A REPORT ON 1992 WATER LEVELS OF THE GREAT LAKES

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January 1993

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1.0 PURPOSE AND SCOPE

This report summarizes the hydrologic factors that have shaped the water levels on the Great Lakes - St. Lawrence River system in 1992. It also contains a summary of the operations related to Lake Superior and Lake Ontario regulation.

As in previous reports, the assessment of the hydrologic conditions of the Great Lakes - St. Lawrence River system is based on the information available at the time this report was prepared. The data used in this report may be subject to revisions by the agencies issuing these data.

The format of this report is similar to that of previous annual reports prepared for 1985-1991. All data are in metric units. Water level elevations are in metres on the International Great Lakes Datum (IGLD) 1985, which has its reference zero elevation at Rimouski, Quebec in the Gulf of St. Lawrence. A table is included in this report which lists the conversion factors between the 1955 and 1985 datums for the water level gauges listed in the Canadian and United States water level bulletins.

2.0 PHYSICAL FEATURES OF THE GREAT LAKES - ST. LAWRENCE RIVER BASIN

The Great Lakes basin is about 770,000 square kilometres in area (see Figure 1). The basin extends from about 80 kilometres west of the western tip of Lake Superior to the outlet of Lake Ontario, and from Lake Nipigon in the Province of Ontario south to the central portion of the State of Ohio. About 319,000 square kilometres of the area are in Canada and the remaining 451,000 square kilometres are in the United States which include the entire State of Michigan and portions of Minnesota, Wisconsin, Illinois, Indiana, Ohio, Pennsylvania and New York.

The Great Lakes with their connecting channels and Lake St. Clair have a total water surface area of about 246,000 square kilometres. The St. Lawrence River, from Lake Ontario to Quebec City, adds an additional 337,000 square kilometres of drainage area, most of which is located in the Province of Quebec and the State of New York. The dimension of the Great Lakes and other physical dimensions are shown in Table 1.

As shown in Figure 2, the Great Lakes comprise a series of natural storage reservoirs which discharge into the St. Lawrence River. They are positioned in a step-wise manner, with Lake Superior being the highest and Lake Ontario the lowest, and are interconnected by a series of rivers and straits. Lake Superior discharges through the St. Marys River into Lake Huron. Lake Michigan, located entirely in the United States, also flows into Lake Huron through the Straits of Mackinac. The hydraulically unified Lakes Michigan and Huron (often called Lakes Michigan-Huron) discharge into Lake Erie through the St. Clair - Lake St. Clair - Detroit River system.

Lake Erie's outflow is discharged through the Niagara River into Lake Ontario and Lake Ontario, in turn, flows into the Atlantic Ocean via the St. Lawrence River.

The water levels of the Great Lakes fluctuate according to the climate of the region. Over-lake precipitation, evaporation and runoff in the basin are the main factors affecting water level fluctuations. Other natural factors also having an effect on lake levels are flow retardation due to ice in the river in the winter, or due to aquatic vegetation growth in the summer, and meteorological disturbances. Artificial factors include dredging, diversions, consumptive uses and regulation. A detailed description of these factors can be found in the report by the International Great Lakes Levels Board dated 1973.

3. FACTORS AFFECTING GREAT LAKES LEVELS IN 1992

3.1 Hydrologic Conditions Leading to 1992

Before examining in detail the water level fluctuation in 1992, it is worthwhile to review briefly the conditions just prior to 1992.

Table 4 shows the net basin supplies the upper Great Lakes received in 1991 and 1992. The supplies to Lake Superior in 1991 were slightly above average. The high supplies in October and November of 1991 brought the Lake Superior levels, which had been below average for a number of months, close to average by year end. No deviations from the regulation plan were necessary in 1991 in the regulation of the outflows of Lake Superior.

For Lakes Michigan-Huron, the levels followed closely to the long-term average seasonal fluctuation during 1991. The slightly above average supplies in the first half of 1991 were offset by the low supplies in the late summer months. Similar to Lake Superior, high supplies also occurred in October and November which placed the levels near average by year end.

Accurate figures for supplies for Lake Erie are not available, it was estimated that the lake received below average supplies in 1991. This brought the level which had been well above average at the beginning of 1991 to slightly above average by December 1991.

The net basin supplies to Lake Ontario for 1991 were well above average early in the year, but were steadily below average for much of the rest of the year. The annual net basin supplies, as shown in Table 5, were slightly above average. As described in the 1991 annual report, the International St. Lawrence River Board of Control implemented a program of over-discharge from February to May 1991 at the time when both Lake Erie and Lake Ontario levels were high. The purpose of the program was to avoid exceeding the upper limit of 75.37 metres (247.29 feet), IGLD (1985) on Lake Ontario as specified in the International Joint Commission's Orders of Approval. Once the threat of higher Lake Ontario level passed, the Board ended its program of over-discharge and initiated a program of under-discharge to offset the high flows that occurred earlier. However, the low water supplies in the subsequent months caused the Lake Ontario levels to decline rapidly to below average by December 1991.

3.2 Precipitation

Records since 1900 show that, on average, about 820 millimetres (32 inches) of precipitation falls on the Great Lakes Basin each year. Average annual precipitation varies from lake basin to lake basin and ranges from less than 700 mm northwest of Lake Superior to as much as 1320 mm in the Adirondacks east of Lake Ontario in the State of New York. Table 2 compares the monthly precipitation for each basin in 1991 and 1992 with the long-term averages.

Great Lakes basin-wide precipitation in 1992 was about 109 percent of average. All the basins received higher than average precipitation. The Lake Ontario and Lake Erie basins received much higher than average precipitation. In July, the precipitation on the Lake Erie basin was a record high.

3.3 Water Supplies to the Great Lakes

Net basin supply is a term used to describe the amount of water a lake receives from its local drainage basin. It is the net effect of over-lake precipitation, basin runoff and evaporation from the lake. The units, as listed in Table 4 and Table 5, are in cubic metres per second for each month.

Net total supply to a lake is the sum of the net basin supply to that lake and the inflow to the lake from the lake upstream. For example, the net total supply to Lake Ontario consists of the inflow from Lake Erie and the supply from its basin. As on average about 85 percent of the total supply to Lake Ontario comes from Lake Erie, conditions on the upper lakes is one of the main factors affecting Lake Ontario level fluctuation.

As shown in Table 4, the net basin supplies to Lake Superior for much of 1992 were slightly above average. Low supplies occurred in March and June, months in which precipitation was below average.

For Lakes Michigan-Huron, May and June were dry months while September and November were on the wet side. The figures for Lake Erie were estimated to be above average except for May and June.

The water supplies to Lake Ontario were below average in early 1992, but were above average in the fall months. The figures for Lake Ontario are listed in Table 5.

3.4 Outflows

Table 3 lists the monthly outflows from the Great Lakes for 1992. The outflow of Lake Superior in 1992 was about 2230 cubic metres per second (m^3/s) which is slightly higher than the long-term average. Near average outflow from Lake Michigan-Huron occurred in 1992 and is a reflection of the near average water level conditions on those lakes.

The Lake Erie outflow for 1992 was about 6280 m^3/s, about 8 percent higher than average. The outflow from Lake Ontario was also high, being 7460 m^3/s, and is about 9 percent higher than average.

3.5 Great Lakes - St. Lawrence River Water Levels

Figures 3 to 8 show the seasonal fluctuations of the Great Lakes and Montreal Harbour in 1992. All the data in these figures, including the long-term average curve and the historical maximum and minimum values, are for a specific site on each lake. These diagrams, also used in the monthly Canadian water level bulletins, give a good picture of the seasonal fluctuations for the past two years.

Table 6 lists the monthly average levels for the Great Lakes in 1992 and how they compare with the historical data. To obtain an accurate lake-wide water surface elevation, a network of gauges are used. For Lake Superior, readings from five sites on the lake are used to determine the lake-wide water level elevation. For Lakes Michigan-Huron, six gauges are used. The names of the gauges used in the computation for each lake are listed in Table 7.

Normally, the water levels of the Great Lakes follow a seasonal cycle in which water level rises in the spring and summer months due to increased runoff from snowmelt. Lake levels then normally drop in the late summer and fall months due to reduced runoff and increased evaporation. In 1992, the levels of Lake Superior followed this trend fairly closely.

The seasonal fluctuations on the other lakes varied somewhat from the normal seasonal trend. For Lakes Michigan-Huron, the spring rise was much less than average. The lake levels remained fairly constant for most of the summer months with very little seasonal decline in the fall. The levels were near average at the beginning of the year, and were slightly above average by December 1992.

Lake St. Clair and Lake Erie experienced a normal rate of seasonal rise in the spring. But high water supplies in the fall halted their seasonal decline and, by year end, the levels remained similar to the summer's peaks. The Lake Erie level in December was about 50 centimetres above average.

The levels of Lake Ontario were below average at the beginning of the year. High supplies caused the levels to rise sharply in the spring. Above average supplies also reduced the rate of decline in late summer and early fall. By December, the levels were generally 30 centimetres above average.

The water levels of Montreal Harbour were below average until September. The high flows from the Ottawa River and the St. Lawrence River helped maintain the levels above average for the rest of the year. During 1992, the levels in the harbour were well above the navigation chart datum.

4.0 EFFECTS OF GREAT LAKES WATER LEVELS

There were no serious flood or erosion damages reported in 1992 on the Great Lakes - St. Lawrence River system. However, some damages were reported when several storms passed over the lower Great Lakes region in the fall.

The below average water level conditions on Lake Superior during the summer months made some boat docks unusable. This problem also occurred in 1991 when water levels were also below average. The shore property owners on Lakes Michigan-Huron were generally satisfied with the levels in 1992.

The water levels on Lake Erie and Lake Ontario commencing in August were much higher than average. During the last two months in 1992, some residents on Lake Erie and Lake Ontario expressed concerns about the high water level conditions and a possibly more serious condition in the spring of 1993.

For Lake Ontario, the conditions in November 1992 were vastly different from those one year earlier. In November 1991, the levels were about 20 centimetres below average. Many residents in eastern Lake Ontario had difficulties with dry shore wells because of the low lake levels. In November 1992, levels were about 25 centimetres above the seasonal average.

The high flows in the international section of the St. Lawrence River in early 1992 and again in the fall of the year were a subject of concern to shore residents. In 1991, high Lake Ontario levels and high flows in the river combined with waves generated by ships caused some shoreline erosion and property damages in the Morrisburg area. As the levels in early 1992 were much lower than those one year earlier, the problem diminished somewhat.

Recreational boaters on Lake Ontario and the upper reach of the St. Lawrence River were generally satisfied with the water level conditions.

In the fall of 1992, several storms passed over the lower Great Lakes region at the time when levels were above average. The most severe storm occurred on November 13-14. A number of shore residents in eastern Lake Ontario in the Trenton area suffered shoreline erosion and property damage as a result of the storm. Minor flooding also occurred in the Port Dover and Long Point areas along Lake Erie.

Another storm passed over the region on December 11. Strong easterly winds affected the west ends of Lakes Ontario and Erie, but no flooding was reported.

Lake St. Louis and Montreal Harbour experienced high water level conditions in the spring and again in the last two months of the year. However, no damages were reported and levels on Lake St. Louis were below the damage elevation.

No water level problems were encountered for the shipping interests on the Great Lakes - St. Lawrence River system. The 1992 navigation season opened as scheduled on the Welland Canal section and the international reach of the St. Lawrence River. The closing of the navigation season also took place without incident. The mild weather and the absence of ice in late December enabled the last commercial vessel to exit smoothly the international reach of the St. Lawrence River on December 28.

Montreal Harbour experienced adequate depths for commercial navigation throughout 1992. The levels in the harbour in November and December when high flows occurred were well above the minimum requirements for the vessels which used the harbour.

The hydro-electric facilities at Sault Ste Marie in the St. Marys River utilized all the waters they were allocated by the regulation plan - Plan 1977-A. The gate setting at the Lake Superior Compensating Works was set at one-half gate open during 1992 which is the minimum requirement for the St. Marys Rapids.

The high flows in the Niagara River and the St. Lawrence River resulted in above average hydro-electirc power production. There was some spillage at the Beauharnois-Cedars power plants (near Montreal) in the fall and early winter months when the river flows exceeded the plants' capacities.

The Long Sault Spillway, located adjacent to the Moses-Saunders power plants at Cornwall, Ontario, was not used in 1992 since all the river flows could be discharged through the power plants. However, the high flows have resulted in the less efficient use of the water for power generation.

5.0 WATER MANAGEMENT ACTIONS RELATED TO GREAT LAKES WATER LEVELS

5.1 Lake Superior Regulation

In 1992, the International Lake Superior Board of Control regulated the outflows of Lake Superior according to the criteria specified by the International Joint Commission and the use of Regulation Plan 1977-A. Since there were no unusual water supply or water level conditions, the Board did not make any major departures from the regulation plan. The outflows of Lake Superior consist of the flows through the power plants, the Lake Superior Compensating Works, and the navigation locks, all located at Sault Ste. Marie, Ontario and Sault Ste. Marie, Michigan.

A slight departure from the regulation plan was made in February, March and April when the outflows were reduced slightly from those specified by the regulation plan. This action was taken to satisfy Criterion (c) of the IJC's Orders of Approval. The criterion states that whenever the Lake Superior level is below 183.40 metres (601.7 feet), IGLD (1985), the Lake Superior outflow shall be no greater than that which would have occurred under the 1887 conditions, or pre-project outflow conditions. The objective of the criterion is to prevent excessive lowering of the Lake Superior levels. The amounts of the departure from the regulation plan were small and caused about a one centimetre increase temporarily in Lake Superior levels.

5.2 Lake Ontario Regulation

In 1992, the International St. Lawrence River Board regulated the outflows of Lake Ontario generally according to Plan 1958-D, with some departures as described below. The outflow of Lake Ontario is regulated by the Saunders-Moses hydro-electric power plants and the Long Sault Spillway located at Cornwall, Ontario and Massena, New York.

With the exception of some minor deviations from Plan 1958-D in January as part of the winter operation, the outflows of Lake Ontario in early 1992 were those specified by the regulation plan. During the period April 18 through May 8, the Board reduced the outflows during the Ottawa River freshet to maintain levels below the flood stage on Lake St. Louis. The impact of this action was equivalent to about 4 centimetres of rise on Lake Ontario when compared with the conditions with strict application of the plan.

In the middle of May, the level of Lake Ontario reached its seasonal daily peak at 75.12 m (246.45 feet), IGLD (1985). This level was 23 centimetres lower than the daily maximum in 1991, and was also 14 centimetres above the seasonal average.

From May 23 to June 12, the Board reduced the outflow from Lake Ontario by a small amount from that specified by the regulation plan. By June 12, the accumulated underdischarge deviations from Plan 1958-D were 820 m^3/s-weeks (29,000 cfs-weeks) which was equivalent to the storage of about 3 cm (1 inch) of water on Lake Ontario.

Between August 29 and mid-November, the Board approved reductions in the flows to avoid large spills of water at the Beauharnois-Cedars hydro-electric power complex near Montreal, and at the Moses-Saunders power plant. This period coincided with the intensified maintenance and repair work at the hydro facilities which temporarily reduced their discharge capacities. By November 13, the accumulated underdischarge deviations from Plan 1958-D were 3200 m^3/s-weeks (114,000 cfs-weeks) which was equivalent to the storage of 10 cm (4 inches) of water on Lake Ontario. No adverse impacts to other interests were experienced as a result of these outflow deviations.

On November 13, the Board terminated its program of underdischarge in light of the high supplies conditions, and began to direct high flows. The relatively mild weather and the absence of ice in December enabled flows much higher than usual to be discharged and thus eliminated all the previous under-discharge deviations by the end of the year.

In 1992, the International St. Lawrence River Board of Control authorized three series of temporary emergency flow reductions. These occurred on November 2, November 23 and December 11. These reductions occurred during periods of very high outflows from Lake Ontario. High flows result in low water levels on Lake St. Lawrence just upstream of the Moses-Saunders power plants. The effects of strong easterly winds further lowered the levels at the Eisenhower Lock to the chart datum level. The temporary flow reductions restored water depths to safe levels for navigation and thus avoided possible ship grounding. The flow reductions lasted a few days on each occasion and resulted in a total of 400 m^3/s-weeks of under-discharge compared to Plan 1958-D, or 1 cm rise of Lake Ontario.

5.3 Great Lakes Water Levels Communications Centre (GLWLCC)

The Great Lakes Water Level Communications Centre in Burlington, Ontario, continued its activities in 1992 by issuing the monthly news releases that accompany the monthly water level bulletins. The six-month forecasts that appear in the bulletins are prepared monthly by Environment Canada's office in Cornwall, Ontario. The Centre also provided information and responses to inquiries from the public and media, and gave presentations at meetings.

In 1992, the Environment Canada staff in Cornwall commenced issuing the monthly water level bulletins for the Lake Ontario - St. Lawrence River system. The bulletins, issued jointly with the U.S. Army Corps of Engineers during the boating season, give water level conditions for six sites from Kingston, Ontario to Point Claire on Lake St. Louis in Quebec, as well as a forecast of the water levels. The bulletins are distributed to the local media, shore property owners and marinas who have an interest in water level fluctuations in the river.

The GLWLCC responded to about 150 telephone and mail requests for information. A number of calls came to the Centre expressing concerns about the high water levels on Lake Erie and Lake Ontario in November and December, and about possible more serious conditions in the spring of 1993.

5.4 International Joint Commission Water Levels Reference Study

The Levels Reference Study is examining methods that could be taken to alleviate the adverse consequences of fluctuating Great Lakes and St. Lawrence River water levels. The final phase of the study is nearly complete. The Study Board's draft report will be reviewed at four public meetings February 22 to 25 before being finalized and presented to the International Joint Commission in March 1993.

The study was undertaken in response to public concern about record high levels of four of the five Great Lakes in 1985 and 1986. A progress report was completed in 1989, and the final phase of the study began in the latter part of 1990. This final part of the study has emphasized citizen participation through an 18-member Citizens Advisory Committee and an intensive public information program.

Upon completion of the last part of the study, the Study Board will have visited 17 Great Lakes - St. Lawrence River communities to learn about the problems of specific areas and to discuss the study with local citizens:

Windsor, Ontario
Alexandria Bay, New York
Cleveland, Ohio
Port Rowan, Ontario
Duluth, Minnesota
Traverse City, Michigan
Baraga, Michigan
Toledo, Ohio
Burlington, Ontario
Thunder Bay, Ontario
Milwaukee, Wisconsin
Sarnia, Ontario
Watertown, New York
Sault Ste. Marie, Ontario
Chicago, Illinois
Buffalo, New York
Dorval, Quebec

The last eight of these events were public forums; four of which discussed the range of options available to governments and four of which reviewed the draft final report.

In addition to the public involvement activities, the Study Board has discussed the range of options for recommendations with senior federal, state and provincial government officials in Hull, Quebec, Indianapolis, Indiana, and Washington, D.C.

6.0 FORECAST OF FUTURE WATER LEVEL CONDITIONS

A six-month forecast of the water levels of the Great Lakes and Montreal Harbour is shown in Figures 3-8. It should be noted that the water levels of the Great Lakes fluctuate according to the climatic conditions in the basin. Since it is not possible to accurately forecast long-term weather conditions, the forecasts are made assuming average, wet and dry climatic conditions for the next six months.

Assuming the most probable water supplies over the next six months, the level of the Great Lakes would remain above their respective seasonal average levels. The Montreal Harbour levels are expected to remain above chart datum. Levels in the harbour during the winter months can not be precisely predicted since ice conditions vary greatly among the winters.

7.0 FINDINGS AND CONCLUSIONS

1. The high water supplies to the Great Lakes in 1992 raised their levels to above average conditions by the end of the year. In the case of Lake Erie and Lake Ontario, levels were well above average after the high precipitation of November and December.

2. The absence of ice problems in the St. Lawrence River has made high Lake Ontario outflows possible in December 1992; and high flows are expected to continue during the winter months. However, the potential for spring flooding exists and the precipitation in the next three months will be crucial in deciding how much the levels will rise during the spring.

3. There were no serious flood and erosion damages on the Great Lakes in 1992. But there were reports of some damages on Lake Erie and Lake Ontario in late 1992 when storms acted on the already above average water level conditions.

Table 1 Dimensions of the Great Lakes

	Area Sq Km	Volume Cu Km	Shoreline Length Mainland Km	Shoreline Length Island Km	Water Depth Average Metres	Water Depth Maximum Metres
Lake Superior	82100	12100	2780	1600	147	405
St. Mary's River	230		153	244		
Lake Michigan	57800	4920	2250	383	85	281
Lake Huron	59600	3540	2970	3180	59	229
St. Clair River	55		93	8		
Lake St. Clair	1110		210	204		6
Detroit River	100		96	116		
Lake Erie	25700	484	1290	116	19	64
Niagara River	60		111	60		
Lake Ontario	18960	1640	1020	125	87	244
St. Lawrence River*	610		484	567		
**	1540		1130	750		

Source: Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data

* Measured from Lake Ontario to Cornwall/Massena.

** Measured from Cornwall/Massena to Ile d'Orleans near Quebec City

Table 2 Precipitation on the Great Lakes Basin in 1991, 1992* and Their Comparison with Long-Term Average (millimetres)

Superior Basin

	Average	1992	% of Average	1991	% of Average
Jan	49.4	36.3	73	50.3	102
Feb	37.4	33.5	90	20.6	55
Mar	44.6	27.4	61	63.5	142
Apr	49.2	75.4	153	62.0	126
May	68.6	73.2	107	84.3	123
Jun	83.1	59.4	71	67.6	81
Jul	81.6	94.0	115	107.7	132
Aug	82.2	91.7	112	55.6	68
Sep	88.5	126.2	143	124.0	140
Oct	68.4	48.5	71	90.9	133
Nov	63.6	60.2	95	112.5 R	177
Dec.	51.4	75.2	146	44.4	86
Total	768.1	801.0	104	883.4	115

Michigan-Huron Basin

	Average	1992	% of Average	1991	% of Average
Jan	52.6	50.0	95	36.6	70
Feb	43.9	40.1	91	27.2	62
Mar	54.9	61.0	111	90.7	165
Apr	64.7	72.6	112	91.7	142
May	75.9	34.8	46	91.7	121
Jun	78.7	52.6	67	34.3	44
Jul	74.9	105.4	141	106.4	142
Aug	78.0	83.3	107	52.8	68
Sep	87.7	112.8	129	85.6	98
Oct	70.9	55.1	78	145.8	206
Nov	69.2	127.0	184	79.2	114
Dec	58.9	60.2	102	60.4	103
Total	810.0	854.9	106	902.5	111

Erie Basin

	Average	1992	% of Average	1991	% of Average
Jan	61.4	64.3	105	49.3	80
Feb	52.5	52.6	101	42.7	81
Mar	71.0	70.9	101	78.2	110
Apr	78.8	96.5	124	98.0	124
May	83.6	62.7	77	101.6	122
Jun	87.5	57.4	66	45.0	51
Jul	83.4	182.9 R	222	59.4	71
Aug	80.3	97.5	122	70.4	88
Sep	79.1	130.8	167	49.3	62
Oct	68.9	66.8	97	106.2	154
Nov	71.2	137.7	193	76.2	107
Dec	65.8	88.9	135	61.0	93
Total	883.4	1109.0	126	837.2	95

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Table 2 (Continued)

Ontario Basin

	Average	1992	% of Average	1991	% of Average
Jan	67.4	62.2	93	58.4	87
Feb	60.3	53.3	89	36.6	61
Mar	67.5	84.1	125	115.1	171
Apr	72.0	94.0	133	113.0	157
May	77.6	86.9	114	81.5	105
Jun	78.4	41.7	54	31.5	40
Jul	78.7	134.1	171	67.6	86
Aug	78.9	101.4	129	70.9	90
Sep	80.7	108.0	134	79.5	99
Oct	76.3	64.8	85	70.6	93
Nov	78.4	108.5	138	62.2	79
Dec	73.4	81.8	110	77.5	106
Total	889.5	1020.8	115	864.4	97

Great Lakes Basin

	Average	1992	% of Average	1991	% of Average
Jan	54.6	47.5	88	44.7	82
Feb	45.2	41.7	93	28.4	63
Mar	55.5	55.9	101	84.6	152
Apr	63.1	79.2	126	87.1	138
May	74.8	55.1	74	89.7	120
Jun	80.9	53.8	66	44.4	55
Jul	78.2	116.3	149	95.8	123
Aug	79.5	89.7	113	58.2	73
Sep	85.9	118.4	138	90.4	105
Oct	70.5	55.9	79	116.8	166
Nov	69.0	108.0	156	85.8	124
Dec	59.5	70.6	119	58.2	98
Total	816.7	892.1	109	884.2	108

Source: NOAA, Corps of Engineers
* Preliminary Data.
Averages for 1900-1989 as computed by NOAA dated June 21, 1991
R denotes new record
All figures are in millimetres rounded to one decimal place.

Table 3 Outflows from the Great Lakes in 1991 and 1992
(cubic metres per second)

Lake Superior	1992	1991	Average 1900-1990	Previous Recorded Maxima & Minima (Year of Occurrence) Maximum	Minimum
Jan	2290	1590	1950	2630 (1971)	1250 (1922)
Feb	2260	1560	1900	2610 (1969)	1270 (1982)
Mar	2180	1560	1870	2690 (1969)	1270 (1982)
Apr	2180	1930	1950	2940 (1951)	1300 (1982)
May	2320	2150	2120	3450 (1951)	1250 (1931)
Jun	2350	2150	2180	3480 (1951)	1220 (1922)
Jul	2100	2180	2290	3570 (1938)	1270 (1922)
Aug	2290	2460	2380	3600 (1950)	1270 (1926)
Sep	2150	1950	2380	3570 (1950)	1160 (1955)
Oct	2290	1930	2290	3510 (1968)	1250 (1926)
Nov	2240	1980	2270	3740 (1985)	1250 (1981)
Dec	2100	2320	2070	3200 (1950)	1300 (1981)
Annual	2230	1980	2140		

Lakes Michigan-Huron	1992	1991	Average 1900-1990	Previous Recorded Maxima & Minima (Year of Occurrence) Maximum	Minimum
Jan	4980	4590	4450	6060 (1987)	3060 (1934)
Feb	4930	4730	4360	5720 (1974)	3000 (1942)
Mar	5100	4930	4810	5830 (1986)	3510 (1931)
Apr	5150	5210	5150	6260 (1986)	3600 (1901)
May	5270	5380	5350	6370 (1986)	4390 (1964)
Jun	5270	5490	5470	6430 (1985)	4420 (1964)
Jly	5210	5490	5520	6570 (1974)	4500 (1964)
Aug	5120	5470	5520	6630 (1986)	4530 (1964)
Sep	5070	5320	5490	6600 (1986)	4470 (1933)
Oct	5180	5180	5440	6740 (1986)	4420 (1933)
Nov	5210	5150	5380	6650 (1986)	4390 (1934)
Dec	5270	5320	5180	6230 (1986)	3990 (1935)
Annual	5150	5190	5180		

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Table 3 (Continued)

Lake Erie

	1992	1991	Average 1900-1990	Previous Recorded Maxima & Minima (Year of Occurrence) Maximum	Minimum
Jan	5660	6570	5580	7420 (1987)	4050 (1936)
Feb	5750	6510	5470	7050 (1987)	3340 (1936)
Mar	5970	6540	5610	7480 (1986)	4110 (1934)
Apr	6290	6600	5890	7700 (1974)	4390 (1935)
May	6400	6480	6200	7760 (1974)	4590 (1934)
Jun	6060	6290	6230	7820 (1986)	4560 (1934)
Jly	6260	6200	6120	7670 (1986)	4450 (1934)
Aug	6430	6030	6000	7420 (1986)	4470 (1934)
Sep	6630	5890	5890	7140 (1986)	4450 (1934)
Oct	6510	5720	5800	7450 (1986)	4420 (1934)
Nov	6650	5750	5800	7280 (1986)	4280 (1934)
Dec	6800	5860	5780	7620 (1985)	4330 (1934)
Annual	6280*	6200	5830		

Lake Ontario

	1992	1991	Average 1900-1990	Previous Recorded Maxima & Minima (Year of Occurrence) Maximum	Minimum
Jan	6140	6710	6260	8470 (1987)	4700 (1935)
Feb	6370	8010	6290	8160 (1986)	4360 (1936)
Mar	6570	8890	6600	8890 (1987)	5010 (1935)
Apr	6940	7900	7050	9200 (1973)	5070 (1964)
May	7730	8670	7310	9540 (1973)	4980 (1965)
Jun	7730	7930	7390	9910 (1973)	5350 (1965)
Jly	7360	7590	7330	9910 (1976)	5520 (1934)
Aug	7790	7360	7160	9340 (1974)	5300 (1934)
Sep	8100	7170	6990	9230 (1986)	5100 (1934)
Oct	8130	6770	6800	9170 (1986)	4960 (1934)
Nov	8300	6340	6680	9570 (1986)	4810 (1934)
Dec	8350	6200	6570	9260 (1986)	4810 (1934)
Annual	7460	7460	6870		

Source: Water Planning and Management Branch, Environment Canada
* Preliminary Data

Table 4 Lakes Superior and Michigan-Huron Supply Summary
(cubic metres per second)

Lake Superior Net Basin Supplies (m^3/s)

		1992		1991	
	1900-1988 Average	N.B.S. (m^3/s)	Difference in Storage (m)	N.B.S. (m^3/s)	Difference in Storage (m)
Jan	-400	0	0.01	-790	-0.01
Feb	310	250	0	-250	-0.02
Mar	1270	570	-0.02	2830	0.05
Apr	4220	4110	0	4530	0.01
May	5240	5210	0	4930	-0.01
Jun	4450	2150	-0.07	3540	-0.03
Jul	3680	4560	0.03	3710	0
Aug	2860	2970	0	1390	-0.05
Sep	2100	3910	0.06	1190	-0.03
Oct	1080	1390	0.01	2550	0.05
Nov	540	1420	0.03	3230	0.09
Dec	-650	990	0.05	-450	0.01
Sum	24700	27530	0.09	26410	0.05

Lakes Michigan-Huron Net Basin Supplies (m^3/s)

		1992		1991	
	1900-1988 Average	N.B.S. (m^3/s)	Difference in Storage (m)	N.B.S. (m^3/s)	Difference in Storage (m)
Jan	1500	2100	0.01	760	-0.02
Feb	2520	2750	0.01	1610	-0.02
Mar	5210	4100	-0.02	7960	0.06
Apr	8130	7560	-0.01	11300	0.07
May	7110	3000	-0.09	7700	0.01
Jun	5780	3000	-0.06	2780	-0.07
Jul	3620	4560	0.02	2750	-0.02
Aug	1560	2660	0.02	-710	-0.05
Sep	910	2750	0.04	-2800	-0.08
Oct	30	540	0.01	4050	0.09
Nov	1020	6880	0.13	1760	0.02
Dec	820	1360	0.01	3060	0.05
Sum	38210	41260	0.07	40220	0.04

Source: International Lake Superior Board of Control
31360 m^3/s-month is equivalent to 1 metre storage on Lake Superior
44690 m^3/s-month is equivalent to 1 metre storage on Lakes Mich-Huron

Table 5 Lake Ontario Supply Summary

	1900-1988 Average	1992 N.B.S. (m^3/s)	1992 Difference in Storage (metres)	1991 N.B.S. (m^3/s)	1991 Difference in Storage (metres)
Jan	910	740	-0.02	1390	0.06
Feb	1050	850	-0.03	1440	0.05
Mar	2120	1420	-0.09	3340	0.16
Apr	2630	3280	0.09	3060	0.06
May	1700	1780	0.01	1640	-0.01
Jun	1160	820	-0.05	420	-0.10
Jul	680	1420	0.10	250	-0.06
Aug	230	930	0.09	0	-0.03
Sep	140	910	0.10	-60	-0.03
Oct	200	650	0.06	80	-0.02
Nov	570	1980	0.19	140	-0.06
Dec	760	1610	0.11	790	0
Sum	12150	16390	0.57	12490	0.05

Source: International St. Lawrence River Board of Control
7430 m^3/m-months is equivalent to 1 metre storage on Lake Ontario

Table 6. Great Lakes Water Levels in 1992 and 1991 and Their Comparison with Previous Records (Metres, IGLD-1985)

Lake Superior Water Levels	Five Gauge 1992	Five Gauge 1991	Five Gauge 1918-1990	Previous 1918-90 Mean Lake Maximum	Maxima & Minima (Year of Occurrence) Minimum
Jan	183.37	183.23	183.36	183.70 (1986)	182.83 (1926)
Feb	183.29	183.16	183.30	183.64 (1986)	182.76 (1926)
Mar	183.25	183.14	183.26	183.61 (1986)	182.74 (1926)
Apr	183.22	183.21	183.29	183.68 (1986)	182.72 (1926)
May	183.33	183.31	183.39	183.74 (1986)	182.76 (1926)
Jun	183.37	183.37	183.48	183.77 (1986)	182.85 (1926)
Jul	183.45	183.46	183.54	183.82 (1950)	182.96 (1926)
Aug	183.47	183.46	183.57	183.86 (1950)	183.02 (1926)
Sep	183.52	183.44	183.57	183.86 (1985)	183.12 (1926)
Oct	183.54	183.43	183.54	183.91 (1985)	183.10 (1925)
Nov	183.51	183.46	183.50	183.89 (1985)	183.01 (1925)
Dec	183.47	183.45	183.43	183.81 (1985)	182.92 (1925)

Lakes Michigan-Huron Levels	Six Gauge 1992	Six Gauge 1991	Harbor Be. 1900-1990	Previous 1900-90 at Harbor Beach Maximum	Maxima & Minima (Year of Occurrence) Minimum
Jan	176.39	176.35	176.36	177.20 (1987)	175.59 (1965)
Feb	176.36	176.31	176.35	177.11 (1986)	175.61 (1964)
Mar	176.39	176.33	176.36	177.12 (1986)	175.58 (1964)
Apr	176.45	176.49	176.45	177.23 (1986)	175.58 (1964)
May	176.53	176.60	176.54	177.27 (1986)	175.71 (1964)
Jun	176.53	176.66	176.61	177.32 (1986)	175.75 (1964)
Jul	176.55	176.64	176.65	177.39 (1986)	175.77 (1964)
Aug	176.54	176.59	176.63	177.41 (1986)	175.77 (1964)
Sep	176.53	176.48	176.58	177.38 (1986)	175.76 (1964)
Oct	176.49	176.40	176.52	177.49 (1986)	175.71 (1964)
Nov	176.52	176.38	176.45	177.39 (1986)	175.65 (1964)
Dec	176.53	176.40	176.41	177.26 (1986)	175.60 (1964)

Lake St. Clair Water Levels	Two Gauge 1992	Two Gauge 1991	S.C. Shore 1900-1991	Previous 1900-91 at St.Clair Shore Maximum	Maxima & Minima (Year of Occurrence) Minimum
Jan	175.01	175.23	174.80	175.80 (1986)	173.88 (1936)
Feb	175.04	175.12	174.73	175.81 (1986)	173.89 (1926)
Mar	175.09	175.19	174.85	175.81 (1986)	174.05 (1934)
Apr	175.19	175.27	175.01	175.82 (1986)	174.26 (1901)
May	175.25	175.33	175.09	175.83 (1986)	174.43 (1934)
Jun	175.25	175.39	175.15	175.91 (1986)	174.46 (1934)
Jul	175.33	175.34	175.17	175.93 (1986)	174.50 (1934)
Aug	175.35	175.30	175.13	175.89 (1986)	174.42 (1934)
Sep	175.37	175.19	175.07	175.85 (1986)	174.34 (1934)
Oct	175.24	175.03	174.98	175.97 (1986)	174.27 (1934)
Nov	175.27	174.96	174.89	175.82 (1986)	174.18 (1934)
Dec	175.24	175.20	174.90	175.80 (1986)	174.25 (1925)

(Continued on next page)

Table 6 (Continued)

Lake Erie Water Levels	Two Gauge 1992	Two Gauge 1991	Cleveland 1900-1990	Previous 1900-90 Maxima & Minima at Cleveland (Year of Occurrence) Maximum	Minimum
Jan	174.09	174.42	173.91	174.85 (1987)	173.19 (1935)
Feb	174.12	174.36	173.91	174.78 (1987)	173.15 (1936)
Mar	174.22	174.42	173.99	174.86 (1986)	173.20 (1934)
Apr	174.34	174.47	174.16	174.97 (1985)	173.37 (1934)
May	174.42	174.53	174.24	174.96 (1986)	173.44 (1934)
Jun	174.42	174.55	174.28	175.04 (1986)	173.45 (1934)
Jul	174.47	174.45	174.27	175.03 (1986)	173.45 (1934)
Aug	174.52	174.35	174.21	174.94 (1986)	173.42 (1934)
Sep	174.52	174.24	174.12	174.85 (1986)	173.38 (1934)
Oct	174.40	174.09	174.02	174.92 (1986)	173.29 (1934)
Nov	174.43	174.03	173.94	174.83 (1986)	173.18 (1934)
Dec	174.45	174.04	173.92	174.86 (1986)	173.16 (1934)

Lake Ontario Water Levels	Six Gauge 1992	Six Gauge 1991	Oswego 1900-1990	Previous 1900-90 Maxima & Minima at Oswego (Year of Occurrence) Maximum	Minimum
Jan	74.44	74.93	74.55	75.17 (1946)	73.82 (1935)
Feb	74.45	74.99	74.58	75.28 (1952)	73.80 (1936)
Mar	74.56	75.05	74.66	75.38 (1952)	73.95 (1935)
Apr	74.85	75.19	74.87	75.66 (1973)	74.04 (1935)
May	75.11	75.28	74.99	75.74 (1952)	74.13 (1935)
Jun	75.05	75.18	75.03	75.77 (1952)	74.20 (1935)
Jul	75.00	75.04	74.99	75.67 (1947)	74.15 (1934)
Aug	75.03	74.86	74.89	75.58 (1947)	74.00 (1934)
Sep	74.98	74.64	74.76	75.42 (1947)	73.90 (1934)
Oct	74.85	74.49	74.64	75.24 (1945)	73.84 (1934)
Nov	74.82	74.35	74.56	75.20 (1945)	73.75 (1934)
Dec	74.86	74.39	74.54	75.20 (1945)	73.76 (1934)

Montreal Harbour (Jetty No.1)	1992	1991	Average 1967-1991	Previous Recorded Maxima & Minima (Year of Occurrence) Maximum	Minimum
Jan	6.18	6.85	6.99	8.96 (1968)	6.21 (1989)
Feb	6.43	7.07	7.12	9.04 (1967)	6.34 (1989)
Mar	6.28	7.41	7.15	8.36 (1973)	6.13 (1989)
Apr	6.91	8.06	7.67	8.82 (1976)	6.44 (1989)
May	7.01	7.22	7.44	8.93 (1974)	6.42 (1968)
Jun	6.21	6.32	6.85	8.12 (1974)	5.93 (1988)
Jul	6.11	6.02	6.59	7.49 (1973)	5.72 (1988)
Aug	6.27	5.93R	6.49	7.27 (1972)	5.93 (1991)
Sep	6.50	5.85R	6.43	7.08 (1986)	5.85 (1991)
Oct	6.60	5.82R	6.50	7.16 (1986)	5.82 (1991)
Nov	6.99	5.64R	6.61	7.31 (1967)	5.64 (1991)
Dec	6.80	5.93	6.68	7.24 (1972)	5.87 (1978)

R denotes new record. * Preliminary Data.

Table 7 Conversion Factors between IGLD 1955 and IGLD 1985

To convert from IGLD 1955 to IGLD 1985, use the following formula:

IGLD (1955) elevation + Factor = IGLD (1985) elevation

To convert from IGLD 1985 to IGLD 1955, use the following formula:

IGLD (1985) elevation - Factor = IGLD (1955) elevation

		Conversion Factor in metres
Lake Superior at	Thunder Bay*	0.383
	Marquette**	0.345
	Duluth	0.285
	Michipicoten	0.439
	Point Iroquois	0.377
Lakes Michigan-Huron at	Goderich*	0.195
	Harbor Beach**	0.214
	Mackinaw City	0.232
	Ludington	0.150
	Thessalon	0.258
	Milwaukee	0.156
Lake St. Clair at	Belle River*	0.215
	St. Clair Shore**	0.191
Lake Erie at	Port Stanley*	0.191
	Fairport**	0.175
Lake Ontario at	Kingston*	0.176
	Oswego**	0.158
	Port Weller	0.135
	Toronto	0.132
	Cobourg	0.131
	Rochester	0.147
Montreal Harbour at	Jetty 1	0.060

* Used in the Canadian water level bulletins
** Used in the United States water level bulletins
The gauges used to determine the mean lake level for each lake are also listed in this table.

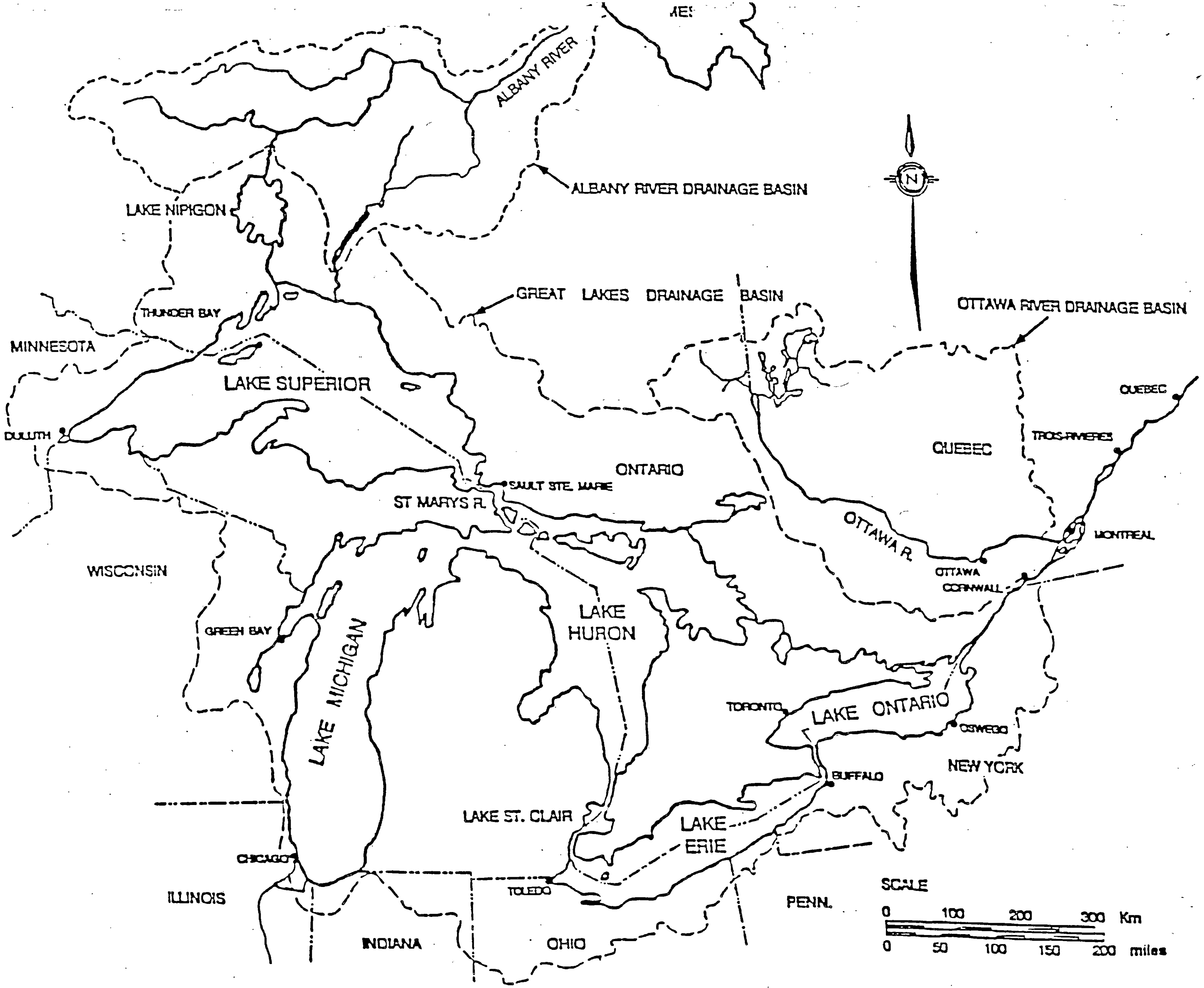


Figure 1. GREAT LAKES-ST. LAWRENCE RIVER BASIN

WATER SURFACE ELEVATIONS ARE AT CHART DATUM
IGLD (1985)

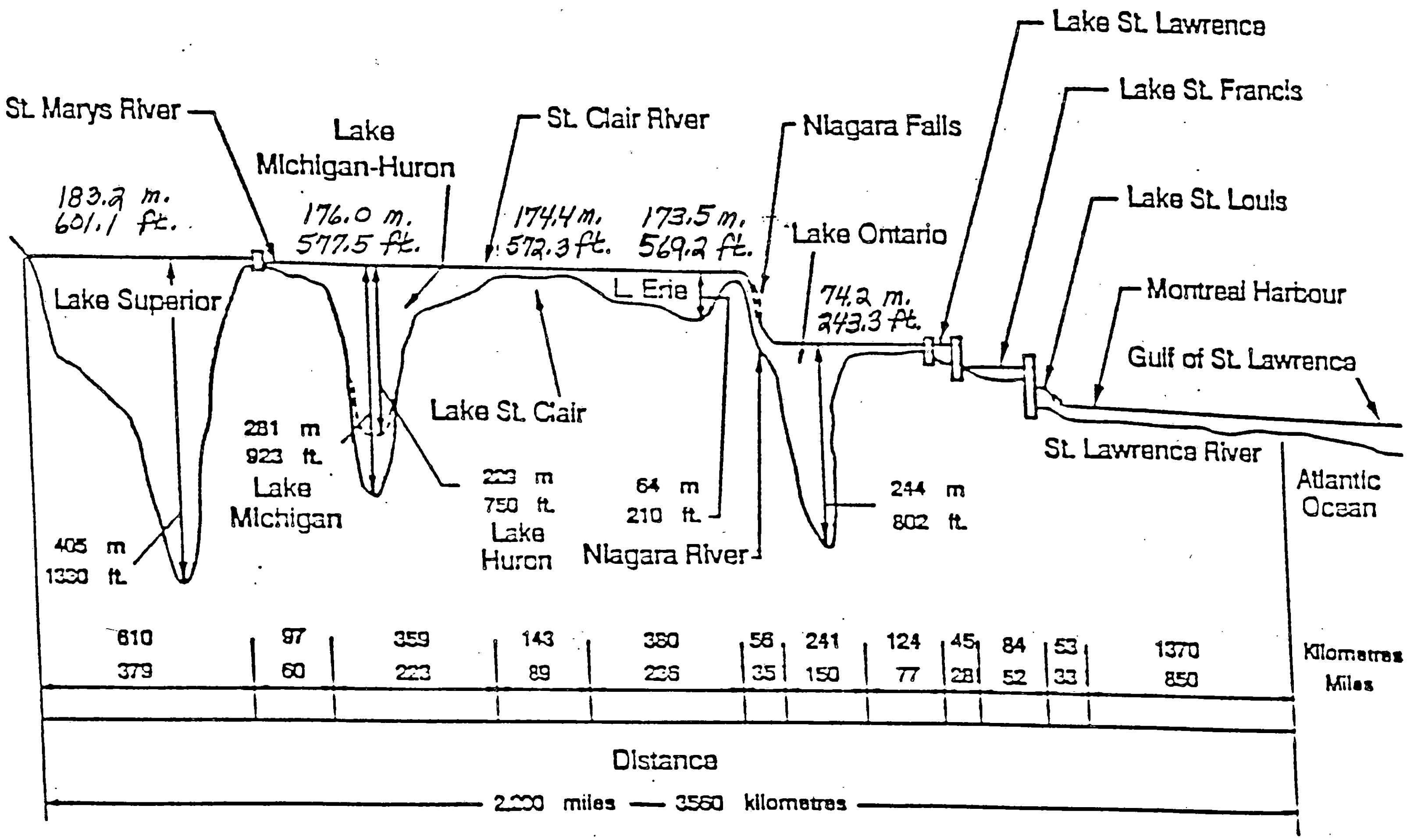
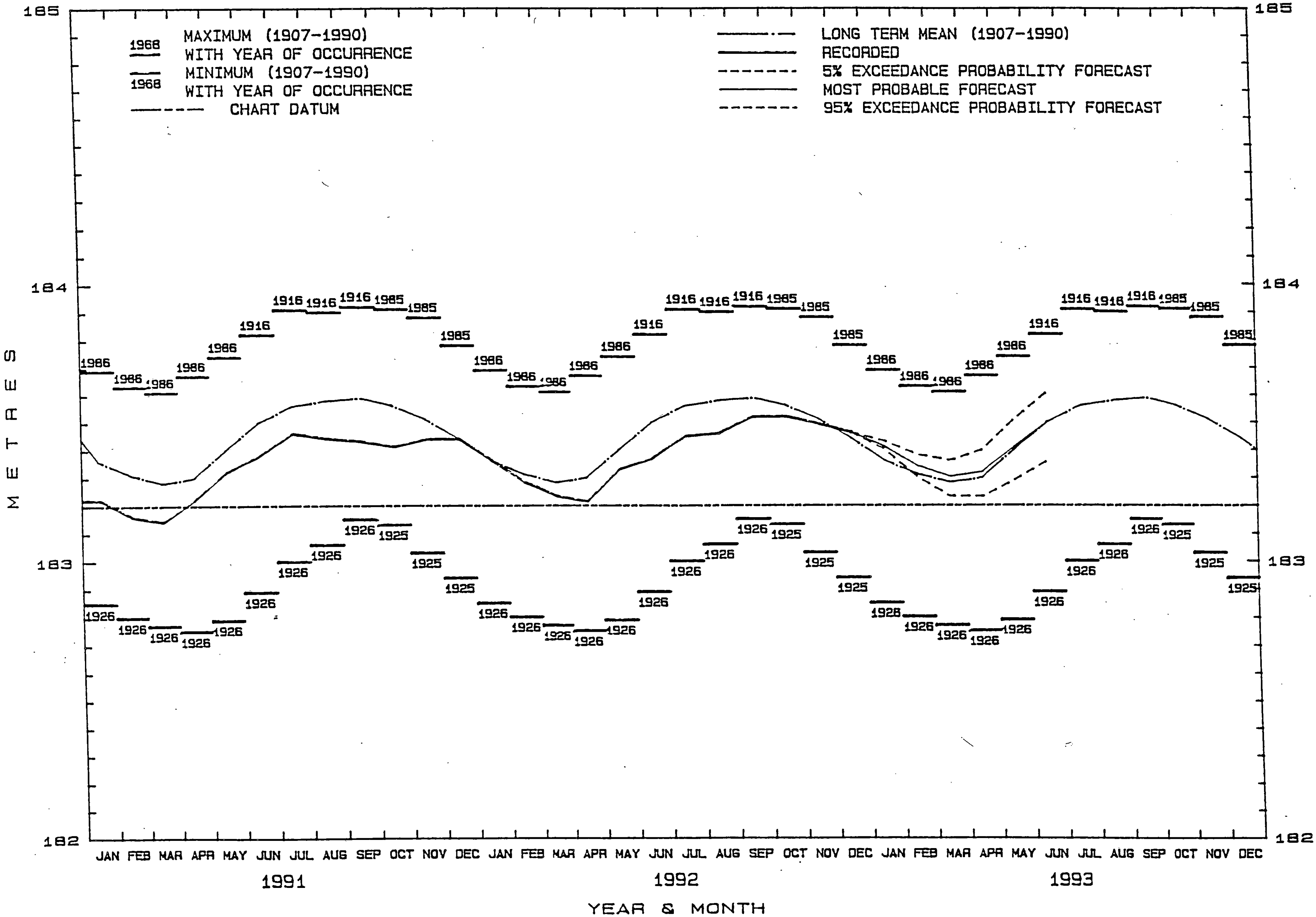
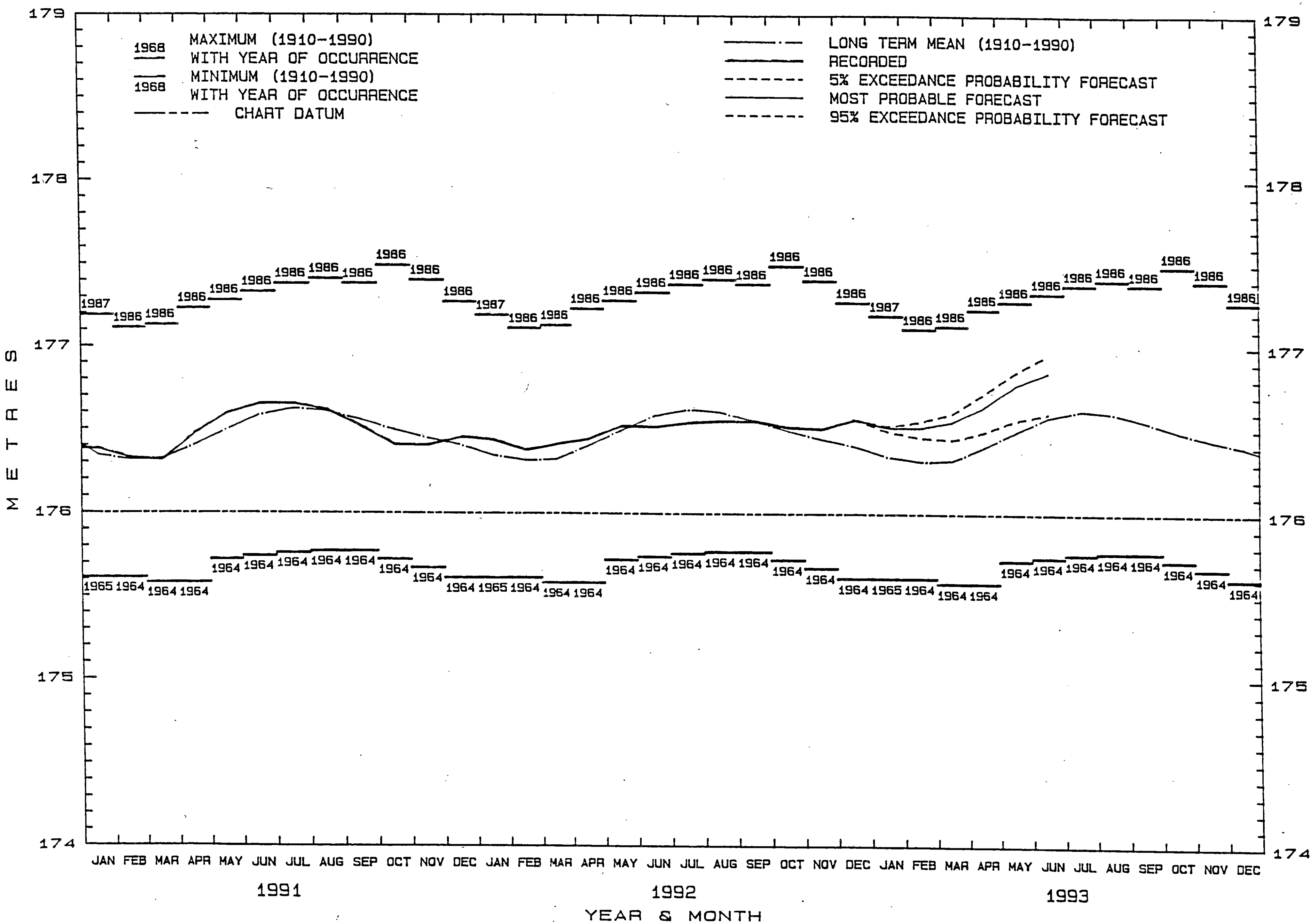


Figure 2 SCHEMATIC PROFILE OF THE GREAT LAKES - ST. LAWRENCE RIVER SYSTEM

LAKE SUPERIOR AT THUNDER BAY



LAKE HURON AT GODERICH



LAKE ST. CLAIR AT BELLE RIVER

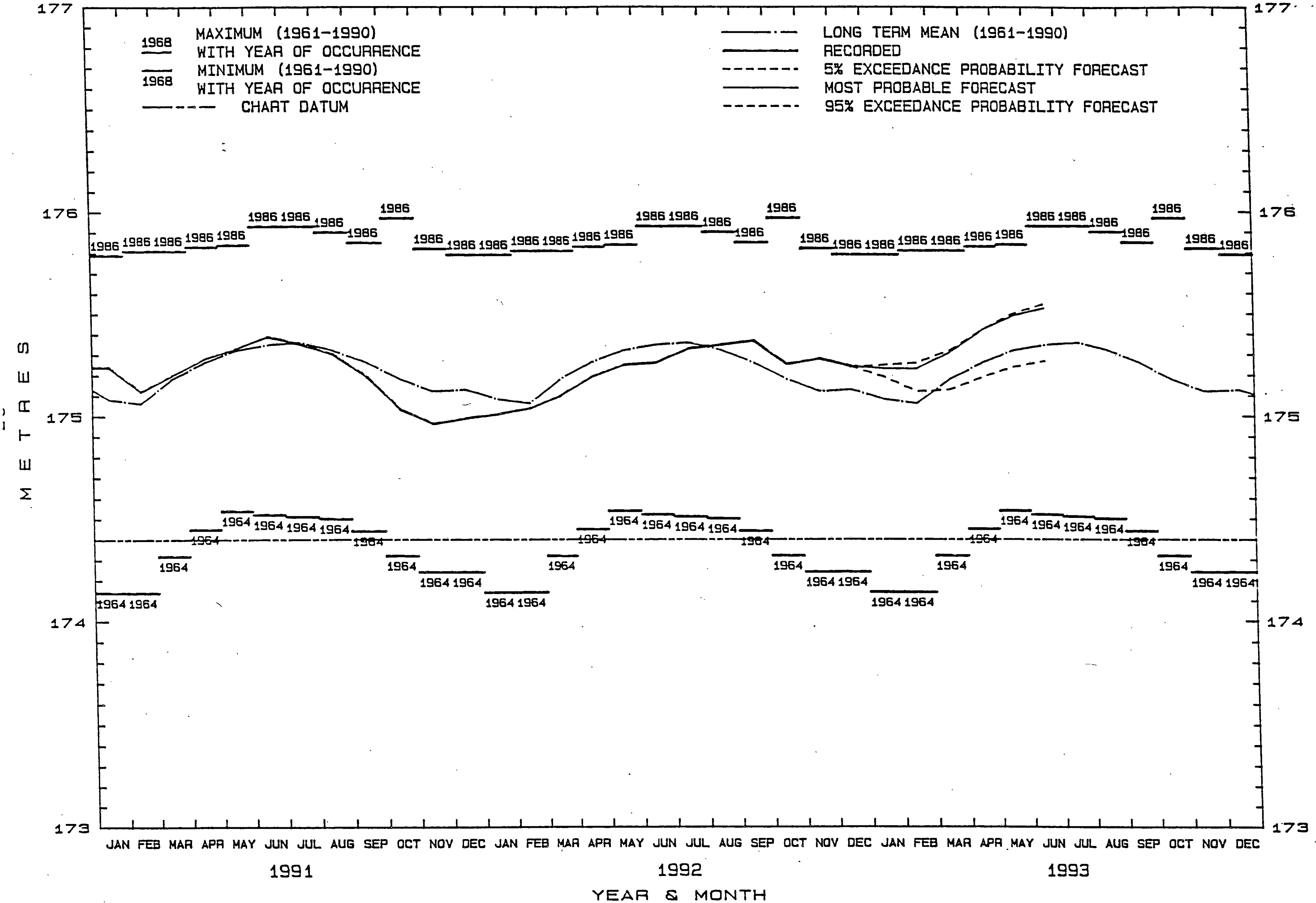
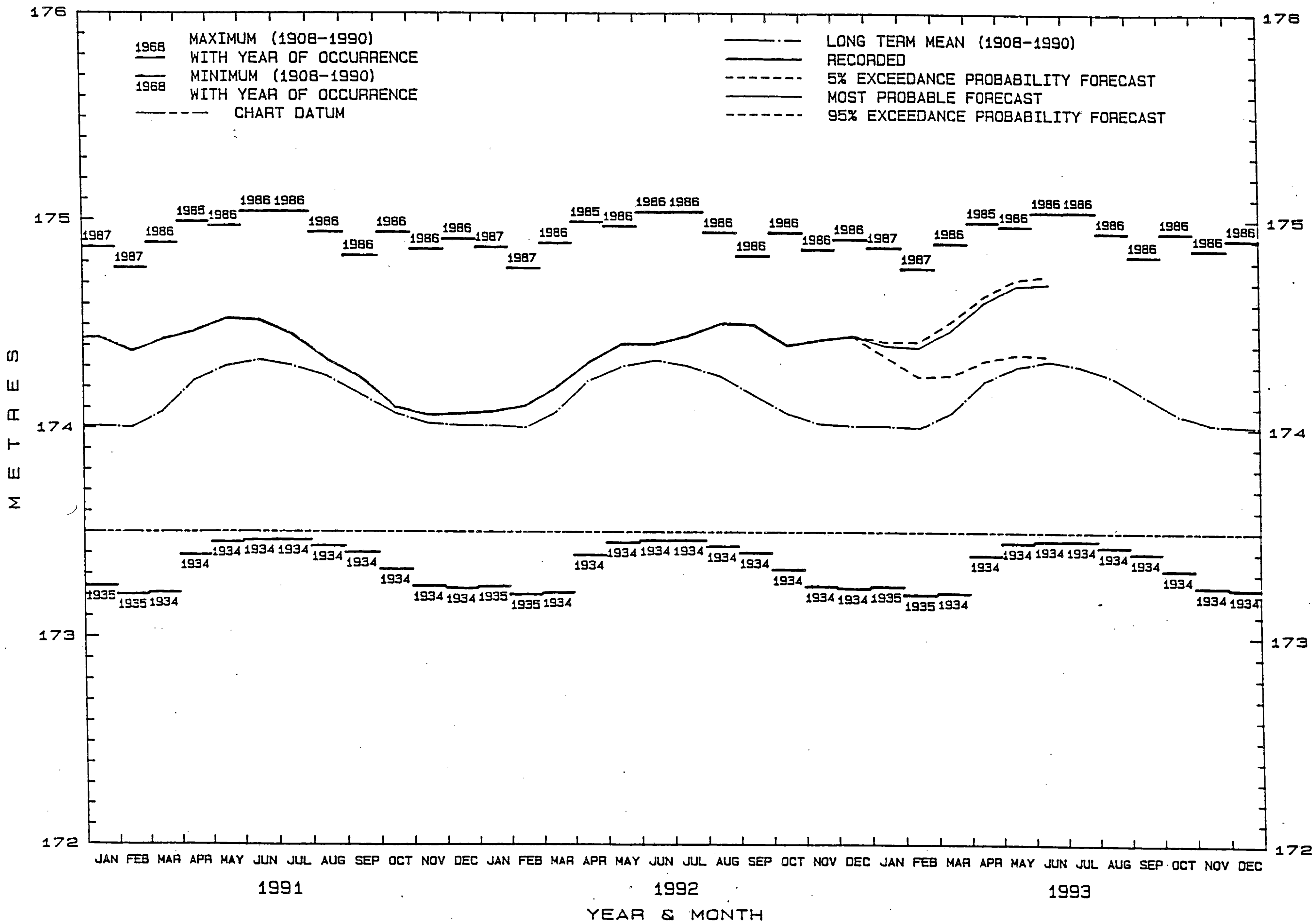


FIGURE 5

LAKE ERIE AT PORT STANLEY



LAKE ONTARIO AT KINGSTON

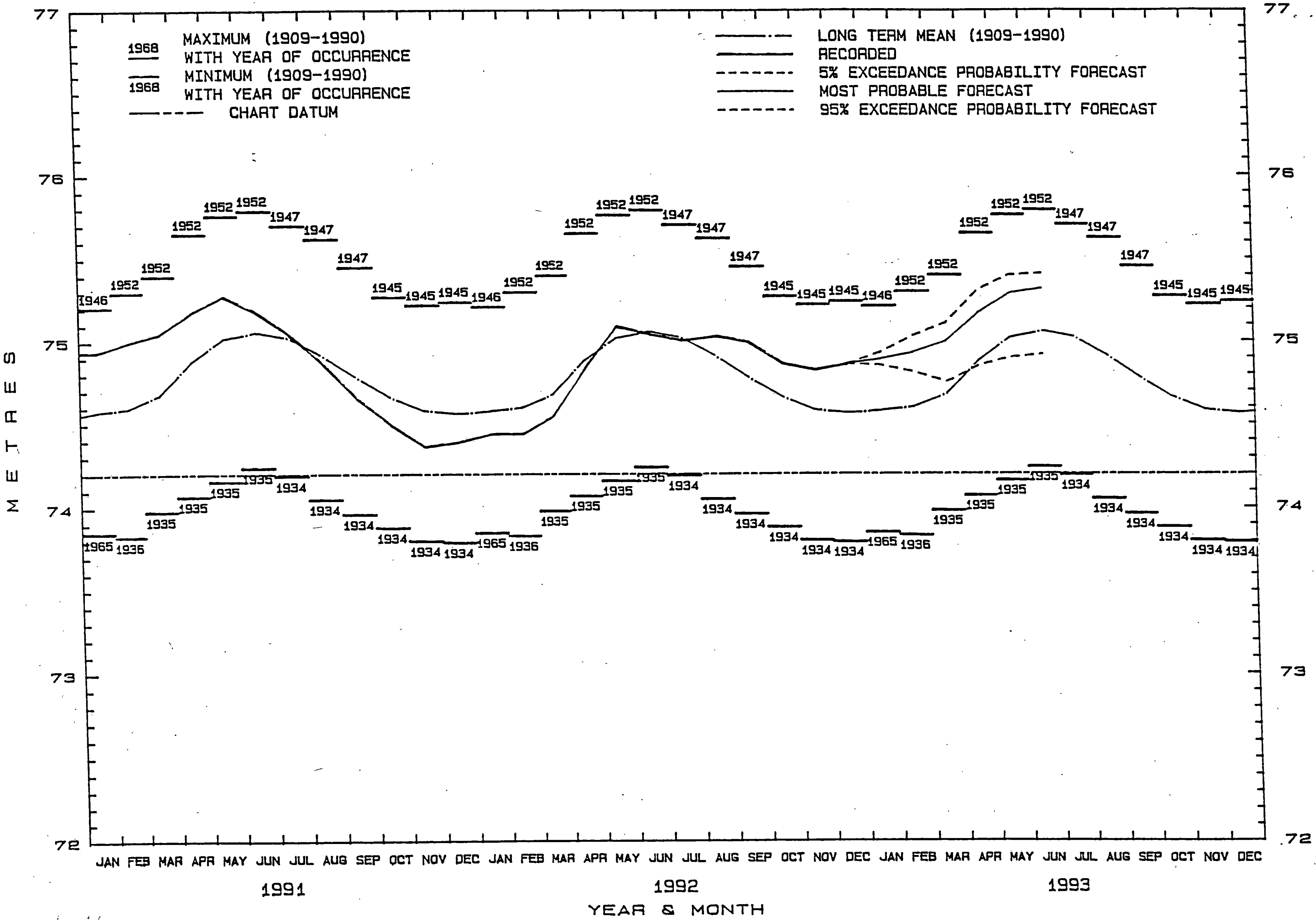


FIGURE 7

MONTREAL HARBOUR (JETTY NO. 1)