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HISTORICAL BASIS FOR LIMITS ON LAKE SUPERIOR WATER LEVEL REGULATIONS

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ABSTRACT. The 1979 International Joint Commission (IJC) Supplementary Orders of Approval for the regulation of Lake Superior outflows call for maintaining Lake Superior water levels below an elevation of 183.49 m above the International Great Lakes datum of 1955 (IGLD55). When Lake Superior rose above 183.49 m (IGLD55) in 1985, the IJC ordered discharges in excess of the operational regulation plan outflows. Continued pressure to reduce high water levels on the lower Great Lakes by storing water in Lake Superior calls into question the sanctity of the 183.49 m (IGLD55) limit. Based on IJC hearings and historical water level records, the present limit appears to be equivalent to the upper limit specified in the original 1914 Orders of Approval, when the latter is adjusted for differential isostatic rebound. However, testimony reveals that the IJC of 1914 expected levels to exceed the limit by about 0.15 m during water supply conditions similar to those of 1869 and 1876, which were matched in 1985. Although the expected exceedance of the 1914 limit appears to be based on an inaccurate maximum water level record, other historical records substantiate that Lake Superior should be expected to rise above 183.49 m (IGLD55) during times of high water supplies, such as 1985.
ADDITIONAL INDEX WORDS: International commissions, international law, water level fluctuations.

INTRODUCTION

Present International Joint Commission (IJC) Orders of Approval for the regulation of Lake Superior (International Lake Superior Board of Control 1982) call for maintaining the lake's levels "as nearly as may be" within the recorded range of levels below 602.0 feet[1] (183.49 m) above the International Great Lakes datum of 1955 (IGLD55). However, beginning in September 1985, Lake Superior set monthly record-high levels for 9 consecutive months (Pratt 1986a,b) and exceeded the 602.0 ft (183.49 m) (IGLD55) limit 3 months during that period (U.S. Army Corps of Engineers [USACE] 1985a,b,c). Although the present Lake Superior regulation plan (Plan 1977) calls for management of Lake Superior outflows for the mutual benefit of Lake Superior and Michigan-Huron interests, such management becomes increasingly difficult when both lakes are at extremely high levels. The IJC attempted to reduce the levels of the lower lakes by retaining water on Lake Superior that would have been discharged under Plan 1977, beginning in May 1985 (Environment Canada and Detroit District USACE 1985, IJC 1985). Subsequent heavy precipitation over the Lake Superior basin and rapidly rising Lake Superior levels prompted the IJC to order, beginning in October 1985, discharges from Lake Superior in excess of the Plan 1977 outflows (Environment Canada 1985). (The IJC reinstated Plan 1977 outflows in March 1986.)

Continued pressure to reduce water levels of the lower Great Lakes by storing water on Lake Superior calls into question the sanctity of the 602.0 ft (183.49 m) (IGLD55) limit specified by the IJC. However, the absence of a thorough summary of

[1]Testimony from the IJC hearings, historical water level records, and differences among benchmark elevations related to different Great Lakes datums all are published in English units; conversion to metric units would obscure many of the references to the data and make comparison of values difficult. Additionally, water levels are expressed in terms of the 1903 datum, except where noted.

the evolution of Lake Superior regulation (the regulation rules have been changed five times since their first implementation) has caused confusion concerning the intent of the limits and rules of Plan 1977. This paper examines the historical basis for the IJC limits on Lake Superior levels; impacts associated with exceeding those limits are not included here. Public hearings and historical water level records were considered to determine the intentions of the IJC in establishing the original Orders of Approval of 1914 (IJC 1917). Those intentions may affect present Great Lakes water level management strategies that are based on Lake Superior outflow regulations.

HISTORICAL BACKGROUND

Prior to 1887, a natural flow regime controlled Lake Superior outflows through the St. Marys River (International Waterways Commission 1910, IJC 1914a). Construction of the International Bridge in 1887 restricted a critical cross-section of the river and effectively decreased the river's flow. By 1914, more changes had been wrought on the river channel, including U.S. and Canadian ship canals, U.S. and Canadian power canals, the filling-in of the bridge trestle and two sets of rapids, and the blocking of twelve bridge spans. Those projects reduced the river's discharge cross-section from about 16,000 square feet (1,490 m^2) to only about 6,000 square feet (560 m^2) at the same water level elevation (IJC 1914a). Diversions through the canals only partially compensated for the reduction in channel capacity, and by 1912 Lake Superior levels had been permanently raised by 0.6 ft (0.18 m) (IJC 1914a, Magrath 1914).

The Rivers and Harbors Act of 1902 required the U.S. Secretary of War to approve operation of the early U.S. power canal diversions. That approval included restrictions on diversions when Lake Superior rose or fell outside specified limits (Brown 1913, IJC 1914a). Limits were set for water levels at the canal above the locks at Sault Ste. Marie, referenced to the 1877 datum. Table 1 shows the Lake Superior level limits imposed under the Rivers and Harbors Act of 1902 in terms of the 1877 datum at Sault Ste. Marie and the 1903 datum at Marquette, Michigan. The total range in allowable levels was 2.0 ft (0.61 m). If the lake level fell below the threshold limit, diversions had to be reduced; if levels remained below the threshold for 5 consecutive months or dropped below the absolute minimum allowable level, all diversions had to cease. If the lake rose above the maximum allowable level, the power company was required to operate their canals at maximum capacity; if levels remained above the upper limit for 6 consecutive months, alteration of the canals to enable more flow was required.

In a report on flow conditions in the St. Marys River, the International Waterways Commission (IWC) recommended that Lake Superior be regulated between the absolute limits of 603.2 ft (183.86 m) and 601.7 ft (183.40 m), measured at Sault Ste. Marie (IWC 1906); this translates into limits of 603.6 ft (183.98 m) and 602.1 ft (183.52 m) at Marquette (IJC 1914a) and represents a range of 1.5 ft (0.46 m). In a subsequent report on the potential for regulation of Lake Erie (IWC 1910), the Commission again reviewed Lake Superior's regulation potential. The Commission stated that their previously recommended range of control for Lake Superior was impractical and further suggested that regulation of Lake Superior could not reduce the natural range of lake level fluctuations.

IJC ORDERS OF APPROVAL

Shortly after the Boundary Waters Treaty of 1909 was passed, the U.S. and Canadian power companies asked to increase their diversions for power production (Algoma Steel Corporation 1913, Brown 1913). The approval of these changes in the St. Marys River was the responsibility of the IJC, which had been created by the treaty. The IJC held two series of hearings in March and April 1914 to examine the historical lake level conditions, the effect of existing obstructions in the St. Marys River, and the effects of alternatives regarding the proposed diversions and control works. The power companies, the USACE, the Canadian federal and Ontario provincial governments, and many riparian interests requested that the IJC also determine the operational limits of the control works (Powell 1914). Much of the hearings subsequently dealt with establishing those limits and their impacts.

The Boundary Waters Treaty of 1909 required that IJC decisions concerning boundary waters projects must give preference to domestic and sanitary uses, navigation, and power and irrigation, in that order (IJC 1965). At the hearings, the effects of the proposed diversions and lake level regulations on domestic, sanitary, or irrigation uses were not an issue; navigation was the prime concern. A major industry at that time, shipping charges alone

TABLE 1. Lake Superior level limits specified by the U.S War Department under the Rivers and Harbors Act of 1902[1].

Limits	1877 datum Sault Ste. Marie, Michigan (feet)	(meters)	1903 datum[2] Marquette, Michigan (feet)	(meters)
Maximum Allowable Level	603.0	(183.79)	603.6	(183.98)
Threshold Level	601.5	(183.34)	602.1	(183.52)
Minimum Allowable Level	601.0	(183.18)	601.6	(183.37)

[1]International Joint Commision (1914a)

[2]Conversion to 1903 datum depends on the water level plane of reference (PR) of 1877 being 0.2 ft (0.06 m) lower than the PR of 1903 at Sault Ste. Marie, and the 1903 PR at Sault Ste. Marie being 0.4 ft (0.12 m) lower than the 1903 PR at Marquette (International Joint Commission 1914a).

produced almost $44.5 million in 1913 (Magrath 1914). Although the treaty placed power production below navigation in importance, the hydropower industry also contributed much to the regional economy. Diversions proposed by the U.S. and Canadian power companies were estimated to save about $1 million annually over the same power produced by any other means (Magrath 1914). Riparian interests were not recognized under the treaty; however, the IJC did consider riparians in deciding on Lake Superior regulations. The eight largest cities along the Lake Superior shoreline had a combined population of about 250,000 with taxable property worth about $125 million (Magrath 1914).

Testimony during the hearings convinced the IJC that Lake Superior levels fluctuated about 3.5 ft (1.07 m), based on records beginning in 1860 (IJC 1914a). The highest reported monthly mean lake levels were 604.08 ft (184.12 m) and 603.93 ft (184.08 m), supposedly occurring at Marquette in September 1869 and August 1876, respectively (presently published values do not agree with the 1869 level, however [Hartmann 1986]). The lowest reported lake level was 600.5 ft (183.03 m) at Marquette which occurred in April 1911 (IJC 1914a, National Ocean Survey 1982). A representative from the city of Duluth purported levels there of 600.09 ft (182.91 m) and 605.44 ft (184.54 m); however, these levels are not monthly means and are influenced by local meteorological conditions. The USACE reported that prior to the partial obstruction of the St. Marys River that began in 1887, the range in Lake Superior levels had been 3.32 ft (1.01 m), with a minimum lake level of 600.76 ft (183.11 m) supposedly occurring at Marquette. Obstructions in the St. Marys River had raised Lake Superior levels by 0.6 ft (0.18 m); future lake levels were expected to fluctuate between a low of 601.1 ft (183.22 m) and a high of 604.6 ft (184.28 m) measured at Marquette, unless changes were made to the St. Marys River to enable a greater outflow capacity. Table 2 presents these levels in terms of the 1903 datum at Marquette.

The control works proposed by the power companies consisted of a dike and a series of 16 sluice gates to extend completely across the St. Marys River above the rapids (Magrath 1914). The works were designed to compensate for the proposed diversions; as more water was diverted through the power canals, less water would be allowed through the river channel (IJC 1914a). Additionally, the works could be operated to provide broad public benefits. Engineers for the power companies and the USACE testified that, at best, the sluice gates could be operated so the lake levels would fluctuate within a 2.5 ft (0.76 m) range, rather than the historical range of 3.5 ft (1.07 m). Control of the levels within a smaller range was not deemed practical. An engineer for the Michigan Northern Power Company asserted that "no works can be devised by which the variations of the lake can be held within an absolute range of one foot and a half" (0.46 m). However, the engineers explained that because the river would be under complete control, the upper or lower extremes of Lake Superior levels could be modified. Thus, one of the IJC's major concerns was establishing the range of levels allowable for Lake Superior.

TABLE 2. Historical (1860–1913) and expected Lake Superior levels considered by the International Joint Commission (IJC) during the 1914 hearings.[1]

	Level at Marquette, Michigan 1903 datum	
	(feet)	(meters)
High level, September 1869[2]	604.08	(184.124)
High level, August 1876	603.93	(184.078)
Low level, April 1911[3]	600.5	(183.03)
Low level, February 1871[4]	600.76	(183.112)
Expected high level[5]	604.6	(184.28)
Expected low level[5]	601.1	(183.22)

[1]IJC (1914a).
[2]Presently published values do not agree with the 1869 level (Hartman 1869).
[3]Month not specified in IJC hearings; lowest 1911 level shown by the National Ocean Survey (1982) occurred in April.
[4]Month and year not specified in IJC hearings; lowest level prior to 1887 shown by the International Waterways Commission (1910) occurred in February 1871.
[5]Expected levels based on a recurrence of historical water supplies with unchanged 1914 obstructions in the St. Marys River.

The most important consideration in determining the limits for Lake Superior regulation was the impact on navigation. All other interests were "slight" in comparison. Shallow depths in the channels and harbors required reductions in ship draft and loads in times of low lake levels. A representative for the Lake Carriers Association considered 601.5 ft (183.34 m), measured at Marquette, to be the absolute minimum depth suitable for navigation (IJC 1914a). The USACE and Canadian government reported that lake levels below 602.1 ft (183.52 m) seriously affected navigation (IJC 1914a).

Because the river was to be completely controlled by the proposed structural works, the gates could be operated to maintain lake levels below 603.6 ft (183.98 m), even if conditions leading to the high levels of 1869 or 1876 were to recur. The USACE originally recommended that the IJC set upper and lower limits for Lake Superior regulation at 603.6 ft (183.98 m) and 601.1 ft (183.22 m), respectively, giving a range in levels of 2.5 ft (0.76 m). However, the minimum level of 601.1 ft (183.22 m) was unacceptable for navigation. Although the upper limit of 603.6 ft (183.98 m) negatively affected riparians, the lower limit had higher priority because it affected navigation. The engineers asserted that for most water supply conditions, lake levels could be regulated within a 1.5 ft (0.46 m) range between 603.6 ft (183.98 m) and 602.1 ft (183.52 m), but that the water supply conditions of 1869 and 1876 were "in a class by themselves." If the minimum limit was held to a level suitable for navigation, regardless of the regulation scheme, "those two years would get away from us" and levels would inevitably again reach their historical highs of 604.08 ft (184.12 m) and 603.93 ft (184.08 m), respectively. An engineer for the USACE testified that structural works could be designed with a greater discharge capacity so that reaching 604.1 ft (184.13 m) was only a remote possibility even with a minimum level sufficient for navigation; but because that alternative was "exceedingly" expensive, he recommended against it.

After considering the effects on navigation of their originally suggested limits, the USACE subsequently recommended that the upper and lower limits be set at 603.6 ft (183.98 m) and 602.1 ft (183.52 m), respectively (a range of 1.5 ft [0.46 m]), with the understanding that lake levels could be expected to vary a half foot (0.15 m) about those limits to 604.1 ft (184.13 m) and 601.6 ft (183.37 m), respectively, still giving a range of 2.5 ft (0.76 m). These limits reduced the extreme high stage by a half foot (0.15 m) from that expected, if no changes were made to compensate for the reduced discharge capacity of the St. Marys River, and if the high water supplies of 1869 or 1876 were to recur. The extreme low stage also was raised by a half foot (0.15 m) over that expected if the St. Marys River was left unchanged.

Eventually, the riparians appreciated that Lake Superior could be regulated only within a 2.5 ft (0.76 m) range, that the more constant lake levels were a benefit, and that local economies would be adversely affected if navigation were to suffer low lake levels. They agreed to support IJC approval of the limits, if the regulations were under international control. Thus, the IJC approved both applications in May 1914 subject to conditions described fully in the Orders of Approval (IJC 1914b,c), including upper and lower limits for Lake Superior regulations of 603.6 ft (183.98 m) and 602.1 ft (183.52 m), respectively. The limits thus chosen by the IJC were those that had been used in the War Department's 1902 Instrument of Approval, recommended by the IWC of 1906, and

again recommended by the expert witnesses representing both power companies and all government interests during the 1914 hearings.

IMPLICATIONS FOR PRESENT REGULATIONS

Although the IJC Orders of Approval mention two lake level limits, those limits are not absolute, binding limits like those in the 1902 War Department's Approval or those in the IWC recommendation of 1906. The IJC intended the limits to serve only as goals for Lake Superior's regulation. The hearings show that the IJC realized Lake Superior could not always be regulated within 602.1 ft (183.52 m) and 603.6 ft (183.98 m). The Commission's mandated rules of regulation were simply an attempt to prevent high lake levels due to management for power and navigation benefits at the expense of the riparians. The rules were not meant to prevent high lake levels during conditions of extremely high water supplies.

Although the 1914 IJC hearings show clearly the origin of Lake Superior regulation limits, the evolution of those limits to the current 602.0 ft (183.49 m) (IGLD55) level is not so clear. None of the levels mentioned in the early USACE, IWC, or IJC reports or hearings are equivalent to 602.0 ft (183.49 m) (IGLD55) when they are converted between datums using a single water level gauge location. However, a report by the IJC (IJC 1976) examining the potential for further regulation of the Great Lakes describes the 1914 Orders of Approval as requiring Lake Superior to be maintained between the elevations of 602.0 ft (183.49 m) and 600.5 ft (183.03 m) (IGLD55). This suggests that the 602.0 ft (183.49 m) (IGLD55) limit in the subsequent 1979 Supplementary Orders of Approval (International Lake Superior Board of Control 1982) is based somehow on the earlier 1914 limits. Although testimony at the 1914 IJC hearings generally considered lake levels in terms of measurements at Marquette, the subsequent 1914 Orders of Approval specified that lake levels be determined as the mean of water levels measured by at least four automatic gauges, with half the gauges in each country (IJC 1914b,c). The Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data (CCGLBHHD 1978) presented benchmark elevations for only five water level gauge locations about Lake Superior that enable conversion of lake levels from the 1903 datum to IGLD55: Marquette, Pt. Iroquois, and Southwest Pier (Sault Ste. Marie), Michigan, and Thunder Bay and Gros Cap, Ontario. Other gauge locations are listed in the CCGLBHHD report (including Duluth, Minnesota, and Michipicoten, Ontario, which, with Marquette, Pt. Iroquois, and Thunder Bay, comprise the gauge network used for present Lake Superior regulations), but their lack of reference to suitable benchmarks prohibits direct transfer of elevations between the 1903 datum and IGLD55. Table 3 shows the differences between datums for each of the five gauge locations where 1903 datum and IGLD55 elevations are available. When using the arithmetic mean of the differences between datums for these five gauges, the 603.6 ft (183.98 m) and 602.1 ft (183.52 m) limits of the 1914 Orders become 602.0 ft (183.49 m) and 600.5 ft (183.03 m) (IGLD55), respectively. Table 4 presents the suggested and expected upper and lower limits for Lake Superior levels mentioned in the IJC hearings in terms of the 1903 and IGLD55 datums, based on the use of all five gauges for conversion between datums.

The upper limit on Lake Superior levels given by the present IJC Supplementary Orders of Approval thus appears to be based on the 603.6 ft (183.98 m) guideline limit specified by the IJC in 1914. Following the original intentions of the IJC, the present 602.0 ft (183.49 m) (IGLD55) limit should be considered only as a goal for regulation under ordinary water supply conditions. In 1914, the IJC expected Lake Superior would rise up to a half foot (0.15 m) higher than the upper limit when water supplies were similar to those of 1869 or 1876. Table 5 presents monthly water supplies for Lake Superior in 1869, 1876, and 1985. In 1985, Lake Superior received an annual supply slightly greater than that of 1869 and nearly as large as that of 1876. The lake experienced extremely high water supplies in the autumn of 1985; the exceedance probabilities for the supplies in September, October, and November are 9, 5, and 1 percent, respectively (N. Noorbakhsh, USACE, Detroit District, 1986, personal communication). Thus, under the original intentions of the IJC, Lake Superior would have been allowed to exceed 602.0 ft (183.49 m) (IGLD55) in 1985, precluding the need for excess Lake Superior outflows.

It should be noted that strict adherence to the present operational regulation plan (Plan 1977) may have prevented Lake Superior from exceeding 602.0 ft (183.49 m) (IGLD55) in 1985. Plan 1977 is better than previous regulation plans at reducing

TABLE 3. Benchmark elevations for water level gauge locations about Lake Superior.[1]

Location	Benchmark	Elevation[2] 1903 datum (feet) (meters)	Elevation[2] IGLD55 (feet) (meters)	Difference (feet) (meters)
Marquette, MI	No. 6	628.414 (191.5406)	626.554 (190.9737)	-1.86 (-0.567)
Pt. Iroquois, MI	Lighthouse	622.033 (189.5957)	620.623 (189.1659)	-1.41 (-0.430)
Southwest Pier, MI	Meridian	607.843 (185.2705)	606.431 (184.8402)	-1.403 (-0.4276)
Thunder Bay, ONT	Steel Rivet	616.154 (187.8037)	614.492 (187.2972)	-1.662 (-0.5066)
Gros Cap, ONT	1362	619.780 (188.9089)	618.012 (188.3701)	-1.768 (-0.5389)
Mean difference between datums				-1.6206 (-0.49396)

[1]Although there are other gauge locations about Lake Superior, only Marquette, Pt. Iroquois, Southwest Pier, Thunder Bay, and Gros Cap have benchmarks available with elevations for both the 1903 datum and the International Great Lakes datum of 1955 (IGLD55).

[2]Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data (1978).

TABLE 4. Limits on Lake Superior levels.

	Lake Level 1903 datum		Lake Level IGLD55[2]	
	(feet)	(meters)	(feet)	(meters)
Upper Limit[1]	603.6	(183.98)	602.0	(183.49)
Lower Limit[1]	602.1	(183.52)	600.5	(183.03)
Expected high level[3]	604.1	(184.13)	602.5	(183.64)
Expected low level[3]	601.6	(183.37)	600.0	(182.88)

[1]International Joint Commission (1914a).

[2]Conversion to the International Great Lakes Datum of 1955 (IGLD55) depends on the mean differences between 1903 and 1955 benchmark elevations at Marquette, Pt. Iroquois, and Southwest Pier, (Sault Ste. Marie), Michigan, and Thunder Bay and Gros Cap, Ontario (see Table 3).

[3]Expected high and low levels are 0.5 ft (0.15 m) above and below the upper and lower limits, respectively, giving a 2.5 ft (0.76 m) range in Lake Superior levels (International Joint Commission 1914a).

TABLE 5. Lake Superior monthly water supplies.[1]

Month	Year 1869[2]	1876[2]	1985[3]
January	2 (1.9)	16 (14.9)	-25 (23.2)
February	-43 (-39.9)	33 (30.7)	33 (30.7)
March	86 (79.9)	68 (63.0)	68 (63.2)
April	244 (226.6)	176 (163.5)	178 (165.4)
May	159 (147.7)	303 (281.5)	193 (179.3)
June	155 (144.0)	291 (270.3)	128 (118.9)
July	240 (223.0)	205 (190.4)	142 (131.9)
August	333 (309.4)	121 (112.4)	127 (118.0)
September	185 (171.9)	47 (43.7)	153 (142.1)
October	-29 (-26.9)	31 (28.8)	118 (109.6)
November	-60 (-55.7)	33 (30.7)	125 (116.1)
December	-60 (-55.7)	-12 (11.1)	-19 (-17.7)
Annual Average	101 (93.8)	109 (101.3)	102 (94.8)

[1]Thousand cubic feet per second (hundred cubic meters per second in parentheses).

[2]International Waterways Commission (1910).

[3]Preliminary supplies (N. Noorbakhsh, U.S Army Corps of Engineers, Detroit District, 1986, personal communication).

the frequency and magnitude of high lake level conditions (International Lake Superior Board of Control 1981). However, the original IJC intentions were not violated by suspending Plan 1977 (in effect, using a new ad hoc regulation plan). The IJC of 1914 anticipated that extremely high water supplies similar to those of 1869 and 1876 would cause lake levels to exceed 602.0 ft (183.49 m) (IGLD55) regardless what regulation plan was followed. Because the 1985 supplies to Lake Superior were similar to those of 1869 and 1876, it was consistent with original IJC intentions to allow Lake Superior to exceed 602.0 ft (183.49 m) (IGLD55).

Based on testimony during the 1914 hearings, the IJC believed that Lake Superior levels naturally fluctuated over a 3.5 ft (1.07 m) range. However, a closer look at the testimony and historical data shows the expected fluctuation range to be larger. The USACE erroneously testified that Lake Superior experienced the full 3.5 ft (1.07 m) range in levels prior to modifications in the St. Marys River channel in 1887. In fact, the low water level of 600.5 ft (183.03 m) mentioned by the USACE did not occur until 1911, and this level was artificially raised by about 0.6 ft (0.18 m), due to obstructions in the St. Marys River. Without those obstructions, the low water level of 1911 would have been 599.9 ft (182.85 m). Additionally, in a review of the history of water level measurements at Superior, Wisconsin, where the high level actually was measured in 1869 (not at Marquette as was reported to the IJC), Moore (1944a) noted that the high level measured there probably resulted from a combination of localized heavy rainfall and a partial blocking of the harbor where the gauge was located. While the measurement shows the true local water level, it probably does not represent the true Lake Superior level. However, the high level of August 1876 at Marquette (603.93 ft [184.08 m]) is considered reliable (Hartmann 1986, Moore 1944b). Thus, the potential natural range in Lake Superior levels considered by the IJC in 1914 should have been 4.03 ft (1.23 m).

By failing to recognize the more extreme variability in water supply conditions, the 1914 IJC may have overestimated the ability of proposed regulation to maintain Lake Superior levels within a 2.5 ft (0.76 m) range, and may have set the lower lake level limit too high to prevent substantial riparian damage in times of high water supplies (a recurrence of the supplies of 1876 may prove even Plan 1977 ineffective at maintaining Lake Superior levels below 602.0 ft [183.49 m] [IGLD55]). However, because navigation was of "paramount" importance, the 1914 IJC perhaps could have accommodated the wider range in supply conditions by increasing the upper lake level limit to 604.1 ft (184.13 m) (with the understanding that levels could range a half foot higher [0.15 m]), rationalizing that the 604.6 ft (184.28 m) expected maximum was no worse than what could be expected without compensation for the existing obstructions in the St. Marys River.

SUMMARY

Modifications of Lake Superior levels began in 1888 with man-made obstructions in the St. Marys River channel. By 1912 reductions in the river's discharge capacity had raised the lake level by 0.6 ft (0.18 m). In 1914, the International Joint Commission approved structural works to compensate for increased diversions and the channel obstructions. They specified limits for the operation of the works, including limits on Lake Superior levels. Water level limits of 603.6 ft (183.98 m) and 602.1 ft (183.52 m) (1903 datum) were mandated to prevent the manipulation of lake levels for power and navigation benefits at the expense of riparians. However, the IJC intended these limits to serve only as goals for Lake Superior's regulation; the limits were not meant to prevent high lake levels during conditions of extremely high supplies. Lake Superior levels were expected to rise about a half foot (0.15 m) higher than the upper limit under such conditions. The 1979 IJC Supplementary Orders of Approval specify that Lake Superior should be regulated to stay below 602.0 ft (183.49 m) (IGLD55); this corresponds to the 603.6 ft (183.98 m) (1903 datum) limit of the 1914 Orders when converted to IGLD55 using an arithmetic mean of the difference between datums for five gauging locations about the lake. Under the original intentions of the IJC, Lake Superior levels would have been allowed to reach about 602.5 ft (183.64 m) (IGLD55) during 1985, requiring no excess outflows from Lake Superior.

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