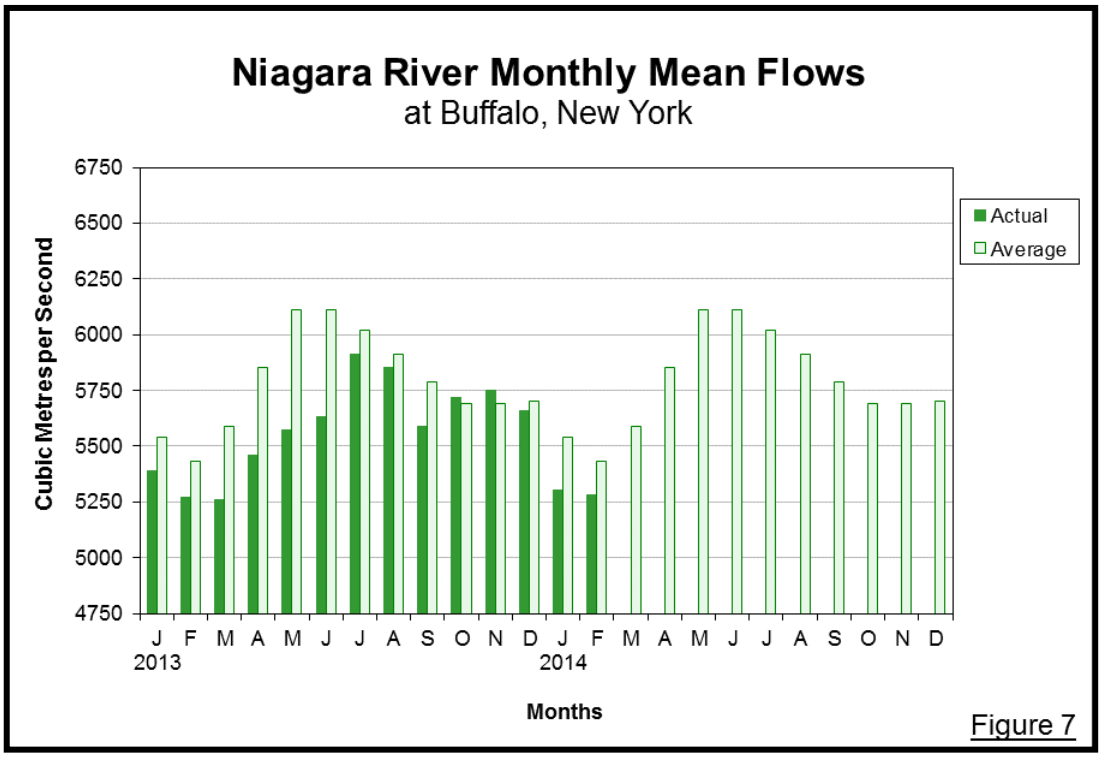


Figure 7

## 3. OPERATION AND MAINTENANCE OF THE INTERNATIONAL NIAGARA CONTROL WORKS

The water level in the CGIP is regulated in accordance with the Board's 1993 Directive. The Directive requires that the Power Entities–Ontario Power Generation (OPG) and the New York Power Authority (NYPA)–operate the International Niagara Control Works (INCW) to ensure the maintenance of an operational long-term average CGIP level of 171.16 m (561.55 feet) to ameliorate adverse high or low water levels in the CGIP. The Directive also establishes tolerances for the CGIP's level as measured at the Material Dock gauge.

The Power Entities complied with the Board's Directive at all times during the reporting period with the following exception. On January 7, 2014, the daily range for the CGIP, as measured at the Material Dock gauge, exceeded the daily allowable range of 0.46 m (1.5 feet) specified in the Board's 1993 Directive for the regulation of CGIP. The range

recorded at the Material Dock gauge was 0.55 m (1.8 feet). As a result of high flow experienced on the Niagara River from mid-day on January 6 through the early hours of January 7, a significant volume of lake ice was driven out of Lake Erie. The ice floes precipitated into ice jams in the CGIP on January 7. Even though all control gates of the INCW were open to pass both water and ice, the flow through a number of control gates was blocked. As a result of the high flow and ice-restricted gates, the CGIP daily range was exceeded. A full review of this incident has been prepared by the First Line Manager of the INCW and provided to the Board. The explanation of the circumstances leading to CGIP's allowable daily range being exceeded on January 7, and the follow up steps taken by the operators of the INCW to limit similar incidents in the future, are acceptable to the Board. No further actions are considered necessary with respect to this failure to comply with the Board's Directive.

The accumulated deviation of the CGIP's level from March 1, 1973 through February 28, 2014 was +0.55 metre-months (+1.8 foot-months) above the long-term operational average elevation. The maximum permissible accumulated deviation is $\pm$0.91 metre-months ($\pm$3.0 foot-months).

Tolerances for regulation of the CGIP were suspended on a number of occasions during the reporting period. They were suspended on October 30 and 31 and on November 1, 2013 as the result of actions taken to accomplish the objectives of the Board's Cableway Section flow measurement program, on January 2-4, 7-12, 20-22, 24-30 and February 8, 10, 11, 16, 2014 due to ice conditions, and on November 18, 2013 and January 6, 2014 due to abnormally high flow conditions.

The locations of the water level gauges on the Niagara River are shown in Enclosure 1. Recorded daily Material Dock water levels covering the period September 2013 through February 2014 are shown in Enclosure 2.

Gate 1 of the INCW remained out of service for rehabilitation work following the completion of OPG's Niagara Tunnel Project. It returned to service on December 19,

2013 following work to repair seven hinges and replace seals. However, it exhibited a significant vibration and was therefore restricted to “full open/full closed operation for ice management emergencies only”. This restriction was modified on January 22, 2014 to allow operation from 100% to 30% closed to better manage ice floes. It was also felt that the vibration appeared to have diminished. An investigation and subsequent repair of the suspected cause of the vibration–a tear in an internal piston seal–is being planned.

During a structural inspection of the INCW, carried out in November 2012, OPG identified a potential issue with the concrete stability of its bridge supports. As a result of this deficiency, the temporary vehicle load restriction that was placed on the structure remains in effect. OPG has initiated an RFP process with contractors for bridge strengthening to address this problem. No contract award or repair design has yet been determined, as engineering and constructability reviews are ongoing.

Following completion of a major overhaul in 2013, involving cylinder/piston refurbishment, trunion seal machining, gate skin testing and internal inspection, Gate 14 of the INCW remains out of service. Due to the ongoing load restriction on the INCW’s bridge deck, the dewatering structure currently in place on the downstream side of Gate 14 cannot be removed using conventional methods. Plans are in place to remove the structure from Gate 14 and place it into Gate 16 during the Spring of 2014, in order to carry out a similar major overhaul. This process will be executed from the water upstream of the INCW using external barges and tugs.

## 4. GAUGING STATIONS

The Niagara River gauges used to monitor the CGIP levels and the flow over Niagara Falls are the Slater's Point, Material Dock, American Falls and Ashland Avenue gauges (see Enclosure 1). The Slater’s Point and Material Dock gauges are owned and operated by the Power Entities. The American Falls gauge is owned and operated by the U. S. National Oceanic and Atmospheric Administration (NOAA). Both NOAA and the Power Entities own and operate water level gauges at the Ashland Avenue location.

Subject to on-going comparison checks of the water level data from the Power Entities' and NOAA's Ashland Avenue gauges by the INC, the Power Entities' gauge is used for officially recording water levels used to determine the flow over Niagara Falls. The Power Entities' gauge at Ashland Avenue was not reporting water level data for short periods of time during November 9 and 18, 2013 in order to undergo gauge calibration. In addition, the gauge was unavailable for short periods on November 22 and December 10, 2013 due to communication failure. The NOAA gauge was used as an alternate during each of these outages. A comparison of water level readings from the Power Entities' and NOAA's Ashland Avenue gauges showed that they were within the acceptable INC tolerances of $\pm$2 cm ($\pm$0.8 in) on a daily basis for all other days during the reporting period.

Water levels from the Material Dock gauge were unavailable for a short period on October 27, 2013 due to the failure of the gauge transmitter. During that time, water level readings were obtained from the Slater's Point gauge.

Water levels from the Fort Erie gauge, used by the Niagara River Control Centre (NRCC) located at the INCW to determine the upper Niagara River flow for operational purposes, were unavailable for short periods of time on November 27, 2013 due to the loss of local power supply to the gauge house. During these times, the Buffalo water level gauge was used to provide an estimated elevation at the Fort Erie gauge.

All gauges required for the operation of the INCW were in operation during the remainder of the reporting period.

A temporary water level datalogger was installed at the Maid of the Mist Steamship Company dock by OPG on August 8, 2012. The datalogger was in place on a trial basis and recorded water levels during the latter portion of the ice-free season of 2012. It was reinstalled on April 19, 2013 and recorded water levels during the ice-free season. Similarly, it will be reinstalled for the 2014 ice-free season. Once sufficient

data is acquired and assessed, the case for installing a permanent water level gauge in the vicinity of this location, to act as an alternative for the Ontario Power Generating Station tailwater gauge and backup for the Ashland Avenue gauge, will be investigated further.

## 5. FLOW OVER NIAGARA FALLS

The International Niagara Treaty of 1950 sets minimum limits on the flow of water over Niagara Falls. During the tourist season (April-October) day time hours, the required minimum Niagara Falls flow is 2,832 cubic metres per second ($m^3/s$) (100,000 cubic feet per second (cfs)). At night and at all times during the non-tourist season months (November-March), the required minimum Falls flow is 1,416 $m^3/s$ (50,000 cfs). The operation of the INCW, in conjunction with power diversion operations, ensures sufficient flow over the Falls to meet the requirements of the 1950 Niagara Treaty. Falls flow met or exceeded minimum Treaty requirements at all times during the reporting period with the sole exception on January 18, 2014, as described below. The recorded daily flow over Niagara Falls, covering the period September 2013 through February 2014, is shown in Enclosure 3.

The flow over Niagara Falls was 44 $m^3/s$ (1,554 cfs) below the Treaty requirement of 1,416 $m^3/s$ (50,000 cfs) for the hour of 8:00 p.m. on January 18, 2014. Prior to the occurrence of the flow violation, ice breaking efforts were underway to clear significant volumes of heavy ice in the U.S. Ice Escape Channel. Those activities, combined with the onset of anchor ice below the INCW, caused a constriction to flow through the open channel. Heavy accumulation of ice below Niagara Falls in the Maid-of-the Mist Pool also contributed to the restriction in flow to the Ashland Avenue gauge. On recognition of the declining flow at the Ashland Avenue gauge, six additional control gates were opened fully between 7:33 p.m. and 7:45 p.m. in an attempt to flush out the channel and restore the gauge elevation. In releasing the additional volume of 1,200 $m^3/s$ (42,378 cfs), the flow at the Ashland Avenue gauge was restored above the minimum required by 8:19 p.m. The INC sheet for January 18 indicates that the flow over

Niagara Falls was 1,584 $m^3$/s (55,938 cfs) for the hour before the violation. It had gone as low as 1,461 $m^3$/s (51,595 cfs) at 3:00 p.m., but was back up to 1,770 $m^3$/s (62,507 cfs) at 6:00 p.m. As such, there is no reason to believe this violation was the result of efforts by operating staff at the NRCC to minimize flow in excess of the Treaty minimum over the Falls or an error in their control actions. In response to this Treaty violation, NRCC staff have been instructed to allow for additional time for water to reach the Ashland Avenue gauge during situations were heavy ice is present in both the Maid-of-the-Mist Pool and the U.S. Ice Escape Channel.

## 6. FALLS RECESSION

As part of its activities, the Board monitors the Horseshoe Falls for changes in its crestline that might result in a broken curtain of water along its crestline or suggest the formation of a notch in the crestline. The formation of a notch could signal a period of rapid Falls recession that has not been seen in more than a century.

The review of recently available imagery indicates that a rockfall occurred on October 2, 2013 between 1:00 pm and 1:15 pm adjacent to the rockfall that occurred in July 2012. Initial analysis indicates it was approximately 500 $m^2$ (5,380 square feet), which is similar in size to the July 2012 rockfall previously reported. The October 2013 rockfall has not resulted in a broken curtain of water over the crestline nor, in the opinion of the Board, in combination with other recent rockfalls negatively affected the scenic beauty of the Falls.

## 7. DIVERSIONS AND FLOW AT QUEENSTON

Diversion of water from the Niagara River for power purposes is governed by the terms and conditions of the 1950 Niagara Treaty. The Treaty prohibits the diversion of Niagara River water that would reduce the flow over Niagara Falls for scenic purposes to below the amounts specified previously in Section 5 of this report.

The hydroelectric power plants, OPG's Sir Adam Beck (SAB) I and II in Canada and NYPA's Robert Moses Niagara Power Project in the United States, withdraw water from the CGIP above Niagara Falls and discharge it into the lower Niagara River at Queenston, ON and Lewiston, NY, respectively. During the period of September 2013 through February 2014, diversion for the SAB I and II plants averaged 1,619 $m^3/s$ (57,170 cfs) and diversion to the Robert Moses Niagara Power Project averaged 1,897 $m^3/s$ (66,990 cfs).

The average flow from Lake Erie to the Welland Canal for the period September 2013 through February 2014 was 176 $m^3/s$ (6,220 cfs). Diversion from the canal to OPG's DeCew Falls Generating Stations averaged 135 $m^3/s$ (4,770 cfs) for the same period of time.

Records of diversions for power generation covering the period September 2013 through February 2014 are shown in Enclosure 4.

The monthly average Niagara River flows at Queenston, Ontario, for the period of September 2013 through February 2014, and departures from the 1900–2012 long-term average are shown in Table 3. Maximum and minimum monthly average flows for the 1900–2012 period of record are shown in Table 4. During the period September 2013 through February 2014, the flow at Queenston averaged 5,575 $m^3/s$ (196,880 cfs), with the monthly values ranging between 5,343 $m^3/s$ (188,690 cfs) and 5,763 $m^3/s$ (203,520 cfs). The flow at Queenston for the same period in 2012–13 averaged 5,216 $m^3/s$ (184,200 cfs), with the monthly values ranging between 5,017 $m^3/s$ (177,170 cfs) and 5,457 $m^3/s$ (192,710 cfs).

TABLE 3 - MONTHLY NIAGARA RIVER FLOWS AT QUEENSTON

| | Cubic Metres per Second | | | Cubic Feet per Second | | |
|---|---|---|---|---|---|---|
| Month | Recorded 2013-14 | Average 1900-2012 | Departure | Recorded 2013-14 | Average 1900-2012 | Departure |
| September | 5564 | 5732 | -168 | 196,490 | 202,420 | -5,930 |
| October | 5730 | 5653 | 77 | 202,350 | 199,630 | 2,720 |
| November | 5763 | 5665 | 98 | 203,520 | 200,060 | 3,460 |
| December | 5692 | 5707 | -15 | 201,010 | 201,540 | -530 |
| January | 5358 | 5544 | -186 | 189,220 | 195,780 | -6,560 |
| February | 5343 | 5437 | -94 | 188,690 | 192,010 | -3,320 |
| Average | 5575 | 5623 | -48 | 196,880 | 198,570 | -1,690 |

TABLE 4 - MONTHLY MAXIMUM AND MINIMUM NIAGARA RIVER FLOWS AT QUEENSTON

| | Cubic Metres per Second | | | | Cubic Feet per Second | |
|---|---|---|---|---|---|---|
| Month | Maximum | Year | Minimum | Year | Maximum | Minimum |
| September | 6880 | 1986 | 4340 | 1934 | 242,960 | 153,270 |
| October | 7220 | 1986 | 4320 | 1934 | 254,970 | 152,560 |
| November | 7030 | 1986 | 4190 | 1934 | 248,260 | 147,970 |
| December | 7410 | 1985 | 4270 | 1964 | 261,680 | 150,790 |
| January | 7240 | 1987 | 3960 | 1964 | 255,680 | 139,850 |
| February | 6900 | 1987 | 3320 | 1936 | 243,670 | 117,240 |

## 8. Flow Measurements in the Niagara River and Welland Canal

Discharge measurements are regularly scheduled in the Niagara River and Welland Canal as part of a program to verify the gauge ratings used to determine flow in these channels for water management purposes. Measurements are obtained through joint efforts of the USACE and EC. Measurement programs require boats, equipment and personnel from both agencies to ensure safety, quality assurance checks between

equipment and methods, and bi-national acceptance of the data collected. The USACE and EC continue efforts to standardize measurement equipment and techniques. Historically, measurements are made at several locations as described below. Regularly scheduled measurements were made during the reporting period at the Cableway Section located in the lower Niagara River; however, as noted below high flows in the Niagara River due to high wind conditions on Lake Erie prevented the measurements of the low flows as planned.

Upper Niagara River: Regularly scheduled measurements are taken near the International Railway Bridge located in the upper Niagara River on a 3-year cycle to provide information for evaluating stage-discharge relationships for flow entering the Niagara River from Lake Erie. The most recent regularly scheduled discharge measurements near the International Railway Bridge were taken in May 2012. Low Lake Erie water levels in the Fall of 2012 provided an opportunity to obtain measurements at lower flows, so an additional set of measurements were made in November 2012. All of the 2012 measured flows were higher than those computed using both the 2001 Buffalo stage-discharge and the Buffalo–Material Dock stage-fall-discharge rating equations. As a result of reviewing previous discharge measurements made near the International Railway Bridge, a revision of the 2001 Buffalo rating equation is being proposed and is under review by the Board's Working Committee. The proposed Buffalo equation is closer to the 2012 measured flows than either of the two older equations, particularly the May 2012 measurements which averaged to be nearly the same as the proposed equation. The Buffalo rating equation is used in Great Lakes water supply routing models to estimate the flow in the Niagara River and to verify other Niagara River flow estimates.

EC is also taking continuous measurements of water levels at a new International Gauging Station (water levels and flow monitoring) located near the International Railway Bridge section. Flow measurements were taken throughout 2013 to observe the trending impact of aquatic plant growth on flow. EC hopes to use continuous Acoustic Velocity measurement data to assist with assessing flow conditions under ice during this winter. Continuous daily discharge data is being published at this location. Since it's installation

in the Spring of 2013, several discharge measurements have been acquired to develop the calibration that may start to be used to confirm discharge data this year.

Lower Niagara River: Discharge measurements are made on a 3-year cycle at the Cableway section, located just upstream of the OPG and NYPA hydroelectric generating stations at Queenston–Lewiston, to verify the 2009 Ashland Avenue gauge rating of the outflow from the Maid-of-the-Mist Pool below the Falls. The Ashland Avenue gauge rating is used to determine the flow over Niagara Falls for purposes of the 1950 Niagara Treaty. In the Spring of 2007, Acoustic Doppler Current Profiler (ADCP) technology replaced the use of conventional current meter measurements at the Cableway section. Measurements have been made using only ADCP technology since that time. In accordance with the 3-year measurement cycle at the Cableway section, a suite of discharge measurements at flows close to the 1,416 and 2,832 $m^3/s$ (50,000 and 100,000 cfs) Falls flow minimums specified in the 1950 Niagara Treaty were scheduled for October 30 through November 1, 2013. The October 30 to November 1 dates were selected for efficiency of the measurement session to coincide with the change from 1950 Niagara Treaty tourist season to non-tourist season minimum Falls flow requirements. On October 30 and 31, four measurements at flows from 2,300 to 3,500 $m^3/s$ (81,220 to 123,600 cfs) were successfully taken. However, due to increased flow in the Niagara River due to high winds out of the west on November 1, the Power Entities were unable to provide stable flow over Niagara Falls and past the Ashland Avenue gauge near the 1,400 and 1,800 $m^3/s$ (49,440 and 63,570 cfs) amounts as planned. The Falls flow ranged from 1,979 and 4,365 $m^3/s$ (69,890 and 154,150 cfs) on November 1 during the daylight hours when measurements can be taken. During the midday, boating conditions were sufficiently safe, and the Power Entities were able to provide approximately one hour of reasonably stable flow conditions to allow the USACE and EC crews on site to complete an additional measurement. This measurement provided an additional confirmatory flow value in the range of 2,600 $m^3/s$ (91,820 cfs). The results of the flow measurements that were taken are being analyzed and plans to measure the low flows during 2014 are being made.

In addition to the measurements at the Cableway section, measurements were made downstream of the OPG and NYPA hydroelectric generating stations at Queenston–Lewiston during run-of-river conditions on October 29 in order to measure the total flow in the lower Niagara River. Each total flow measured will be finalized and then compared to the sum of the outflow from the Maid-of-the-Mist Pool (flow over Niagara Falls) and the discharges from the hydroelectric generating stations. The results may provide greater insight into the turbine ratings and the summation of flow calculations.

American Falls Channel: Discharge measurements are made in the American Falls Channel on a 5-year cycle to verify the rating equation used to determine the amount of flow in the American Falls channel and to demonstrate that a dependable and adequate flow of water is maintained over the American Falls and in the vicinity of Three Sisters Islands. Since American Falls flow is directly related to the operation of the CGIP, the Board monitors this relationship. Historically, measurements were made from the pedestrian bridges between Goat Island, Green Island and the U.S. mainland, using conventional measurement methods. In May 2007, measurements were successfully made using an ADCP mounted on a tethered boat at a new section located near the American Falls Gauge site. The measurements made at this section matched the rating equation very well. In May 2012, as part of the regular 5-year measurement cycle, discharge measurements were again made at this section using an ADCP mounted on a remote control boat. On average, there was no difference between the 2012 measured flows and flows computed using the present American Falls rating equation. Following the 5-year cycle, the next scheduled measurements at this location are expected to be made in the Spring of 2017.

Welland Canal: Discharge measurements are made on a 3-year cycle in the Welland Supply Canal above Weir 8 to verify the index-velocity rating for the permanently installed ADVM, which is used in the determination of flow through the Welland Canal. Regularly scheduled measurements were last made in the Welland Supply Canal in May 2010. However, due to the St. Lawrence Seaway Management Corporation's inability to provide water level data for the time of the 2010 measurements, these measurements could not

be used to verify the rating. Therefore, off-schedule measurements were made in the Welland Supply Canal in May 2012 to address the lack of results from the 2010 measurements. The analysis of the data from the 2012 measurements indicates that the measurements fit the current rating, which is based on the 2007 and 2009 measurement series, well. It is anticipated that the next regularly scheduled measurements in the Welland Supply Canal will take place in 2015.

The discharge at Weir 8 is currently based on data provided by an ADVM and water level gauging equipment installed by the St. Lawrence Seaway Management Corporation. In order to provide redundancy for this installation, a second ADVM has been installed upstream (South) of the existing ADVM by the Seaway Corporation. Depth profiling and discharge measurements at this upstream Weir 8 ADVM site were conducted during the first week in September 2013 to develop a cross-sectional area rating and Weir 8 index-velocity rating for the new installation. These measurements were in addition to the regularly scheduled measurements in the Welland Supply Canal, but were used as an additional validation data set for the pre-existing ADVM rating. Since the validation measurements this fall, the pre-existing ADVM is now using a different water level sensor as the main water level sensor. This change may increase the accuracy of the index velocity rating which is used for discharge calculations at this site, but the differences expected do not seem sufficient to schedule any additional measurements.

## 9. POWER PLANT UPGRADES

OPG began a unit rehabilitation program in 2007 for a number of its Beck I units — Units G3, G7, G9 and G10. G1 and G2, which are 25 Hz units, remain removed from service at this time, and rehabilitation of G4, G5, G6 and G8 will be considered after work is completed on the other units as they were more recently upgraded. The upgrades of Units G7 and G9 were completed in March 2009/February 2012 (in two parts) and December 2010, respectively. Work to replace the G3 runner and for a generator re-wind began in April 2012 and was completed in July 2013. G10 is expected to go out of service in June 2015 for rehabilitation.

The Beck I units were originally built with Johnson Valves at the bottom of the penstocks that could be activated to stop water from entering the units. These valves were removed from Units G3, G7, G9 and G10 when they were upgraded, and their function replaced with headgates that can prevent water from entering the penstocks. As Units G3, G9 and G10 were upgraded; sleeves were installed where the Johnson Valves had been located in order to improve flow through that portion of the penstock. A sleeve was not installed when G7 was initially upgraded in 2009. The unit was taken out of service again, from early March 2011 until late February 2012, to complete this work. Due to the limited production gain with the sleeves in place, OPG has decided not to include this alteration in future upgrades.

Although an Index Test for G7 was scheduled for May 2012, it was postponed because of vibration problems with the unit. Full Gibson Testing was performed on the unit over a period of time during November and December 2013 after the vibration issues were resolved. Representatives of the INC witnessed one of the tests on December 6. The results of the Gibson test are being analyzed. It is recognized that the rating table currently being used for G7 does not reflect the improvements in performance of the unit expected with the installation of the Johnson Valve sleeve because the table was based on earlier model tests, and that it may result in a slight over-reporting of the water used by the unit. Similarly, G3 is being operated on an interim rating table until a Gibson test takes place. The test is tentatively scheduled for November 2014.

## 10. ICE CONDITIONS AND ICE BOOM OPERATION

Preparations for installing the Lake Erie–Niagara River ice boom began in late November. From November 26 to December 3, 2013, the junction plates were raised from the bottom of the lake and floatation barrels attached. The strings of boom pontoons were pulled from their summer storage area and placed inside the Buffalo Harbor breakwall during the period December 4 through 11. In accordance with Condition (d) of the Commission's October 5, 1999 supplementary Order of Approval,

installation of the Lake Erie–Niagara River Ice Boom's spans for the 2013–14 ice season commenced on Saturday, December 14, 2013. Installation of the ice boom may begin when the Lake Erie water temperature as measured at the Buffalo Water Intake reaches 4ºC (39ºF) or on December 16, whichever occurs first. The Lake Erie water temperature was 4ºC (39ºF) on Sunday, December 8. Installation of the ice boom was planned to begin on Thursday, December 12 or earlier if favourable conditions permitted; however, due to strong winds and high waves on the lake on December 12 and 13, installation of the boom spans did not begin until Saturday, December 14. The final spans were installed on December 20, completing the ice boom's installation for the 2013–14 ice season.

Based on data jointly compiled by the Canadian Ice Centre and the U.S. National Ice Center it was determined that ice began to form on Lake Erie during the first week in December, about one week earlier than average, and was above average for all but two weeks near the start of the ice season through to the end of the reporting period. As shown in Figure 8, by mid-December, the lake was about 24% ice covered. The lake's ice cover fell to about 12% at the beginning of January and then climbed to 97% by the end of the month. The lake's ice cover was 98% during the second and third weeks in February, fell to 83% during the last week in the month, and then reached 98% again during the first week in March. Based on its highest percentage of ice cover classified as "Thick Ice" during each of the weeks with 98% ice cover, the maximum ice cover on the lake occurred during the first week in March. The average ice cover on Lake Erie during the first week of March is about 53%. The lake's ice cover was 91% and 89% during the second and third weeks in March, respectively, and was 88%, almost 4.5 times average, at the end of the reporting period. In addition, the eastern basin of the lake was still about 95% ice covered.

Helicopter flights were conducted on February 7 and March 7, 2014 to measure ice thickness at the six standard ice-thickness measurement sites on the eastern end of Lake Erie. The ice thickness at the measurement sites ranged from 32 to 80 cm (12.6 to 31.5 inches) on February 7, averaging 50 cm (19.7 inches), and 51 to 105 cm (20.1

and 41.3 inches) on March 7, averaging 75 cm (29.5 inches). The average thickness recorded on March 7 was the second highest since measurements began on these sites in 1984.

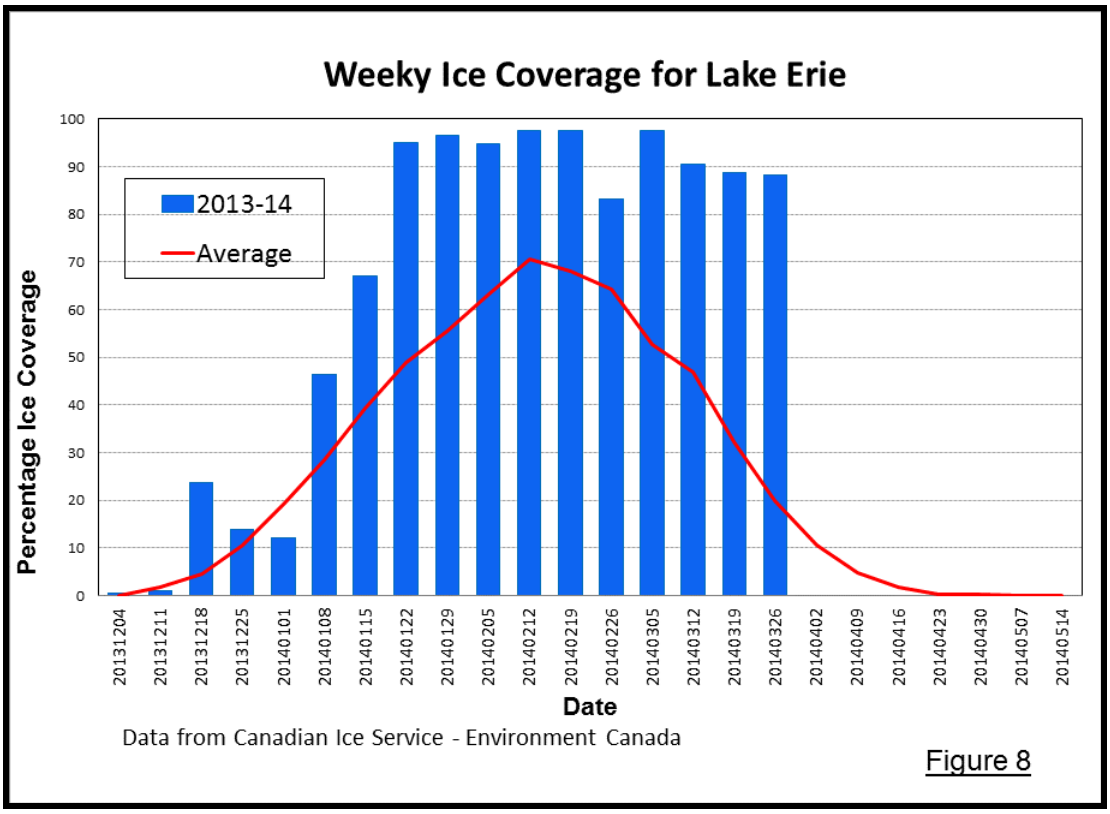


Figure 8

Ice first appeared in the CGIP on December 17, 2013. Ice management measures were undertaken in the CGIP, including extensive ice breaker activity, during much of January. Although ice-free in mid-December, the Maid-of-the-Mist Pool had solid ice along its edges and a broken ice cover in its main channel by January 3, 2014. The Pool was completely ice covered with thick ice by January 8 and partially open on January 15. Photographs of the Pool taken on January 22 and 29 show the Pool filled with thick ice again. Photographs of the Pool taken during a January 30 helicopter flight, including the one provided on cover of this report, show a large buildup of ice in the Pool along the Canadian side of the gorge and open water along the U.S. side. A large portion of the Pool remained ice covered at the end of the reporting period.

The NYPA's *Flood Warning Notification Plan in the Event of Ice-Affected Flooding on the Upper Niagara River* was tested on December 17, 2013. A drill was conducted that simulated a flood event along the U.S. shore triggered by an ice jam between the NYPA Intakes and the Buckhorn Dykes downstream of the North Grand Island Bridge. The flood warning plan was implemented for real during the early morning of January 7, 2014.

As a result of a high wind event that occurred on January 6-8, 2014, ice floes overtopped the Lake Erie–Niagara River ice boom and continued for approximately 50 hours. This resulted in an ice jam occurring in the East Channel of the Niagara River, causing water levels to rise to the point where, at 8:45 a.m. on January 7, 2014, the NYPA flood warning notification plan was executed for a FLOOD WARNING on the LaSalle Expressway. The FLOOD WARNING was extended to include the entire East Channel at 1:15 p.m. due to rising water levels further upstream in the channel. Only minor flooding of the LaSalle Expressway was experienced. On January 8, 2014 at 6:30 a.m., the FLOOD WARNING was de-escalated to a FLOOD WATCH for the LaSalle Expressway area only and the FLOOD WATCH was wholly cancelled at 1:27 p.m. Ice breaking efforts continued around the clock until January 30, 2014. During the event, the water levels in the Maid-of-the-Mist Pool reached 105.98 m (347.7 feet) approximately 5.5 m (18 feet) above normal.

The Board recognizes that the threat of flooding on both sides of the river is a concern. In addition, it is in the interest of the Power Entities and their customers in both countries that ice events be mitigated as quickly as possible. Ice jams are taken very seriously and the Board maintains a keen awareness regarding ice jams and the responses to them. A post-event analysis of the January 7-8 event indicated that the ice boom and other infrastructure performed as designed. As such, no modifications or reconfigurations of the ice boom, or installation of new infrastructure, is warranted. Field crews of the USACE found no evidence of post-event flood damages. Although a local roadway was flooded for less than half a day, the water level readings at gauges in the affected area indicated that the damage level thresholds for residential and commercial property were not exceeded during this event. The Board believes that adequate

procedures are in place to manage the threat of ice jams. These procedures were followed during the January 2014 event. The local flood warning system was activated properly and in a timely basis to allow local first responders to prepare for actions should events worsen. It is the Board's opinion that the authorities involved discharged their responsibilities effectively. At present, there are two ice breaking vessels that are owned and operated by the Power Entities that are adequate to handle these types of events at Niagara. Additional ice-breaking capacity does not appear to be necessary.

On January 30, representatives of the Board participated in a helicopter-based survey of the ice boom. The flight was scheduled due to the heavy ice cover in the area of the ice boom, which was preventing normal inspections by boat. The survey participants were able to determine that there were no major breakages of the main boom cable as a result of the January 6-8 storm, although it was possible a couple of pontoons had become detached at one end.

In response to a report from the U.S. Coast Guard on March 6 of a possible ice boom break, the condition of the ice boom was also assessed during the scheduled helicopter ice thickness flight on March 7. Other than possible broken chains on pontoons in Spans V and P, the ice boom appeared to be intact. A NYPA ice breaker spent some time on the lake during the afternoon of March 17 inspecting the boom. Before experiencing a partial failure of its starboard rudder, the breaker's crew was able to break a number of pontoons from beneath the ice coverage. Up to that point, they had found one trailing pontoon in each of Spans O, P, and U, and there were two pontoons missing from Span N and one missing from Span F. On March 20, the trailing pontoons were removed, instead of being reattached, to ensure that they would not become totally disconnected and drift downstream. Two of the three missing pontoons have been recovered.

Based on the areal extent and thickness of the lake's ice cover mid-March, representatives of the Board's Working Committee decided to postpone the use of fixed-wing ice observation flights to determine the extent and condition of ice remaining

on the eastern basin in preparation for removal of the ice boom until after available satellite imagery shows that the extent of ice cover in lake's eastern basin was less than 75%. As such, no fixed-wing observation flights were taken before the end of the reporting period.

The current Order of Approval governing the operation of the ice boom requires that all floating sections of the boom be opened by the first day of April unless there is more than 650 square kilometres (250 square miles) of ice remaining on eastern Lake Erie. Other factors such as the quality of ice, ice build-up in the river above/below the Falls, in the lower Niagara River or prediction of unfavourable weather are also considered. Considering the large quantity of ice still present on the eastern portion of Lake Erie and in the Maid-of-the-Mist Pool below Niagara Falls in late March, the Board agrees that the ice boom opening will be delayed beyond April 1.

## 11. OTHER ISSUES

Welland River Watershed: The Board continues to investigate the potential impact of fluctuating water levels of the CGIP on the Welland River watershed. Current issues in the watershed include concern of flooding of private property and degradation of the ecosystem. In addition to the potential for impacts from the CGIP, other potential contributors to these issues include urban and agricultural land use practices, past hydraulic modifications of the river (e.g. siphons to carry the river under the Welland Canal and dams for flow control) and the natural flat topography of the river. Mr. Aaron Thompson, Canadian Board Chair, and Ms. Joan Frain, OPG, met with property owners along the Welland River and representatives of the Welland River Floodplain Association (WRFA) and Niagara Peninsula Conservation Authority (NPCA) and toured portions of the river near Pelham, ON, on October 30, 2013. EC staff supporting the Board's Working Committee also visited sections of the Welland River in November 2013 with Ontario Ministry of Resources (OMNR) staff from the Niagara region to discuss issues and plan work. Discussions are ongoing among OPG, NPCA, OMNR, Welland River property owners, WRFA and EC with the short-term goal to better characterize the timing

and extent of water level fluctuations in the Welland River through existing data and potential new water level measurement gauges if necessary. These data will then be used to provide better clarity to potential correlations between water levels in the Welland River and CGIP, and the potential for impact by level fluctuations in the CGIP on the Welland River watershed. This will provide information to the Board on the need for any further action.

American Falls Bridges Project: With the continual deterioration of two of the pedestrian bridges spanning the American Falls Channel over the last several years, New York State Parks (NYSP) has worked with consultants to evaluate their existing structure conditions and possible rehabilitation and replacement alternatives. The two pedestrian bridges in question are the ones crossing the American Falls Channel from Prospect Park to Green Island and from Green Island to Goat Island. NYSP has requested that the New York State Department of Transportation (NYSDOT) assist them through project scoping, design and construction to either rehabilitate the structures to a like-new condition or replace them. Phase 1, the planning and scoping phase, was just completed (Fall 2013) with the second phase, preliminary design phase, just beginning. The final phase, the design and construction phase, is scheduled for the Spring of 2017.

The IJC and the Board may be asked to review the project's plans, which could include rehabilitating the existing bridges, relocating the bridges with portions of the old bridge structure removed or left in place, and the need to cofferdam each bridge pier and/or the entire river channel during construction. The options considered could have a temporary or permanent impact on flow in the American Falls Channel.

U.S. Representatives of the Board attended a NYSDOT Stakeholder meeting at their downtown office in Buffalo, NY on August 6, 2013 in which NYSDOT presented the three alternatives being considered. Procedures for submitting their project application were discussed with the U.S. Representatives. On January 17, 2014, NYSDOT and their contractor, Greenman–Pedersen, Inc., met with the U.S. Representatives at the USACE, Buffalo District Office, to discuss modelling efforts, available data (e.g. levels, flows and

bathymetric), the 1969 American Falls project and the Niagara River Treaty of 1950. After the meeting, the U.S. Representatives recommended to NYSDOT that they meet with the Canadian Representatives of the Board and NRCC personnel to discuss project activities and issues.

## 12. MEETING WITH THE PUBLIC

In accordance with the Commission's requirements, the Board will hold an annual meeting with the public during August or September 2014. The meeting will be in the Niagara Falls, NY area, with the meeting location and date to be determined. The Board's 2013 meeting was held in Niagara-on-the-Lake, ON on September 19. The 2013 annual meeting was the first time the Board has offered telephone and on-line options as an extension of its face-to-face meeting. The Board intends to do so again for its 2014 meeting with the public.

## 13. MEMBERSHIP OF THE BOARD AND ITS WORKING COMMITEE

The membership of the Board and its Working Committee is unchanged from the last report.

## 14. ATTENDANCE AT BOARD MEETINGS

The Board met once during this reporting period. The meeting was held on March 25, 2014, in Detroit, MI. COL Robert Peterson, Alternate U.S. Section Chair, Mr. Aaron Thompson, Canadian Section Chair, and Mr. William Allerton, U.S. Member, and Ms. Jennifer Keyes, Canadian Member were in attendance.

Respectfully Submitted,

*Original Signed by*
COL Robert D. Peterson, Alt. Chair
*For:*

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BG MARGARET W. BURCHAM
Chair, United States Section

*Original Signed by*

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Mr. AARON F. THOMPSON
Chair, Canadian Section

*Original Signed by*

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Mr. WILLIAM H. ALLERTON
Member, United States Section

*Original Signed by*

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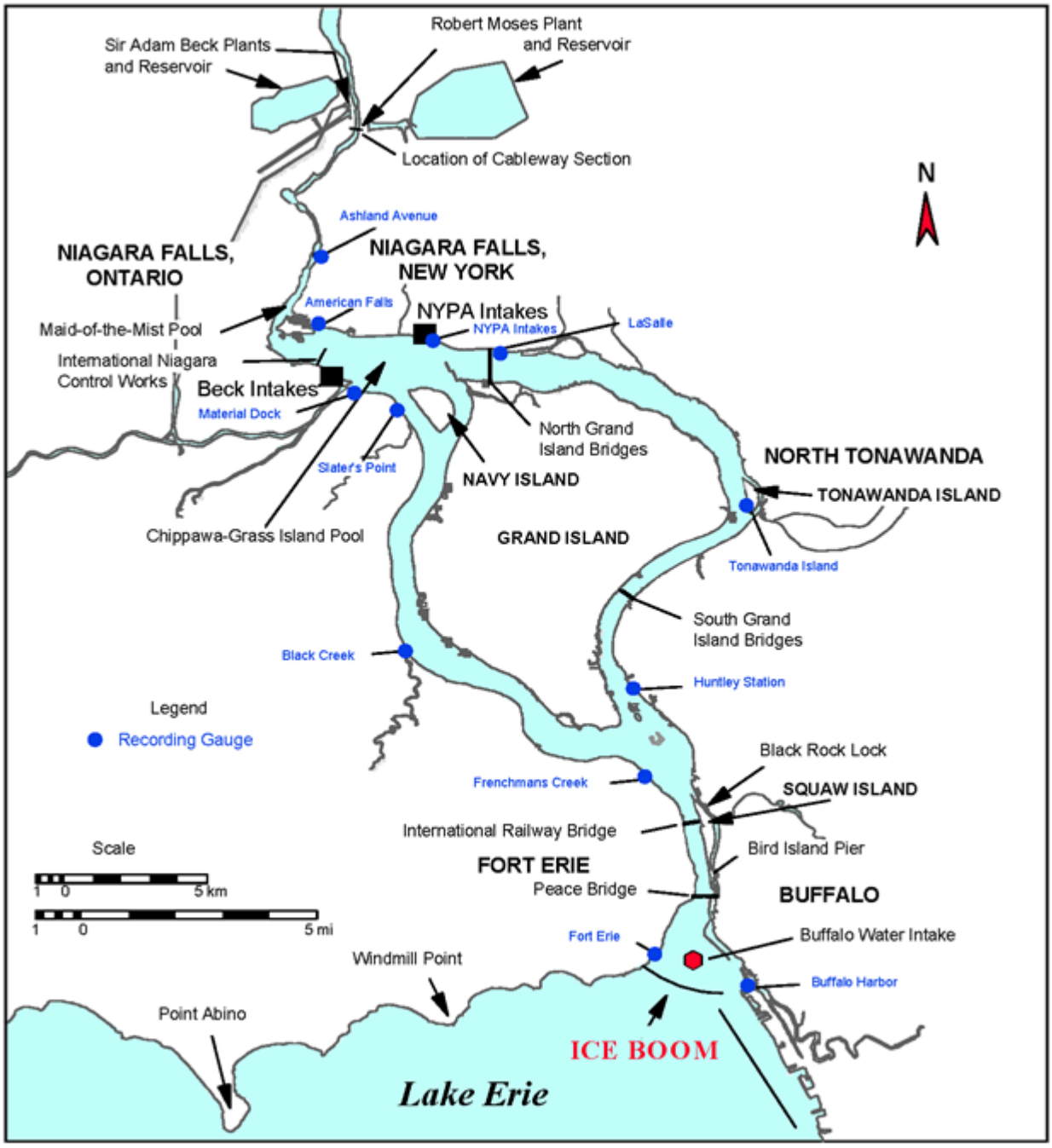
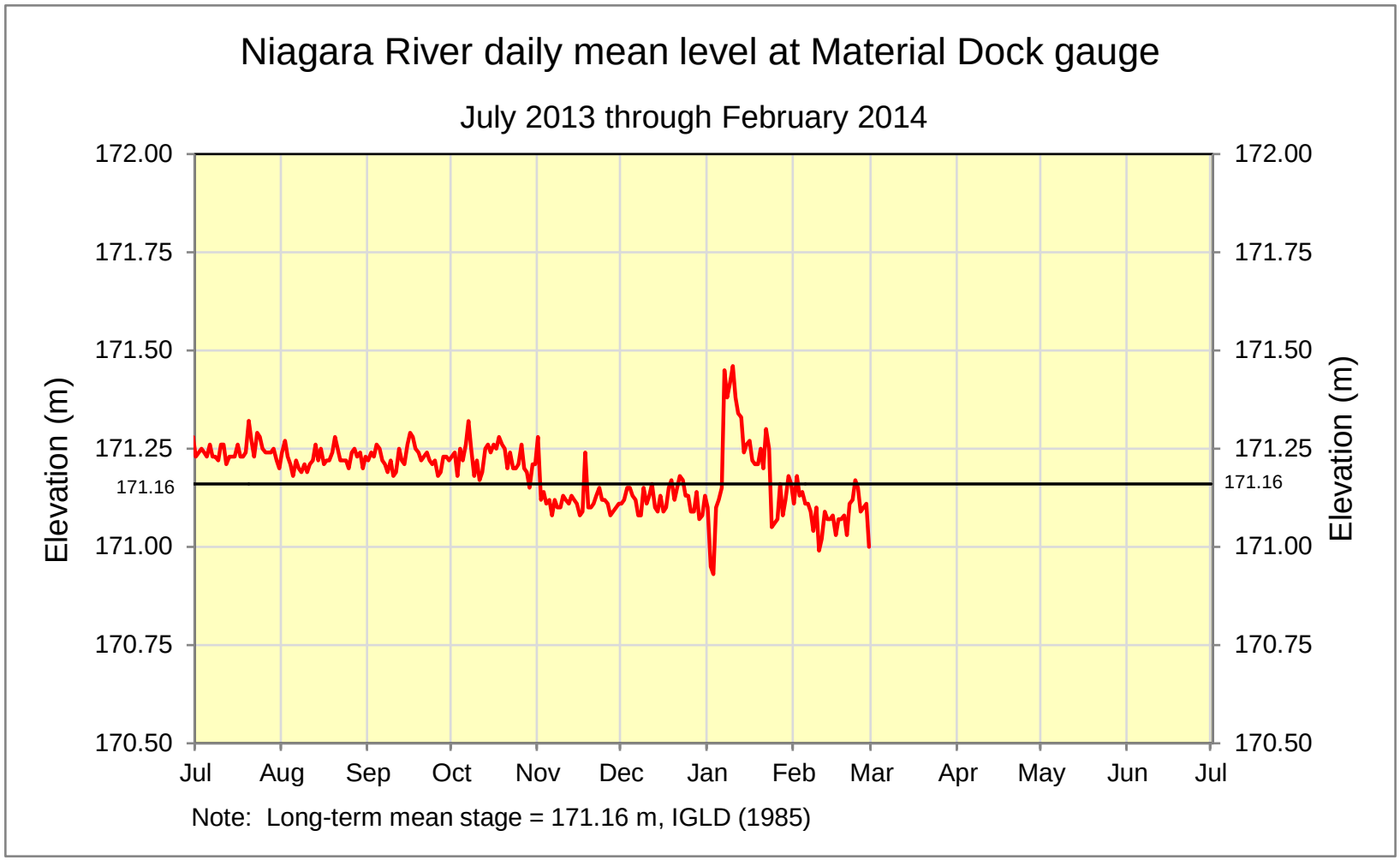
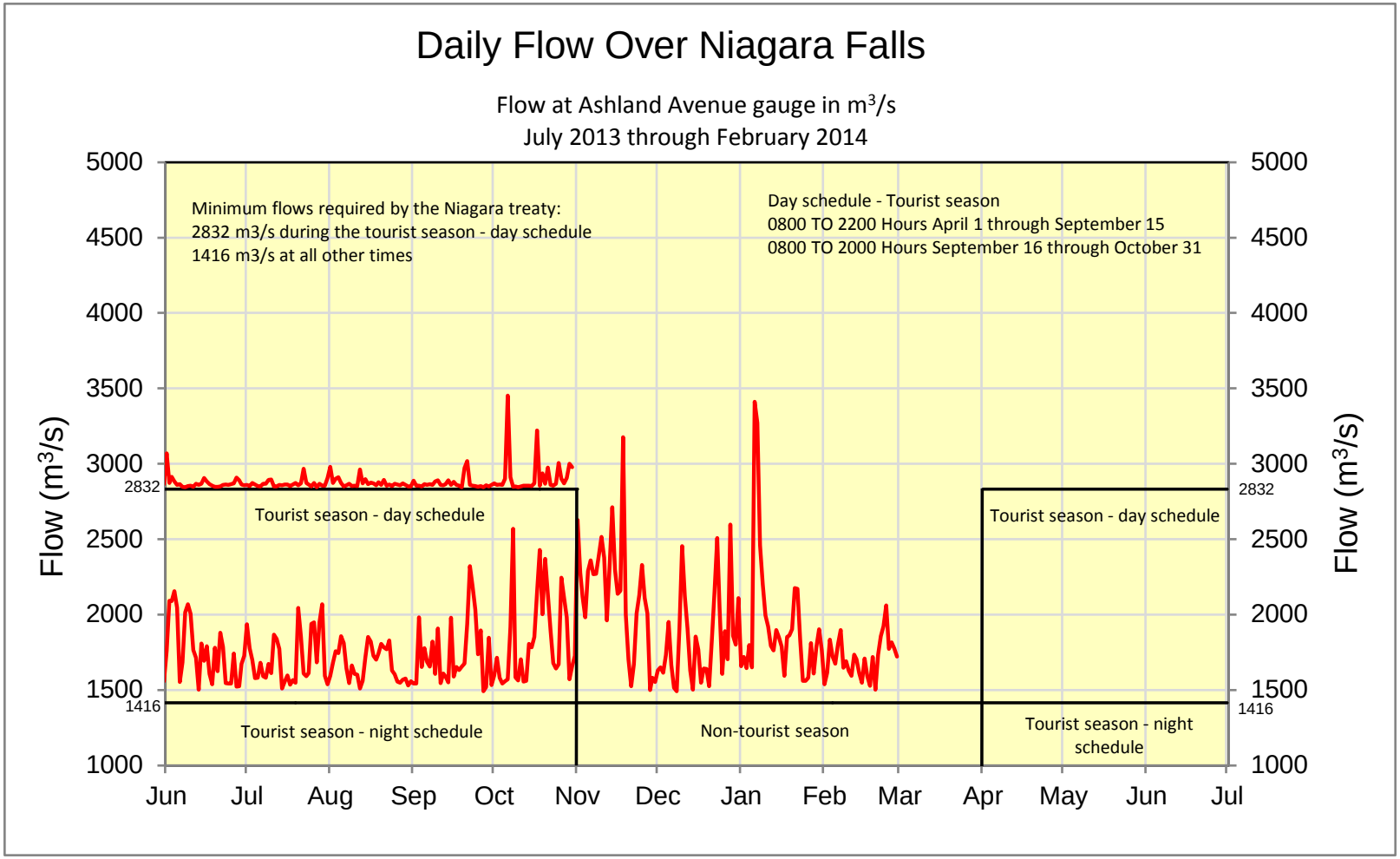
Ms. JENNIFER L. KEYES
Member, Canadian Section


Robert Moses Plant
and Reservoir
Sir Adam Beck Plants
and Reservoir
Location of Cableway Section
N
Ashland Avenue
NIAGARA FALLS,
ONTARIO
NIAGARA FALLS,
NEW YORK
American Falls
NYPA Intakes
NYPA Intakes
LaSalle
Maid-of-the-Mist Pool
International Niagara
Control Works
Beck Intakes
Material Dock
Slater's Point
North Grand
Island Bridges
NAVY ISLAND
NORTH TONAWANDA
TONAWANDA ISLAND
Chippawa-Grass Island Pool
GRAND ISLAND
Tonawanda Island
South Grand
Island Bridges
Black Creek
Huntley Station
Legend
Recording Gauge
Black Rock Lock
Frenchmans Creek
SQUAW ISLAND
International Railway Bridge
Bird Island Pier
Scale
FORT ERIE
Peace Bridge
BUFFALO
1 0 5 km
1 0 5 mi
Fort Erie
Buffalo Water Intake
Windmill Point
Buffalo Harbor
Point Abino
ICE BOOM
Lake Erie

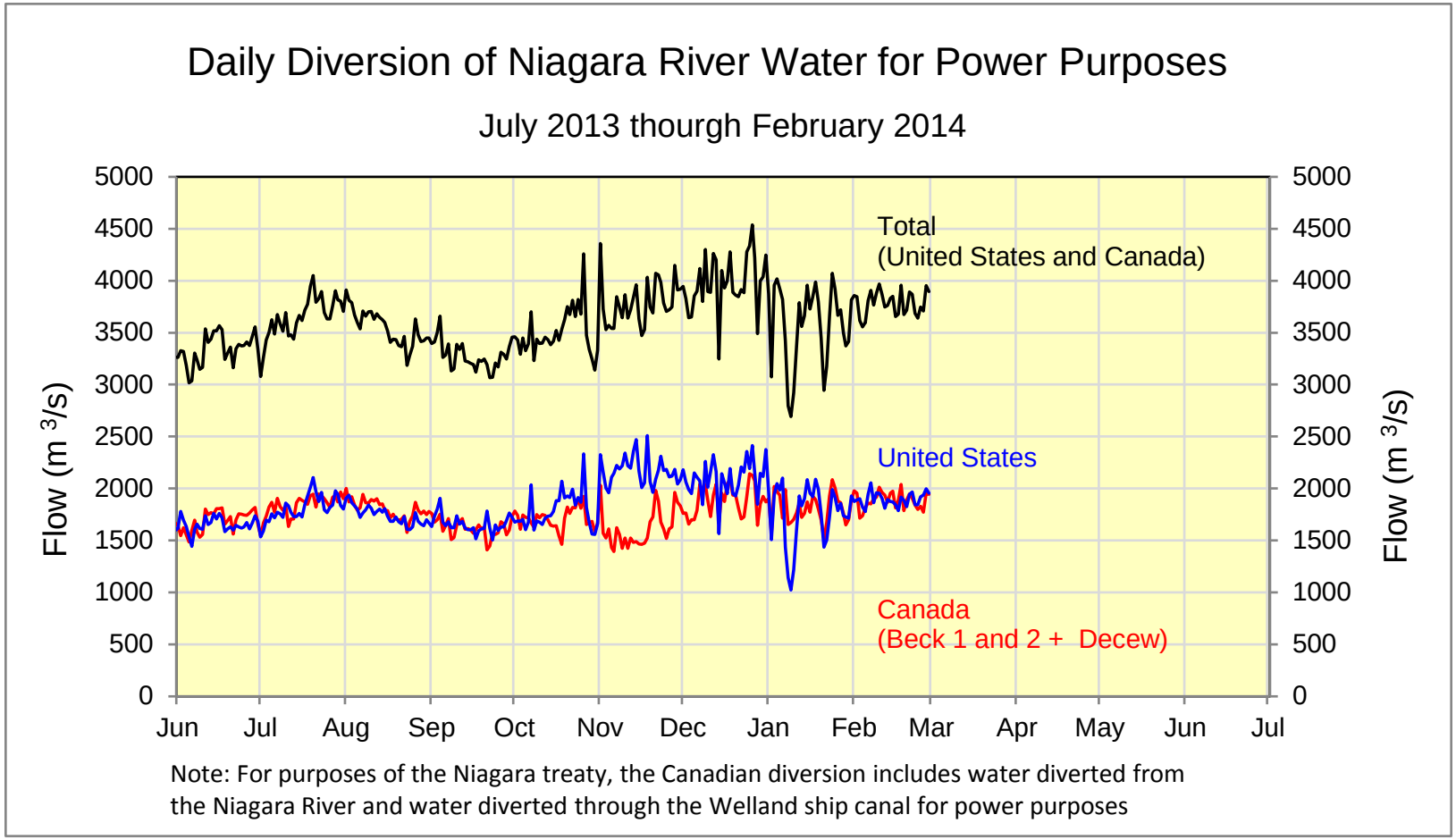
Enclosure 1


Niagara River daily mean level at Material Dock gauge
July 2013 through February 2014
Elevation (m)
172.00
171.75
171.50
171.25
171.16
171.00
170.75
170.50
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Note: Long-term mean stage = 171.16 m, IGLD (1985)

Enclosure 2


Daily Flow Over Niagara Falls
Flow at Ashland Avenue gauge in m³/s
July 2013 through February 2014
Minimum flows required by the Niagara treaty:
2832 m3/s during the tourist season - day schedule
1416 m3/s at all other times
Day schedule - Tourist season
0800 TO 2200 Hours April 1 through September 15
0800 TO 2000 Hours September 16 through October 31
Flow (m³/s)
5000
4500
4000
3500
3000
2832
2500
2000
1500
1416
1000
Tourist season - day schedule
Tourist season - night schedule
Non-tourist season
Tourist season - day schedule
Tourist season - night schedule
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul

Enclosure 3


Daily Diversion of Niagara River Water for Power Purposes
July 2013 thourgh February 2014
Flow (m 3/s)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Total
(United States and Canada)
United States
Canada
(Beck 1 and 2 + Decew)
Note: For purposes of the Niagara treaty, the Canadian diversion includes water diverted from the Niagara River and water diverted through the Welland ship canal for power purposes

Enclosure 4