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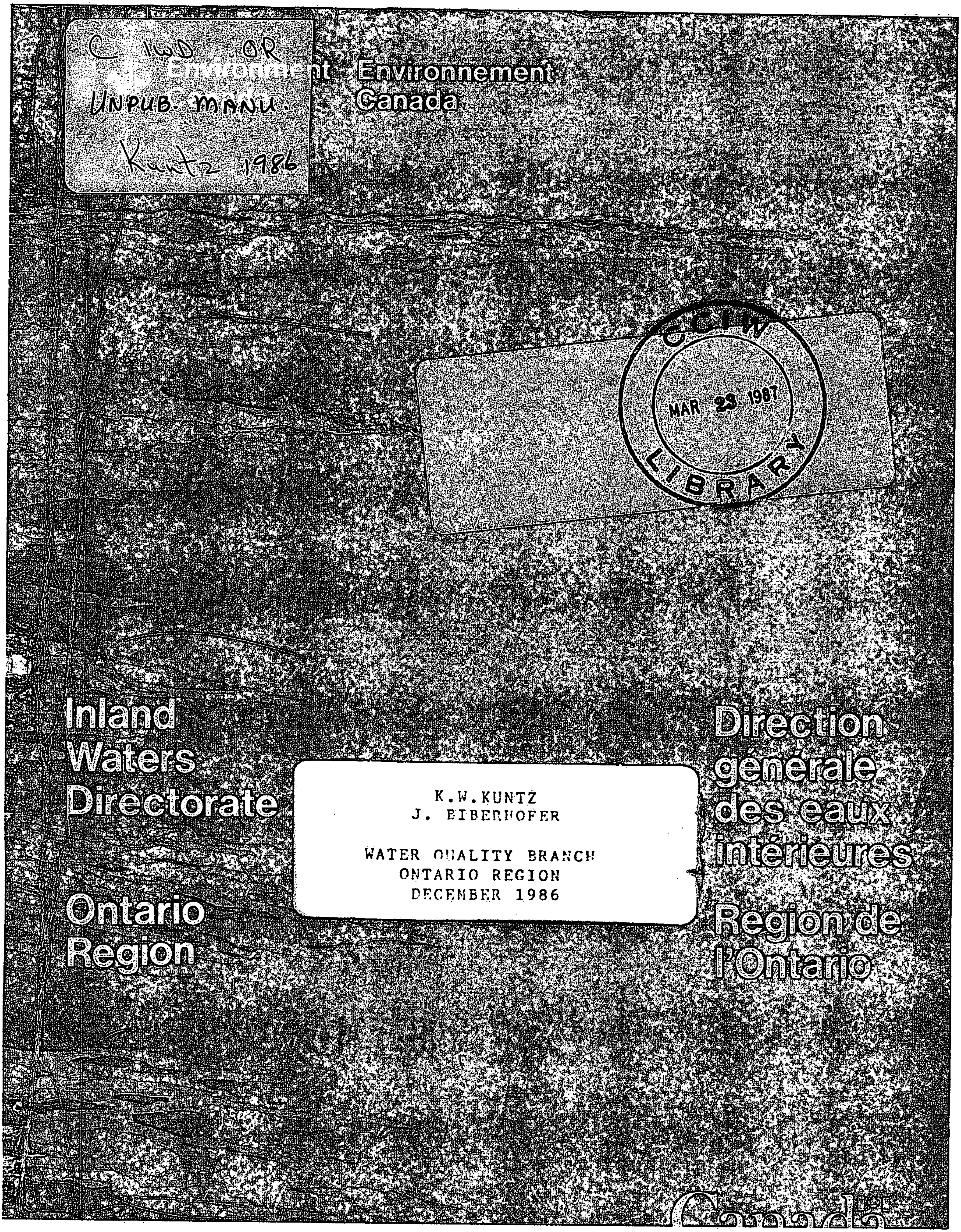

Inland Waters Directorate

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WATER QUALITY BRANCH
ONTARIO REGION
DECEMBER 1986

Direction générale des eaux intérieures

Région de l'Ontario

Canada

# WATER QUALITY OF THE NIAGARA RIVER IN 1985

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ABSTRACT:

Results from Niagara River water samples, collected at Niagara-on-the-Lake (NOTL) and Fort Erie (FE) during 1985 are discussed. Annual mean concentrations and estimated mean annual loadings for selected physical parameters, nutrients, major ions and trace metals are presented. Seasonal changes are shown and annual loadings are compared to historic loading estimates. The observed long term trend for selected parameters since 1975 and compliance with the 1978 Great Lakes Water Quality Agreement specific objectives is discussed.

## INTRODUCTION:

Estimates of changes in the amount of material entering the Great Lakes are required for trend evaluation, model development and future planning and successful management of Great Lakes water resources.

The Niagara River is the major tributary to Lake Ontario, accounting for more than 85 % of the total input water budget (Casey and Salbach, 1974 ). It is the only outflow from Lake Erie and accounts for 50 % of all incoming finegrained sediment materials (silt and clay sized fractions ) to Lake Ontario ( Kemp and Harper, 1976 ) and probably similar fractions of other materials.

Recognizing the importance of loading from the Niagara River to the water quality of Lake Ontario, the Water Quality Branch - Ontario Region established a monitoring program which involved the daily collection of samples from an automated station at the mouth of the Niagara River at Niagara-on-the-Lake (NOTL) in 1975. The primary objectives of this program were to provide annual estimates of chemical loadings and trends in water quality in the Niagara River from the analysis of samples collected at Niagara-on-the-Lake. Due to the success of this station and subsequent requirements for more information by the Niagara River Toxics Committee (NRTC) on the inputs to the Niagara River from Lake Erie, a second station was established at the inlet to the Niagara River at Fort Erie (FE) in October 1983. This report summarizes available 1985 data from both of these stations and estimates differential loadings within the Niagara River for 1985.

## SAMPLING METHODS:

### LOCATION AND SAMPLING APPARATUS:

The NOTL station is located on the former property of the Regional Municipality of Niagara Water Treatment plant in NOTL, on the Ontario side of the Niagara River about one mile upstream of Lake Ontario. This location was selected based on water quality surveys conducted during 1974 indicating that the river was homogeneous at this location (Chan,1977) and was therefore representative of the water flowing into Lake Ontario.

The FE station is located at the customs dock at the foot of Jarvis street at Fort Erie, Ontario. Site selection was based on its accessability and previous surveys of this area of the river by DOE and MOE indicated cross stream variability was minimal and therefore would be representative of the Lake Erie outflow.

Daily water sample collection system consists of an intake line, submersible pump and a daily water sampler. The intake line, 3/4 inch I.D. black polyethylene tubing, anchored to shore with a 1/4 inch stainless steel cable and weighted so as to settle to the bottom of the river. The intake end of the tubing is attached to an anchored spar buoy. This permitted sampling at approximately the mid depth of the river. The spar buoy and intake line were anchored at a point approximately 60m. from shore at NOTL and about 30 m. from shore at FE. Both stations intakes were located in the main current of the river. The intake line extended up the spar buoy to a distance of about 6m. from the bottom and 13m. below the surface at NOTL and about 2m. from the bottom and about 3m. from the surface at FE. A detailed description of this system can be found in an unpublished report, "Water Quality Sampling Methods at NOTL" (Kuntz et al.,1982).

## CHEMICAL ANALYSIS:

Chemical analysis of water samples were conducted according to the WQB "Analytical Methods Manual" (Environment Canada,1979). Daily measurements were made of physical parameters (turbidity, discharge, and spec. conductance at 25 deg. C ) and nutrients (TP, nitrate, TKN and reactive silicate). Weekly analyses for major ions ( T-ALK, Ca, SO4, Cl, Na, Mg, and K) and total trace metals ( iron, aluminum, copper, zinc, nickel, chromium, lead, manganese, arsenic and mercury ) were also conducted.

## DISCUSSION:

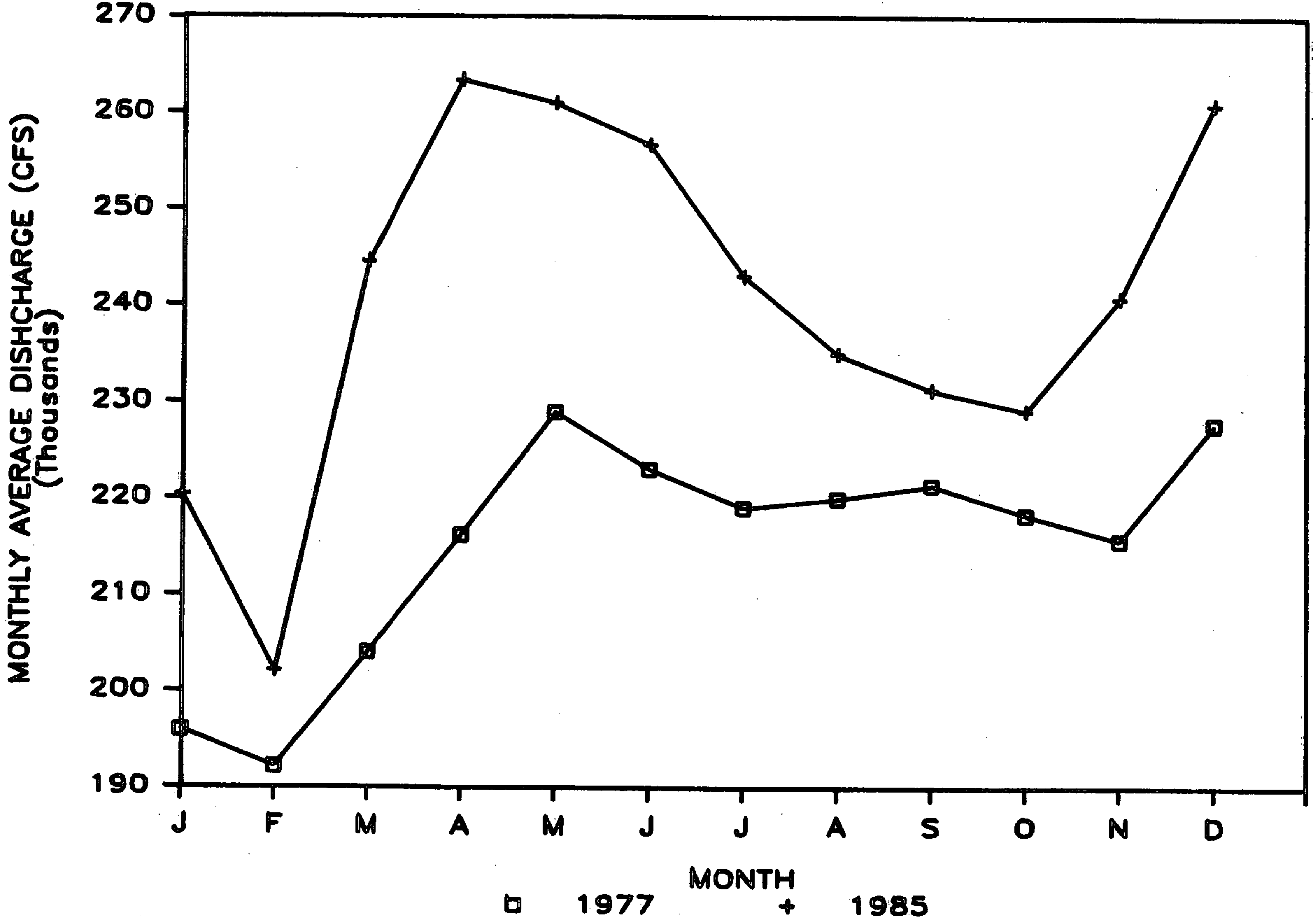
### A) PHYSICAL PARAMETERS:

Annual mean data for 1985 for each of the physical parameters measured at NOTL and FE are given in Table 1.

### DISCHARGE:

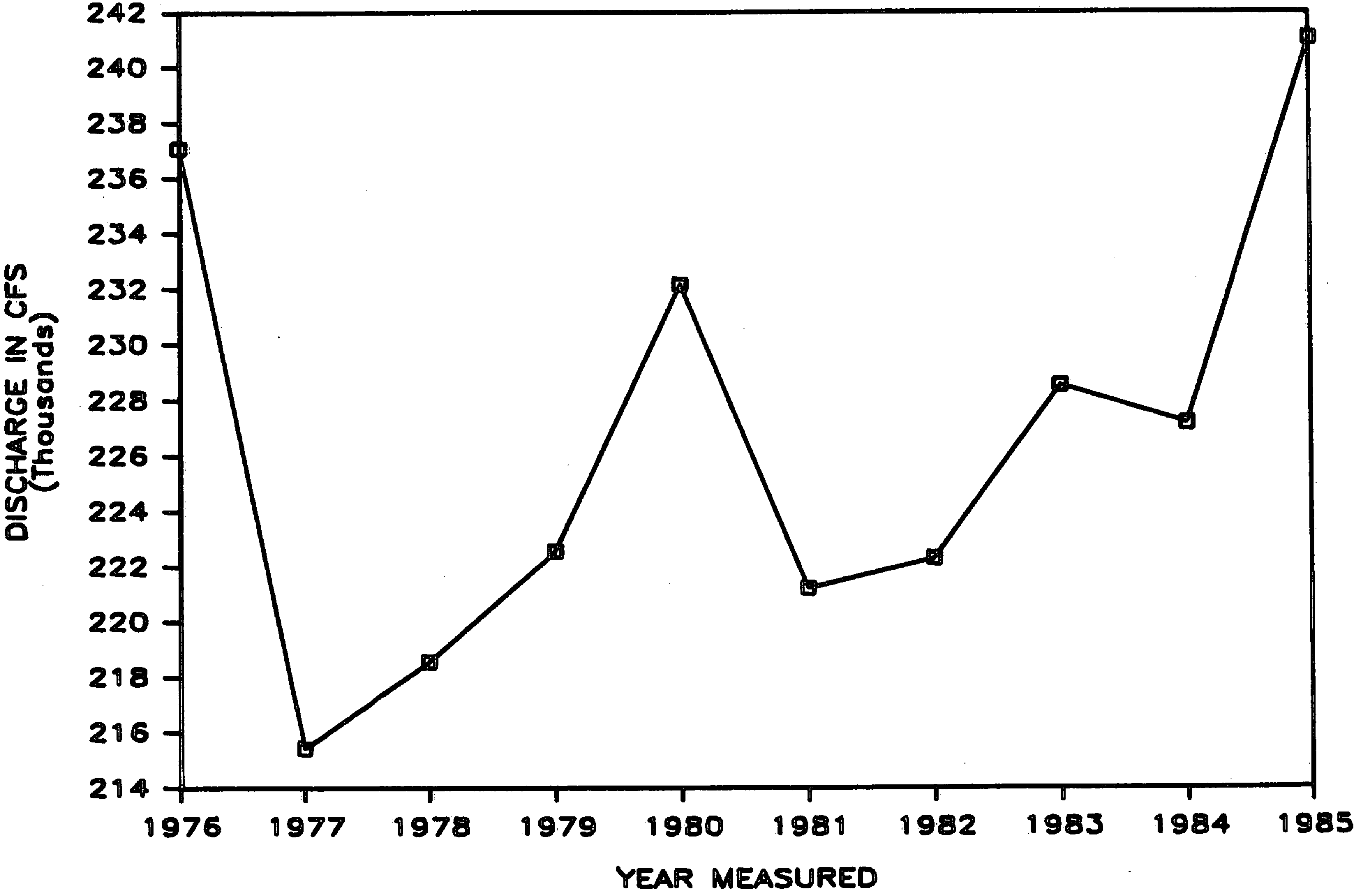
Mean monthly discharge at NOTL (data obtained from Water Planning and Management Section - IWD-OR) varied from a low of 202,114 cfs (5728 $m^3$/sec.) in February to a high of 263,443 cfs

FIGURE 1: NOTL DISCHARGE, 1977 & 1985



# NIAGARA RIVER ANNUAL DISCHARGE (CFS)

FIGURE 2



(7461 $m^3$/sec.) in April. The overall yearly average flow was 241,033 cfs or 6826 $m^3$/sec. The average for the 1975 - 85 eleven year period was 227,546 cfs (6444 $m^3$/sec). The high water levels in the Great Lakes Basin during 1985 have resulted in considerably larger flow through rates for the Niagara river and will therefore significantly increase the material loadings that are presented later in this report.

The monthly average discharge for 1985 (highest flow year) plotted in Figure 1, shows that in every month the mean discharge was higher than in 1977, the lowest flow year during this eleven year period of record. The average annual discharge for the period of record is plotted in Figure 2.

## SPECIFIC CONDUCTANCE:

Specific conductance values at NOTL ranged from a low of 269 uS in April, during the high flow period, to a high of 301 uS in February, during the low flow period. At FE, mean monthly values ranged from 276 uS in April to 298 uS in January. Generally these high specific conductance measurements during the low flow periods are believed to be the result of the smaller dilution factor. However, elevated sodium and chloride concentrations observed during the winter low flow period are suspected to be the result of winter road salting activities and may be responsible for some of the increase in specific conductance during the low flow period.

## TURBIDITY:

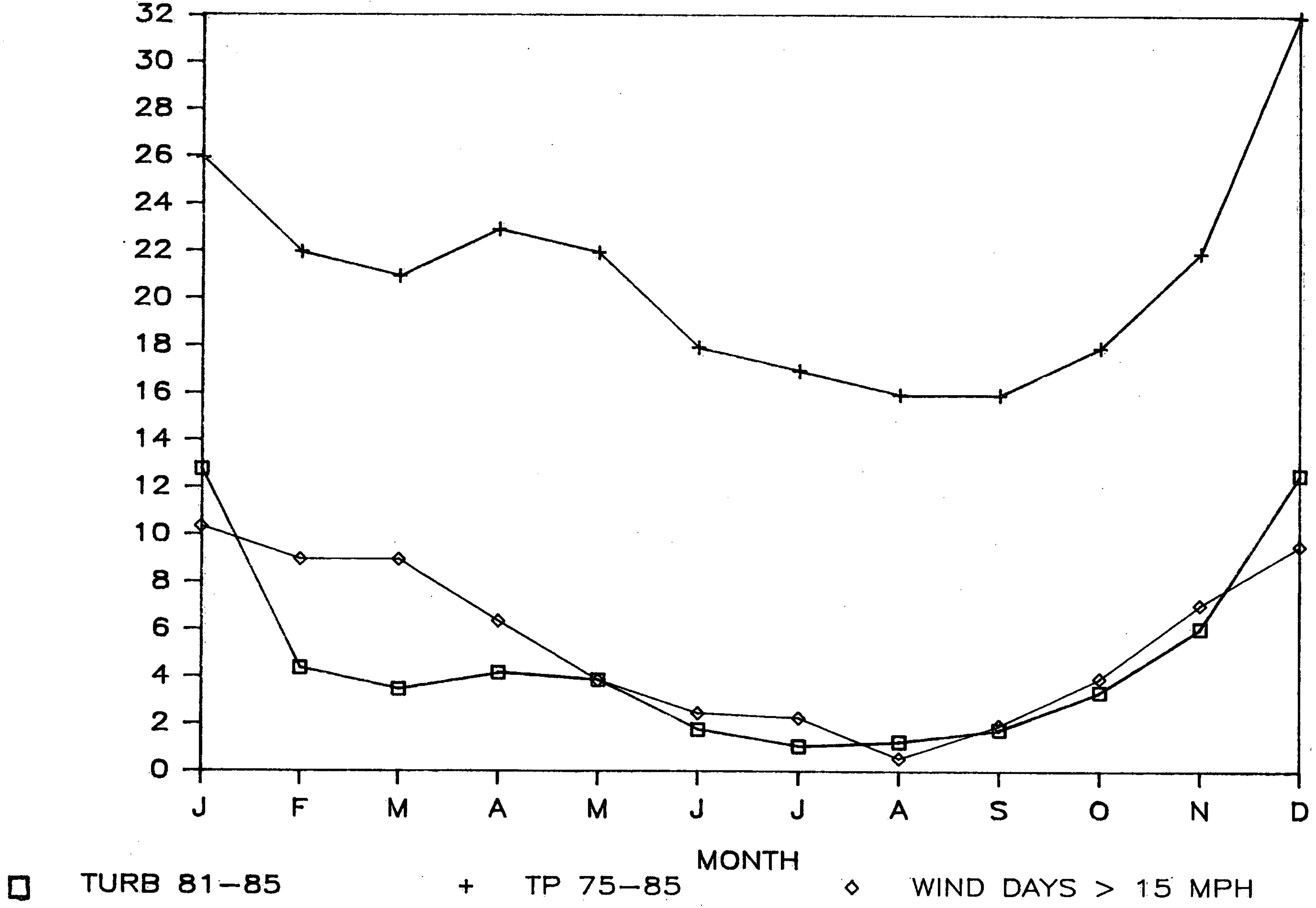
Turbidity shows a seasonal cycle with large increases in January and December at both stations. Mean monthly values at NOTL ranged from very low levels of 0.6 JTU in August to very high levels of 22-24 JTU in January and December. Similarly, high values were observed at the FE station in January (14 JTU) and December (36.8 JTU). These high values at the beginning and end of each year are believed to be the result of the increasing frequency of storms which have occurred in the early and late months of each year. A relatively good correlation is shown between the average number of days in each month with average daily winds greater than 15 mph, the average monthly turbidity and the monthly average total phosphorus concentration (Figure 3). The r value for the correlation of TP vs. Turbidity is 0.91, for Turbidity vs. Frequency of winds greater than 15 m.p.h. is 0.79 and for TP vs. frequency of winds greater than 15 m.p.h. is 0.82.

TABLE 1: PHYSICAL PARAMETERS IN THE NIAGARA RIVER IN 1985

| | NOTL | | FE | |
|---|---|---|---|---|
| | MEAN | S.D. | MEAN | S.D. |
| DISCHARGE ($M^3$/SEC) | 6826 | 659 | 6820 | 629 |
| SPEC.COND.@25 DEG.C | 289 | 9.8 | 288 | 6.9 |
| TURBIDITY JTU | 7.2 | 12.5 | 5.8 | 10.3 |

TURB, TP AND WINDS AT NOTL

FIGURE 3



## B) NUTRIENTS:

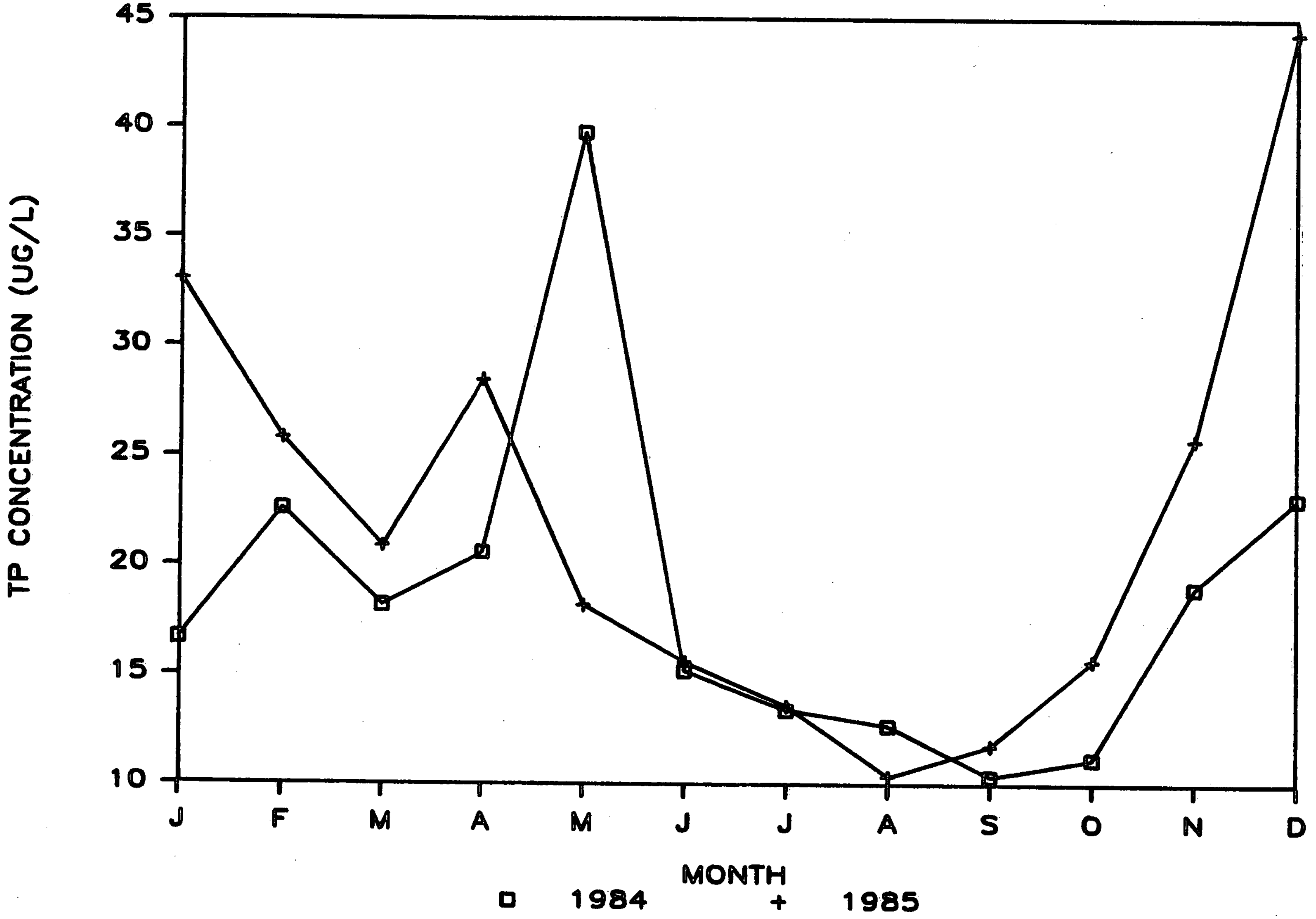
Annual mean summary data for each of the nutrient parameters measured at NOTL and FE in 1985 are given in Table 2.

### TOTAL PHOSPHORUS:

Mean monthly concentrations of total phosphorus at NOTL ranged from a low of 0.010 mg/l in August to a high of 0.044 mg/l in December , with an overall yearly mean of 0.022 mg/l (95% confidence interval of 0.002 mg/l), a considerable increase when compared with the 1984 mean of 0.018 mg/l. At FE, a similar pattern was observed with a low of 0.010 mg/l in July and a high of 0.067 mg/l in December with an overall yearly mean of 0.020 mg/l (95% confidence interval of 0.002 mg/l), up from 0.016 mg/l in 1984. These increases in annual mean from 1984 to 1985 appear to have been caused by higher measured concentrations during the January-April and the October-December periods (Figure 4). These increases are probably caused by an increase in turbidity measured during these two periods. One probable cause of this increased turbidity which in turn results in higher phosphorus concentrations could be the increased erosion of the Lake Erie shoreline and littoral zones due to the high water levels in Lake Erie. In 1984 the average turbidity during these periods was 3.0-3.5 JTU while in 1985 it was 10 - 11 JTU at NOTL and FE.

The seasonal cycle for total phosphorus, as shown by the average monthly concentrations measured at NOTL during the 1975-85 period is given in Figure 3. This data shows a summer minimum and a winter maximum each year. These high values are thought to

FIGURE 4: TP AT NOTL IN 1984 AND 1985



be correlated in part to the high turbidity values also observed at the same time of the year.

NITRATE-NITRITE NITROGEN:

Mean monthly values of nitrate nitrogen at NOTL ranged from a low of .192 mg/l in August to a high of .345 mg/l in May. At FE, a low monthly mean of .167 mg/l was observed in September while the highest monthly mean of .326 mg/l was recorded in May. The yearly average was .243 and .279 mg/l at FE and NOTL respectively.

The seasonal cycle, as shown by the average monthly values at NOTL during the eleven year period from 1975-1985 is given in Figure 5. The spring peak observed in May and the late summer minumum in September are typical features.

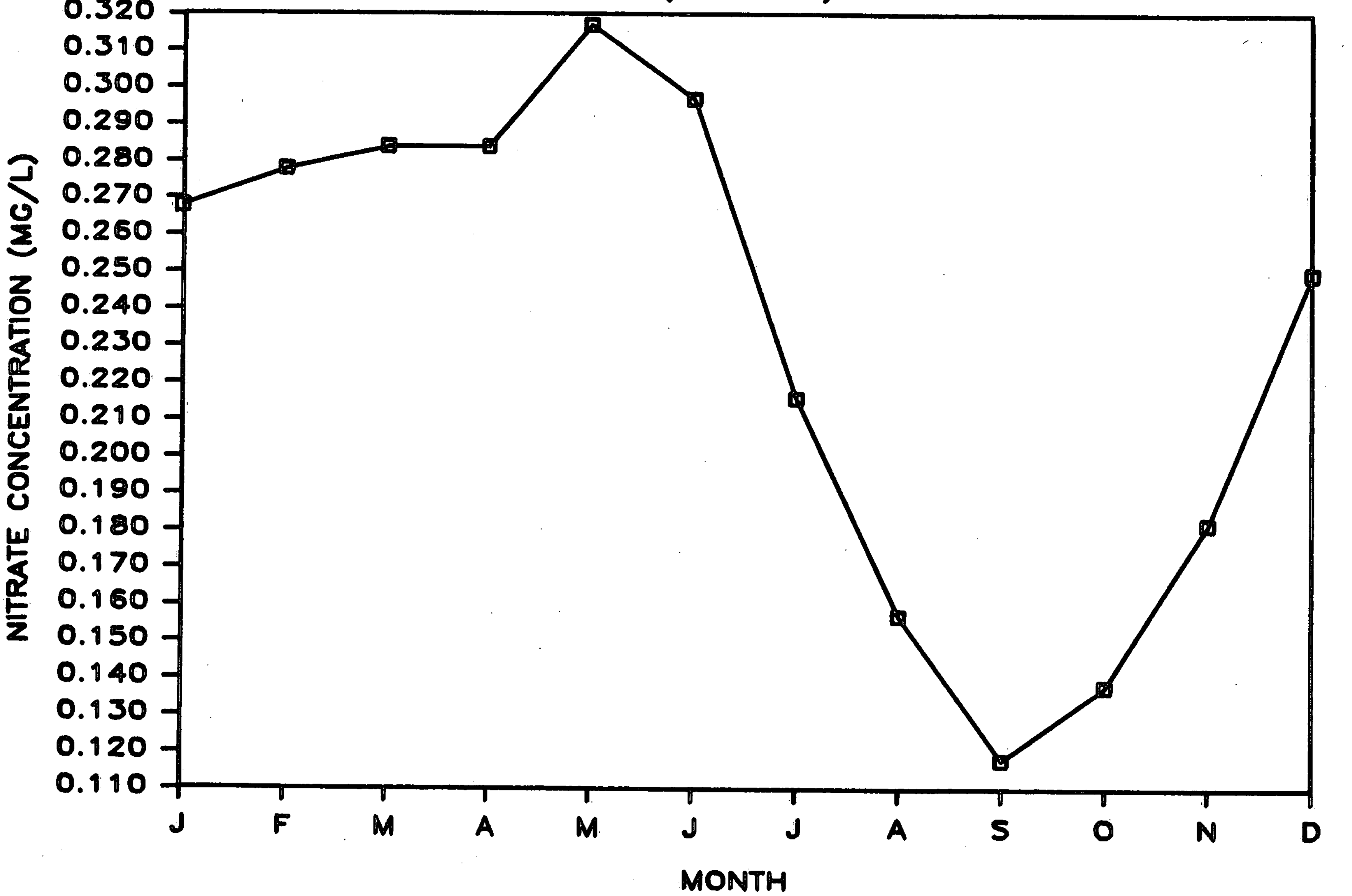
TABLE 2: NUTRIENT CONCENTRATIONS IN THE NIAGARA RIVER IN 1985

| | NOTL | | FE | |
|---|---|---|---|---|
| | MEAN | S.D. | MEAN | S.D. |
| TP | .022 | .016 | .020 | .019 |
| $NO_3$ | .279 | .071 | .243 | .066 |
| TKN | .217 | .031 | .209 | .026 |
| $SiO_2$ | .288 | .197 | .253 | .169 |

TOTAL KJELDAHL NITROGEN:

For total kjeldahl nitrogen, average monthly concentrations varied considerably less than for nitrate nitrogen. Monthly means varied from .191 mg/l in April to .233 mg/l in January at NOTL

FIGURE 5: MONTHLY NITRATE AT NOTL
(1975–85)



and from .180 mg/l in April to .236 mg/l in January at FE. Annual means were .209 and .217 mg/l at FE and NOTL respectively.

## REACTIVE SILICATE:

Reactive silicate concentrations at NOTL ranged from a low monthly mean of .058 mg/l in June to a high of .684 mg/l in December with an annual mean of .289 mg/l. At FE, mean monthly values ranged from a high of .598 mg/l in December to a low of 0.122 mg/l in May with an annual mean of .253 mg/l. The annual seasonal cycle is given in Figure 6 for the 1981-85 period.

## C) MAJOR IONS:

Average annual major ion concentrations measured in 1985 for the two stations at NOTL and FE are given in Table 3. Seasonal cycles, as shown by the average monthly values for the eleven year period 1975-1985 for alkalinity. calcium, sulphate, chloride, sodium and magnesium are given in Figures 7 to 12. All of these major ions show substantially higher concentrations during the early and late months of each year. During the high flow months of April, May and June, the concentration of each of the major ions is usually at its lowest level, probably as a result of the increased dilution factor. Chloride and sodium concentrations are also elevated in the winter months (Figures 8 and 9) likely due to road salting operations.

FIGURE 6: MONTHLY SILICATE CONC. AT
NOTL (1981–85)

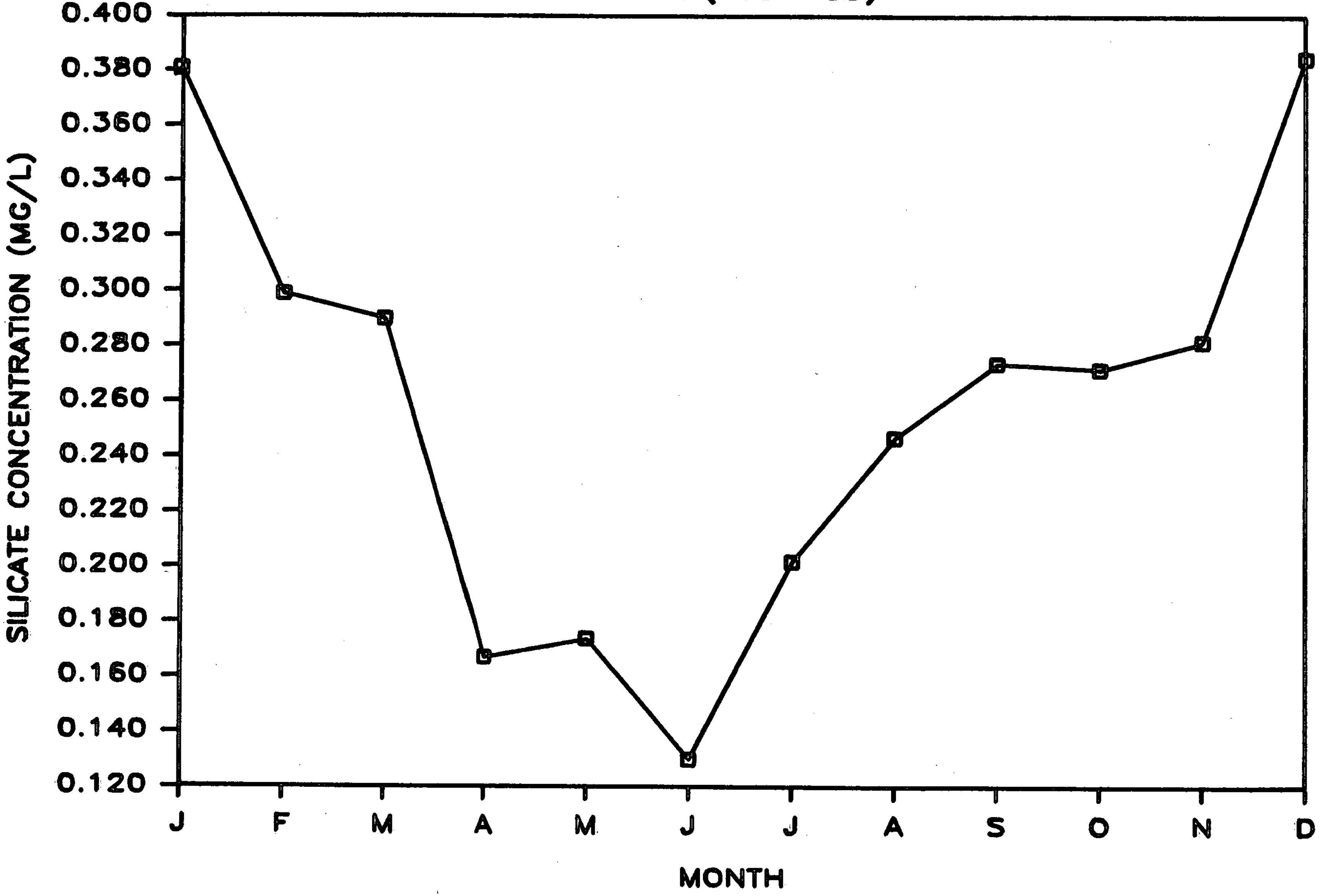


TABLE 3: MAJOR ION CONCENTRATIONS IN THE NIAGARA RIVER IN 1985

| | NOTL | | FE | |
|---|---|---|---|---|
| | MEAN | S.D. | MEAN | S.D. |
| ALKALINITY | 94.5 | 4.6 | 96.7 | 4.6 |
| CALCIUM | 35.4 | 1.4 | 35.7 | 1.3 |
| SULPHATE | 23.8 | 0.8 | 23.4 | 0.8 |
| CHLORIDE | 16.2 | 0.8 | 15.6 | 0.5 |
| SODIUM | 8.7 | 0.5 | 8.3 | 0.3 |
| MAGNESIUM | 8.0 | 0.3 | 8.1 | 0.3 |
| POTASIUM | 1.3 | 0.1 | 1.3 | 0.05 |

## D) TRACE METALS:

Average annual trace metal concentrations for 1985 at both NOTL and FE are given in Table 4. Concentrations of each of the metals at NOTL were greater than those at FE. Exceedance of the 1978 GLWQA objectives occurred for iron in 46 % of the samples collected at NOTL and 26 % of the samples at FE. All other metals were in compliance with the GLWQA objectives.

TABLE 4: TRACE METAL CONCENTRATIONS IN THE NIAGARA RIVER IN 1985

| | NOTL | | FE | |
|---|---|---|---|---|
| | MEAN | S.D. | MEAN | S.D. |
| IRON | .560 | .751 | .344 | .516 |
| ALUMINUM | .153 | .228 | .131 | .212 |
| MANGANESE | .019 | .022 | .015 | .013 |
| ZINC | .004 | .004 | .003 | .003 |
| NICKEL | .002 | .001 | .002 | .001 |
| CHROMIUM | .002 | .001 | .001 | .001 |
| COPPER | .002 | .001 | .001 | .001 |
| CADMIUM | L.001 | -- | L.001 | -- |
| LEAD | .001 | .001 | .001 | .001 |
| ARSENIC | .0007 | .0004 | .0005 | .0002 |
| MERCURY (ug/l) | L.02 | -- | L.02 | -- |

FIGURE 7: MONTHLY ALKALINITY CONC.

AT NOTL (1975-85)

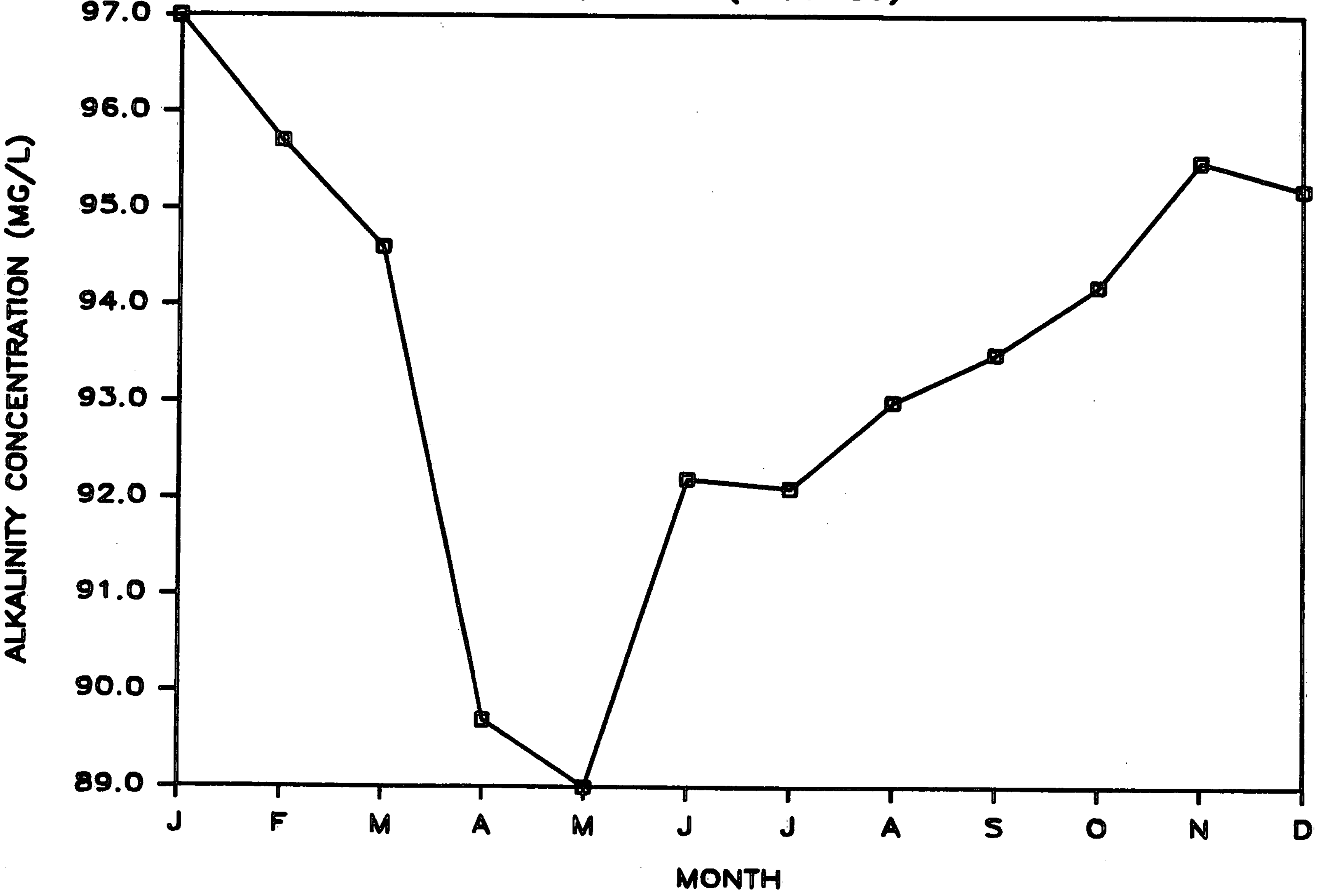


FIGURE 8: MONTHLY CALCIUM CONC.

AT NOTL (1975–85)

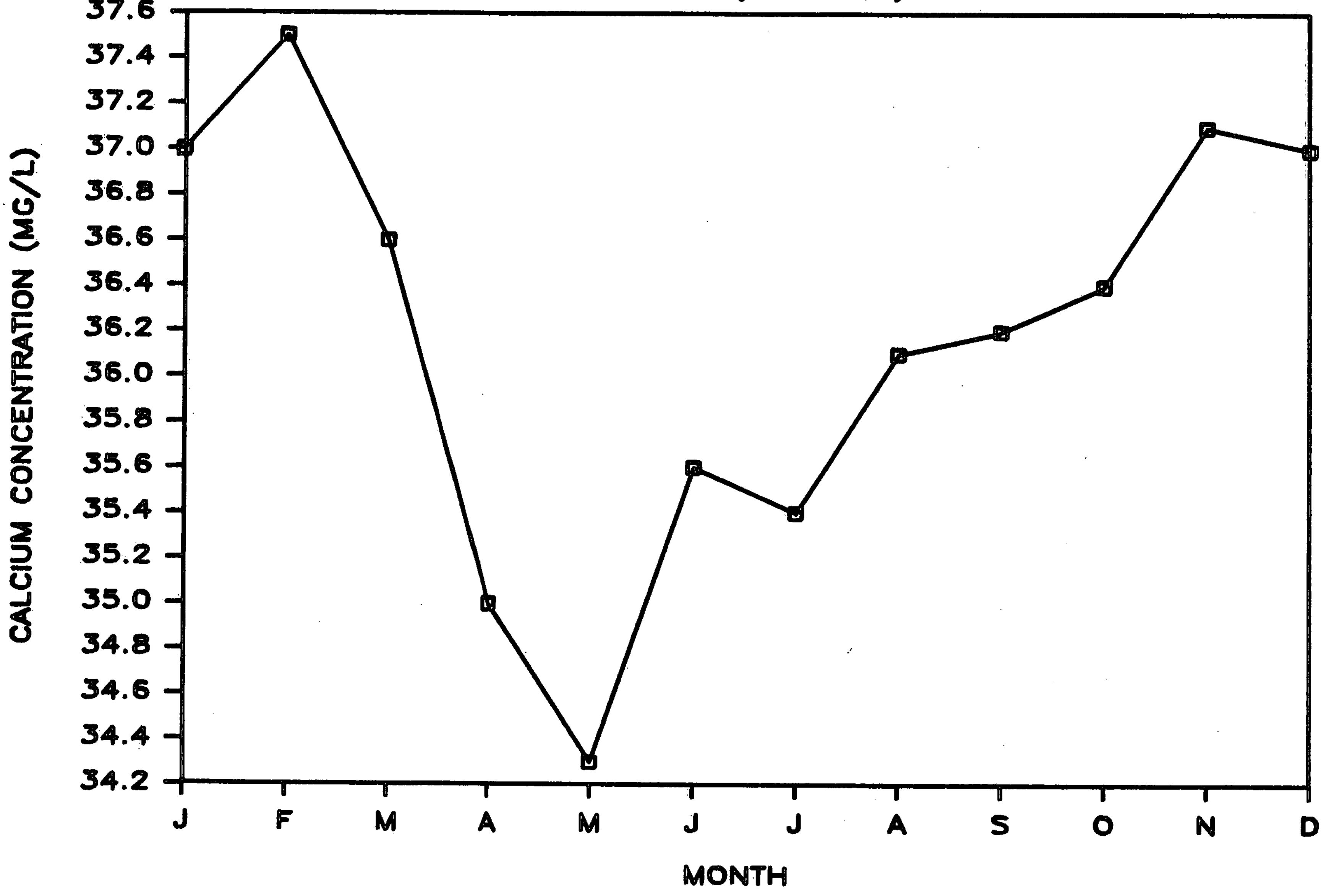


FIGURE 9: MONTHLY SULPHATE CONC.

AT NOTL (1975–85)

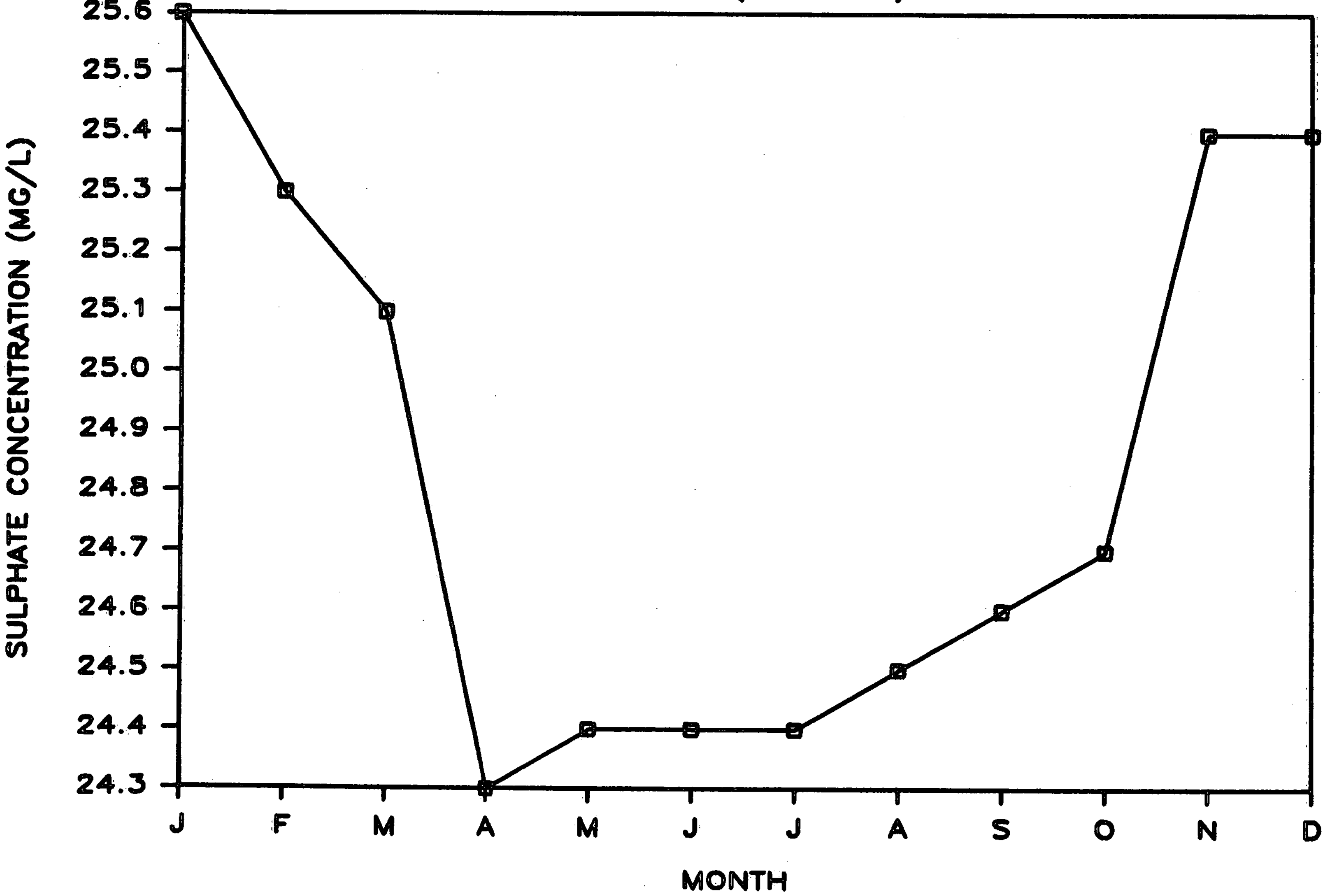
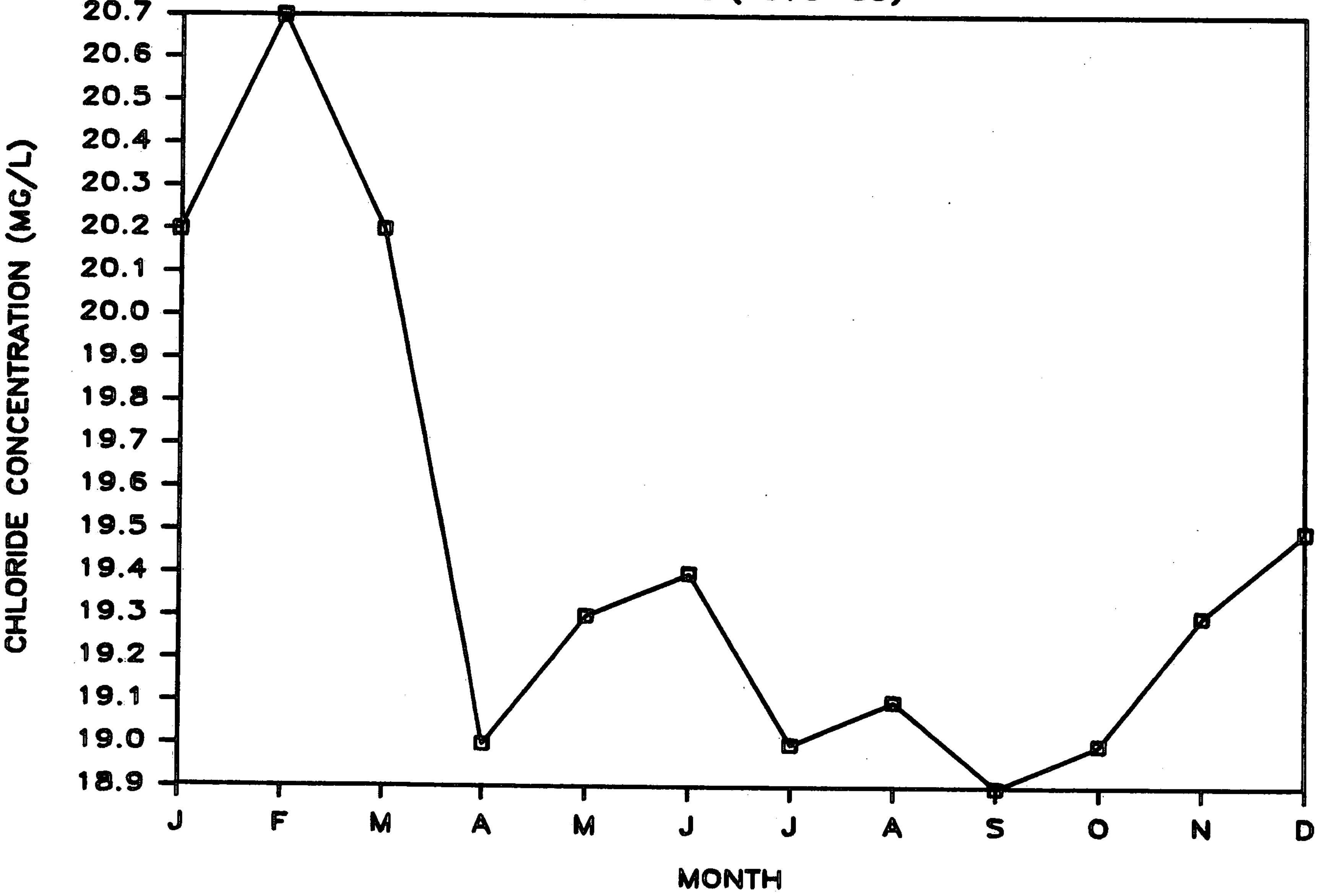


FIGURE 10: MONTHLY CHLORIDE CONC.

AT NOTL (1975–85)



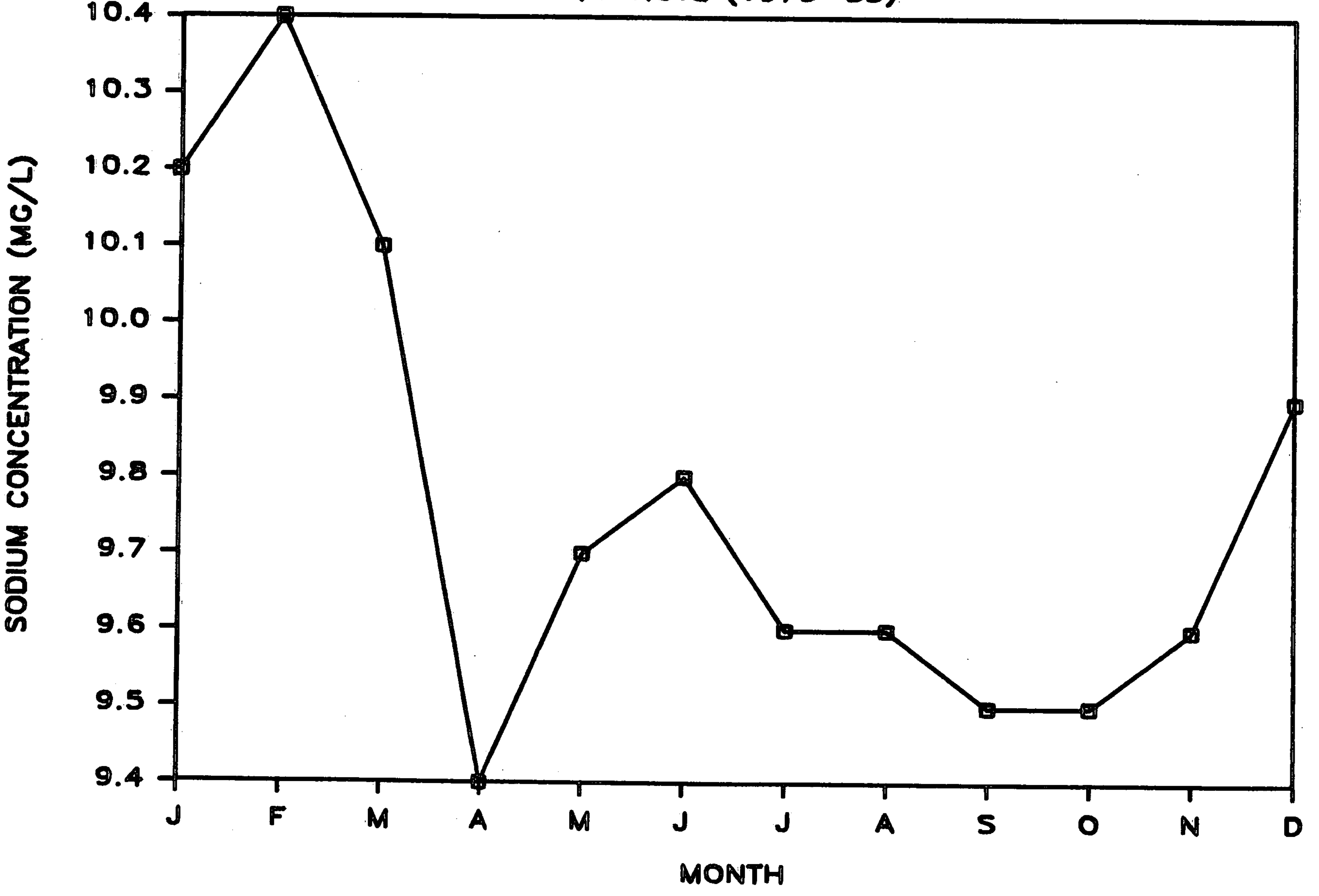
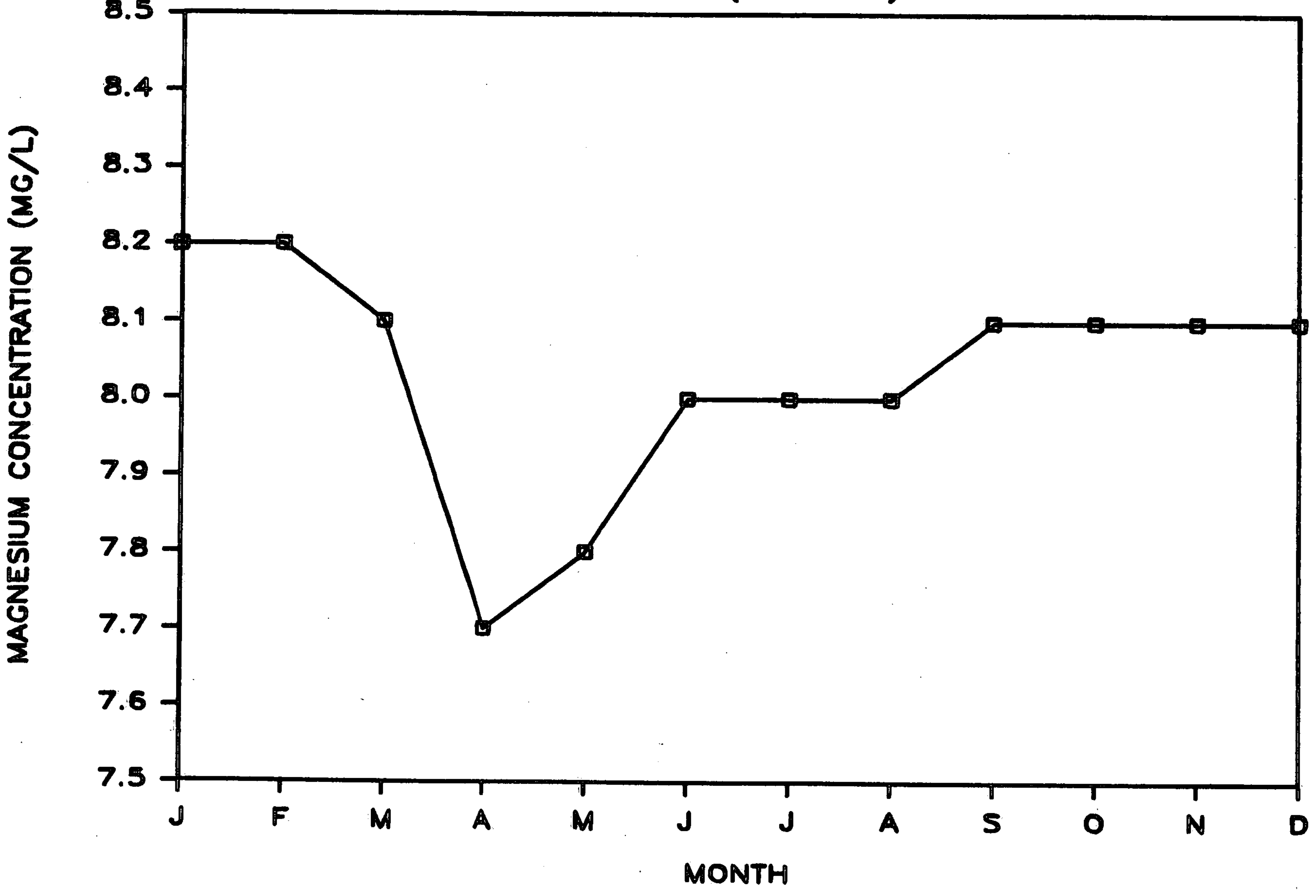


FIGURE 11: MONTHLY SODIUM CONC.

AT NOTL (1975–85)

FIGURE 12: MONTHLY MAGNESIUM CONC.

AT NOTL (1975–85)



E) TRENDS:

Average annual discharge (Figure 2 ) shows an increasing trend since 1977 with the discharge for 1985 being the highest during this 1977-85 period. This is reflective of the high water levels observed in Lake Erie during 1984-85.

Specific conductance (Figure 14 ) seems to be showing a decreasing trend since about 1979. This is probably the result of the decreases observed in the chloride, sodium and calcium concentrations as well as the higher dilution factor resulting from the high water levels during the latter part of this period.

Total phosphorus has also shown a decreasing trend (Figure 13) during this period of record until 1985. In 1985, TP increased dramatically in both concentration and loadings at both ends of the river. Some of the loading increase is caused by the increase in the discharge (about 25 %) but the remainder of the increase is believed to be the result of increased particulate loading in the early and late months of the year. The summer minimum concentrations (shown in Figure 3) show little difference from 1984 to 1985. The high water levels in Lake Erie could also be causing increased erosion and thereby increase the particulate loading of phosphorus to the Niagara River.

For the nitrogen compounds, the picture is confusing. TKN seems to be decreasing slightly since 1976 while nitrate nitrogen is increasing since 1976 (Figure 15 ). One would expect that both of the nitrogen compounds would be either increasing or decreasing. It appears that the nitrate nitrogen is entering the system in the form of nitrate nitrogen but is not being metabolized by the phytoplankton present into the organic nitrogen forms such as TKN . Either they are incapable of doing this or their needs are being adequately met by the increasingly large supply of nitrate nitrogen which is now present during the summer months but was nearly non existant in the early 70's during the early part of this program. This aspect of the nitrogen cycle definitely requires more research effort.

As far as the major ions are concerned, sodium, chloride and calcium have decreased substantially since 1976 (Figures 16 to 18 ). However, other major ions such as sulphate (Figure 17 ), magnesium and potassium have not decreased.

## F) LOADINGS:

### LOADING CALCULATION METHODS:

Daily loadings are calculated using the following formula:

$$\underset{(MT/DAY)}{\text{DAILY LOADING}} = \underset{(MG/L)}{\text{DAILY CONC}} \times \underset{(CFS)}{\text{DAILY DISCHARGE}} \times 2.447 \times 10^{3}$$

To obtain annual loadings at each station, the mean of the daily loadings was multiplied by 365.25. The internal loading for the Niagara River was obtained by taking the difference between the annual NOTL and Fe loadings. A summary of these daily loadings is given in Table 5 and the estimated annual input load from Lake Erie, the estimated annual output load to Lake Ontario and the estimated annual internal load to the Niagara River is given in Table 6. Daily mean loadings to Lake Ontario for each of the parameters measured since 1975 are given in Table 7.

For many of the substances measured, such as TKN, Ca, TALK,

$SO_4$, Mg, and K, levels in 1985 have remained similar to those in 1976. For a few substances, such as TP, $NO_3$, Cl and Na, however, substantial changes have occurred since 1976.

Discharge has increased substantially since 1977 with 1985 the highest year recorded since the previous high of 1976. This high discharge in 1985 has substantially affected the loadings calculated. Therefore an attempt was made to neutralize this effect by using the long term mean flow to normalize the loadings to flow. For example, total phosphorus has shown substantial decreases until 1985, when a large increase in loading was observed. Part of this increase (about 25% )was due to an increase in the discharge. However, the remainder was due to increases, probably mostly in the particulate phosphorus form in the early and late part of the year. For these reasons, it appears that in order to account for the contribution of discharge to the variability in the loadings the annual load would be better expressed in terms of a flow adjusted load. Nevertheless, the difference as shown in Figure 19 is not very striking.

A sample calculation for TP IN 1975 is given below:

DISCHARGE ADJUSTED LOAD = LOAD X TEN YEAR AVG FLOW / 1975 AVG FLOW

= LOAD X 0.9604

= 4788 X 0.9604 = 4599 MT

For total phosphorus, the annual load for 1985 still shows a considerable increase even after this operation (Table 8 ). A loadings for these parameters are much more dependent on flow than on concentrations.

FIGURE 13: TOTAL PHOSPHORUS TRENDS

IN THE NIAGARA RIVER (1976–85)

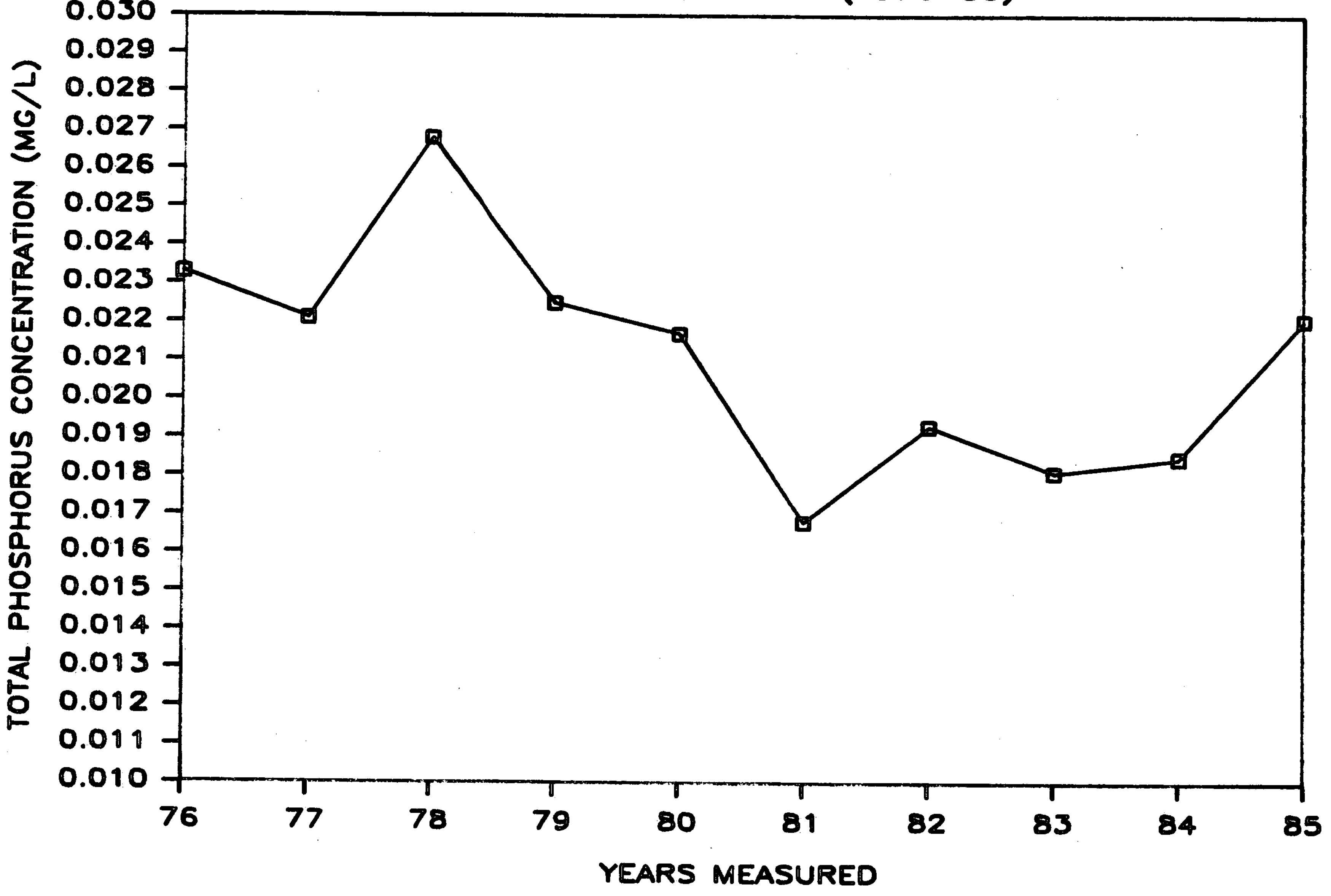
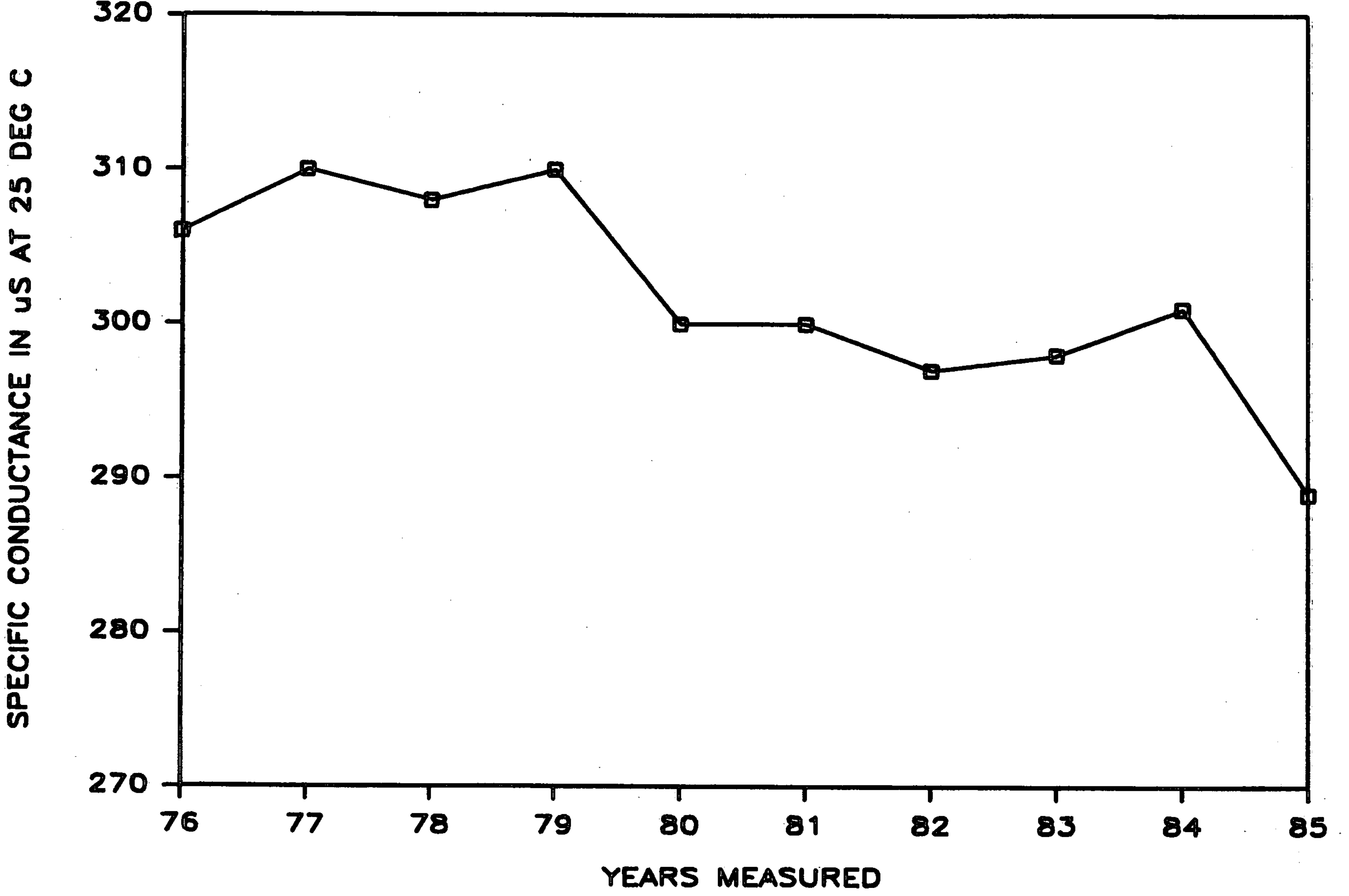


FIGURE 14: SPECIFIC CONDUCTANCE IN
THE NIAGARA RIVER 1976–85



# FIGURE 15: NIAGARA RIVER NITROGENS

1976–1985

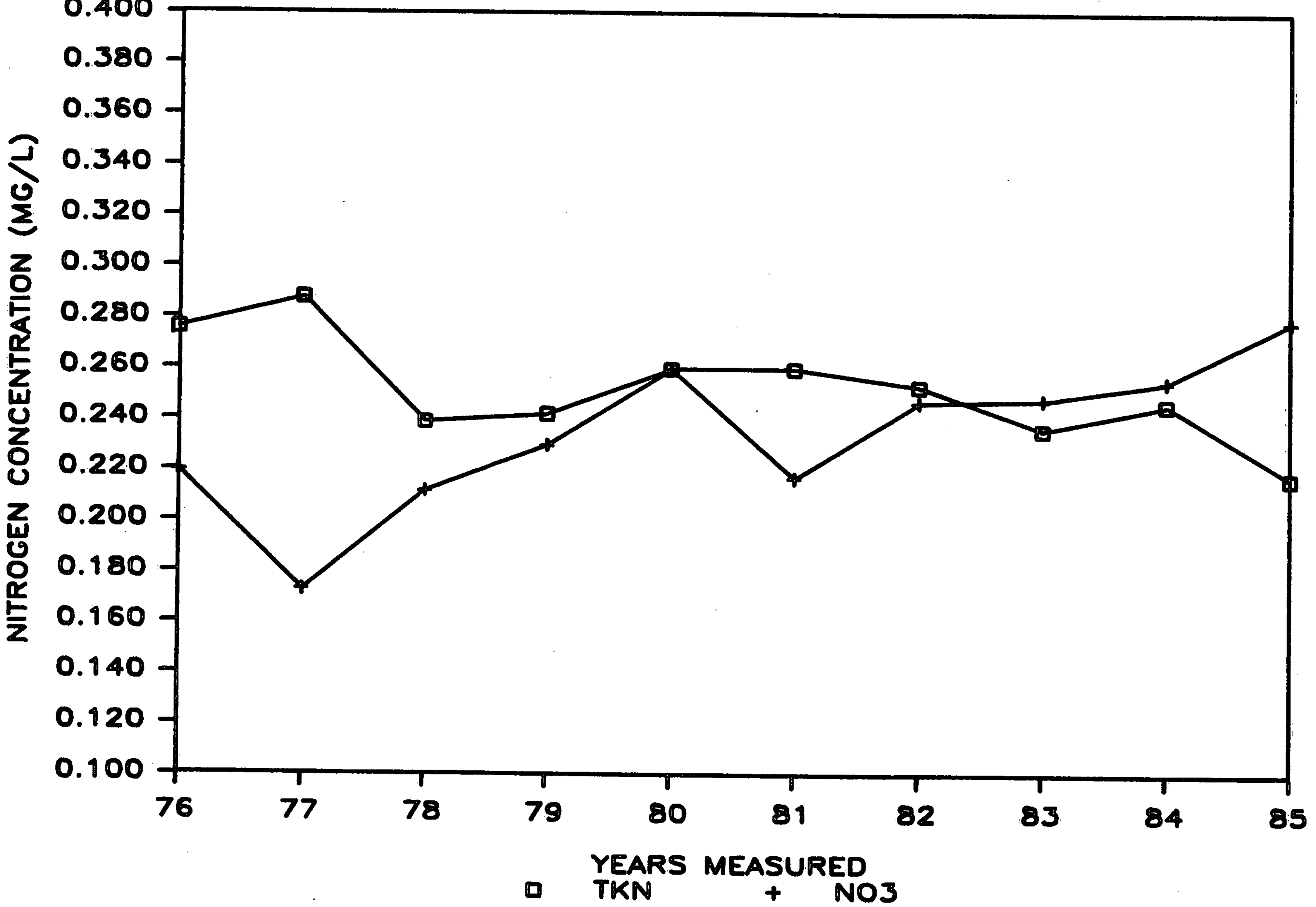
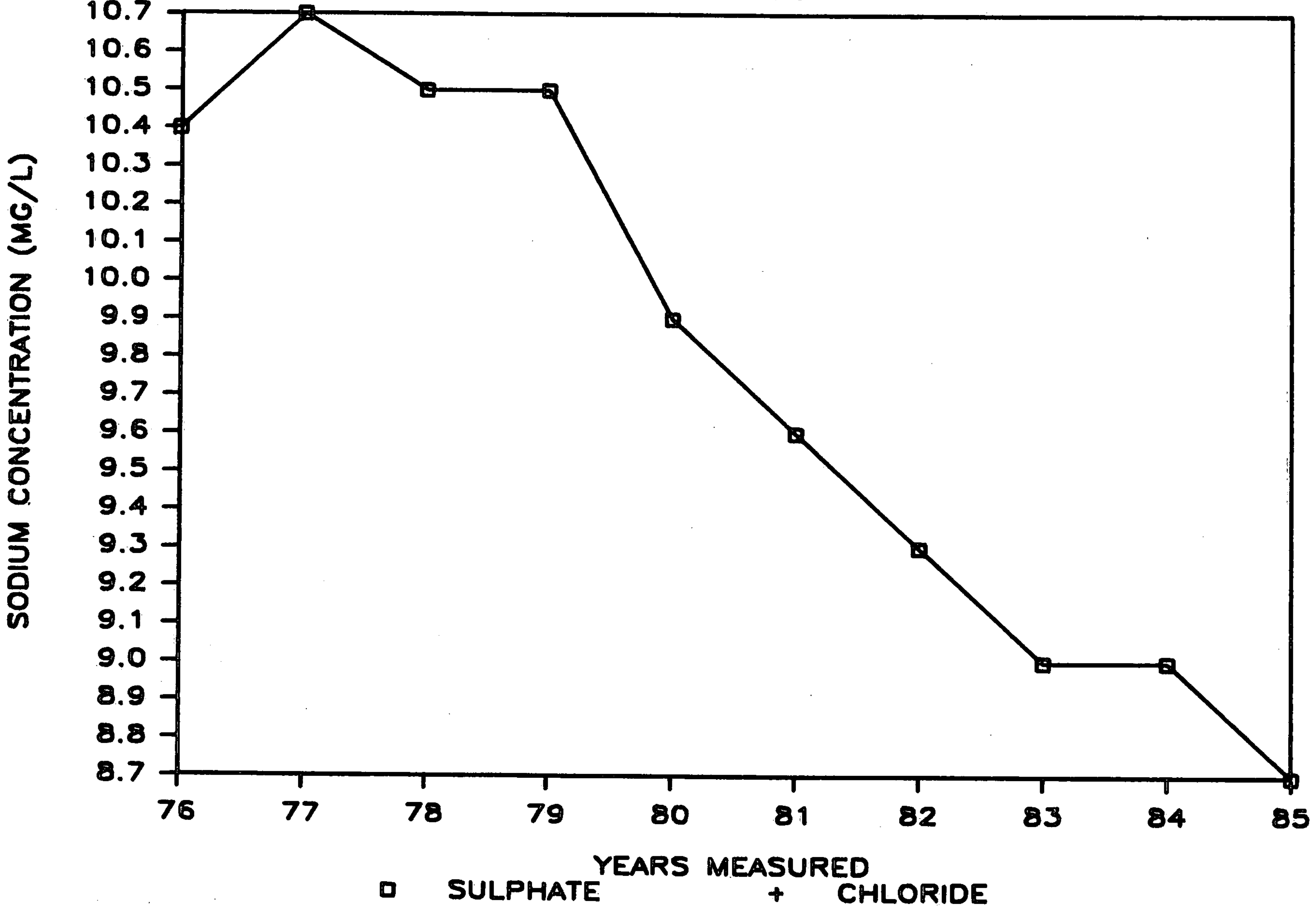


FIGURE 16: SODIUM IN THE NIAGARA RIVER

1976–85



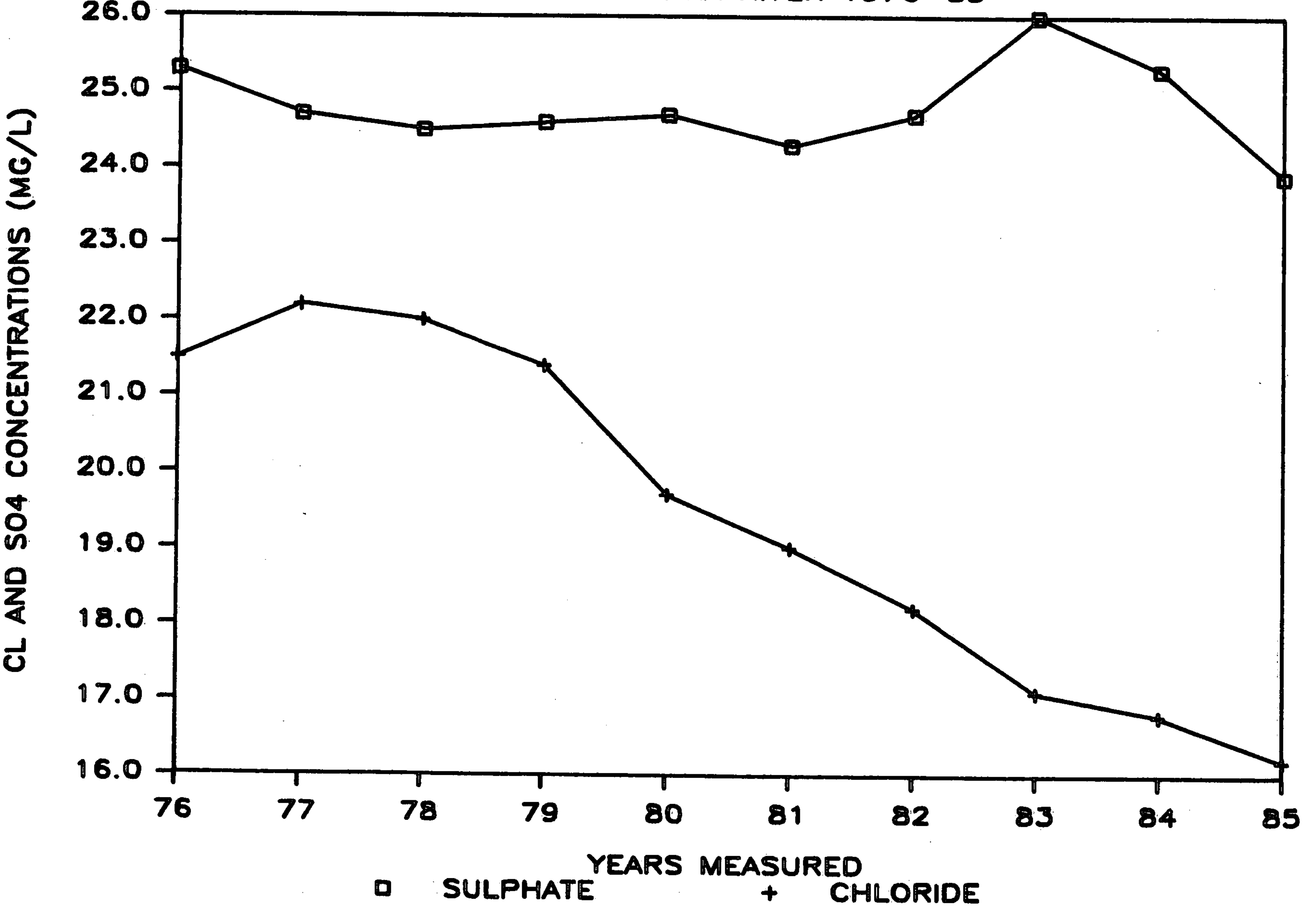


FIGURE 17: SULPHATE AND CHLORIDE

IN THE NIAGARA RIVER 1976–85

FIGURE 18: CALCIUM IN THE NIAGARA RIVER

1976–85

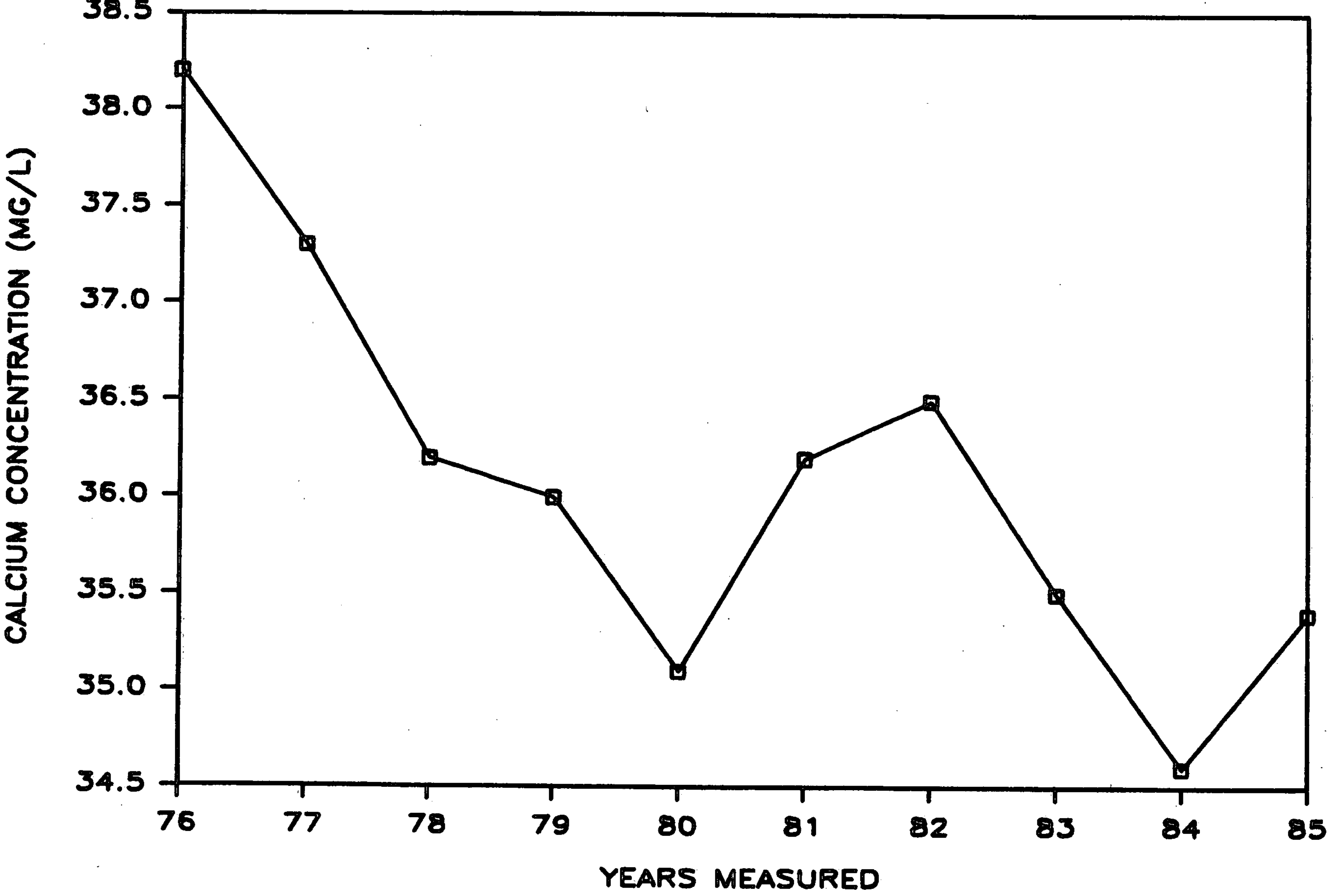
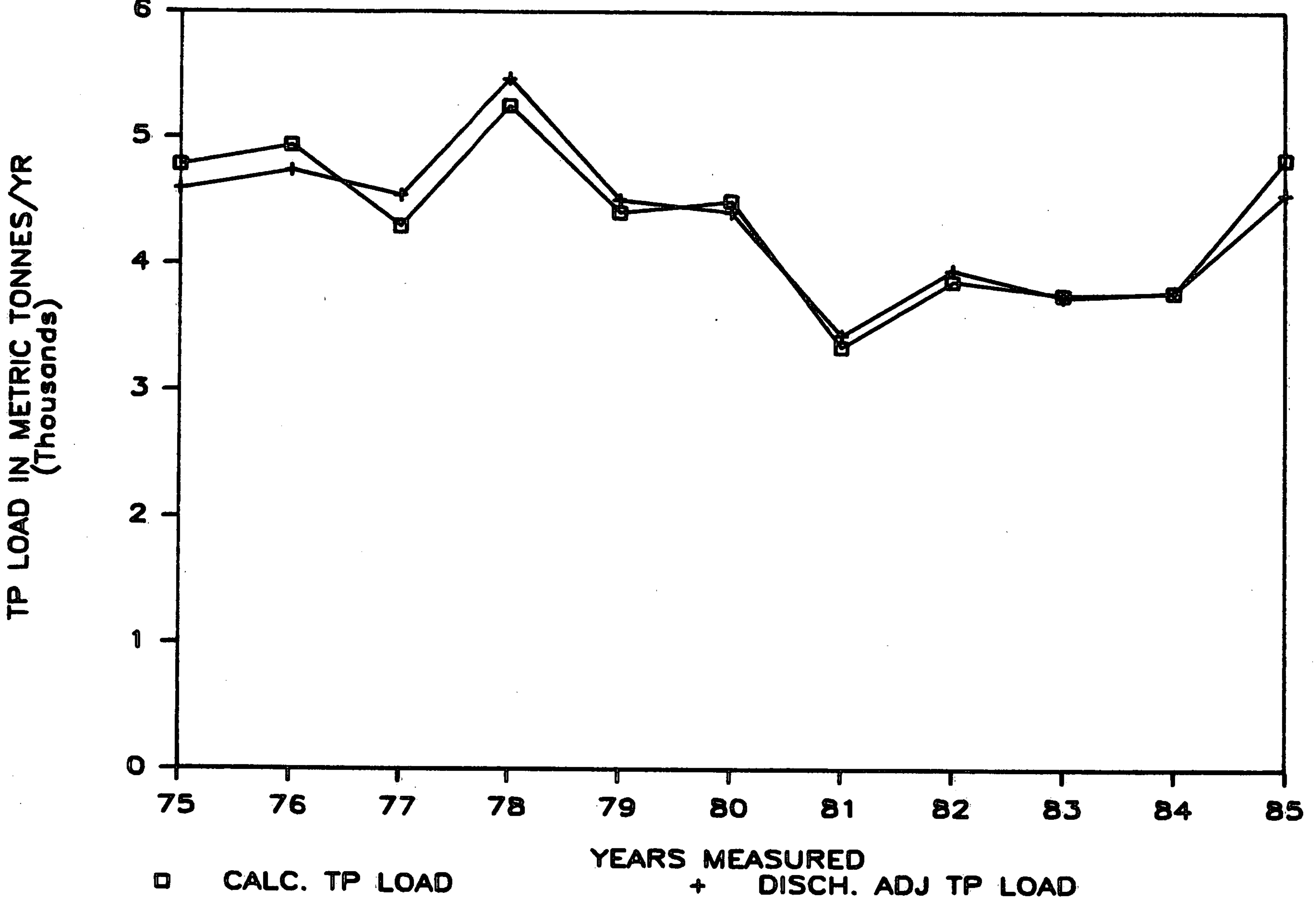


FIGURE 19: DISCHARGE ADJUSTED TP LOAD

IN THE NIAGARA RIVER 1975–85



## TABLE 5: DAILY CHEMICAL LOADING (MT) IN THE NIAGARA RIVER IN 1985

| | OUTPUT LOAD TO L.ONT (NOTL) (MT/DAY) | INPUT LOAD FROM L. ERIE (FE) (MT/DAY) | INTERNAL LOAD TO NIAGARA (MT/DAY) |
|---|---|---|---|
| TP | 13.25 | 11.93 | 1.32 |
| NO3 | 163.9 | 144.6 | 19.3 |
| TKN | 127.5 | 123.5 | 4.0 |
| SIO2 | 175.9 | 146.3 | 29.6 |
| TALK | 56291 | 56191 | 100 |
| CA | 21153 | 20783 | 370 |
| SO4 | 14235 | 13632 | 603 |
| CL | 9635 | 9063 | 572 |
| NA | 5192 | 4852 | 340 |
| MG | 4772 | 4680 | 92 |
| K | 790 | 740 | 50 |
| FE | 338.7 | 207.5 | 131.2 |
| AL | 94.9 | 78.8 | 16.1 |
| MN | 11.6 | 8.4 | 3.2 |
| ZN | 2.29 | 1.47 | 0.82 |
| NI | 1.14 | 0.96 | 0.18 |
| CU | 1.02 | 0.88 | 0.14 |
| CR | 0.96 | 0.77 | 0.19 |
| PB | 0.83 | 0.78 | 0.05 |
| AS | 0.41 | 0.34 | 0.07 |
| CD | <0.6 | <0.6 | - |

TABLE 6: NIAGARA RIVER ANNUAL CHEMICAL LOADINGS (MT) IN 1985

| | ANNUAL OUTPUT TO L.ONTARIO | ANNUAL INPUT FROM L. ERIE | INTERNAL LOAD TO NIAGARA R. |
|---|---|---|---|
| TP | 4839 | 4372 | 467 |
| NO3 | 60558 | 52925 | 7633 |
| TKN | 46935 | 45254 | 1681 |
| SIO2 | 63407 | 55116 | 8291 |
| TALK | $2.06X10^{7}$ | $2.08X10^{7}$ | -- |
| CA | $7.73X10^{6}$ | $7.71X10^{6}$ | $1.61X10^{4}$ |
| SO4 | $5.20X10^{6}$ | $5.06X10^{6}$ | $1.42X10^{5}$ |
| CL | $3.52X10^{6}$ | $3.37X10^{6}$ | $1.57X10^{5}$ |
| NA | $1.90X10^{6}$ | $1.80X10^{6}$ | $9.93X10^{4}$ |
| MG | $1.74X10^{6}$ | $1.74X10^{6}$ | $4.75X10^{3}$ |
| K | $2.89X10^{5}$ | $2.75X10^{5}$ | $1.39X10^{4}$ |
| FE | 123089 | 76155 | 46935 |
| AL | 34443 | 28928 | 5515 |
| MN | 4200 | 3178 | 1023 |
| ZN | 836 | 577 | 259 |
| NI | 413 | 354 | 59 |
| CU | 376 | 329 | 47 |
| CR | 351 | 285 | 66 |
| PB | 303 | 292 | 11 |
| AS | 150 | 124 | 26 |

TABLE 7: MEAN DAILY LOAD (MT/DAY) TO LAKE ONTARIO BY THE NIAGARA RIVER

| YEAR | TP | NO3 | TKN | TALK | CA | SO4 | CL | NA | MG | K | DISCH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1975* | 13.1 | 85.8 | 156.5 | 54532 | 22076 | 14806 | 12498 | 6179 | 4808 | 778 | 236905 |
| 1976 | 13.5 | 130.8 | 160.8 | 54191 | 22337 | 14790 | 12567 | 6093 | 4677 | 779 | 237094 |
| 1977 | 11.8 | 91.5 | 152.6 | 48429 | 19765 | 13081 | 11766 | 5647 | 4213 | 743 | 215429 |
| 1978 | 14.3 | 114.4 | 128.3 | 49274 | 19769 | 13385 | 12017 | 5720 | 4416 | 745 | 218573 |
| 1979 | 12.1 | 123.8 | 132.5 | 50301 | 19895 | 13578 | 11824 | 5773 | 4427 | 753 | 222557 |
| 1980 | 12.3 | 149.1 | 148.5 | 51023 | 20208 | 14227 | 11354 | 5690 | 4678 | 786 | 232140 |
| 1981 | 9.2 | 117.3 | 141.1 | 51483 | 19921 | 13339 | 10437 | 5296 | 4429 | 700 | 221210 |
| 1982 | 10.6 | 135.4 | 137.9 | 54341 | 20027 | 13560 | 9973 | 5106 | 4381 | 746 | 222301 |
| 1983 | 10.3 | 139.9 | 132.8 | 55001 | 20119 | 14731 | 9700 | 5063 | 4654 | 767 | 228557 |
| 1984 | 10.4 | 142.0 | 137.2 | 54030 | 19623 | 14317 | 9541 | 5087 | 4475 | 753 | 237182 |
| 1985 | 13.2 | 163.8 | 127.5 | 56291 | 21153 | 14235 | 9635 | 5192 | 4772 | 790 | 241033 |

* INCOMPLETE DATA SET

TABLE 8: DISCHARGE ADJUSTED LOADS FOR THE NIAGARA RIVER 1975-85

| YEAR | DISCHARGE FACTOR | TP LOAD MT/YR | DISCHARGE ADJUSTED LOADS MT/YR TP | CL | NA |
|---|---|---|---|---|---|
| 1975* | .9604 | 4788 | 4599 | 12004 | 5934 |
| 1976 | .9597 | 4941 | 4742 | 12061 | 5847 |
| 1977 | 1.0562 | 4302 | 4544 | 12428 | 5964 |
| 1978 | 1.0411 | 5256 | 5472 | 12510 | 5955 |
| 1979 | 1.0224 | 4412 | 4511 | 12089 | 5902 |
| 1980 | .9801 | 4503 | 4413 | 11128 | 5577 |
| 1981 | 1.0286 | 3346 | 3442 | 10736 | 5447 |
| 1982 | 1.0236 | 3868 | 3959 | 10208 | 5226 |
| 1983 | .9956 | 3762 | 3745 | 9657 | 5041 |
| 1984 | 1.0016 | 3787 | 3793 | 9556 | 5095 |
| 1985 | .9440 | 4839 | 4568 | 9106 | 4913 |

* INCOMPLETE DATA SET

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* DETAILED DAILY LISTINGS OF CONCENTRATIONS OR LOADINGS FOR SPECIFIC PARAMETERS ARE AVAILABLE UPON REQUEST FROM:

WATER QUALITY BRANCH - ONTARIO REGION
867 LAKESHORE RD.
BURLINGTON, ONTARIO

ATT'N: K.W. KUNTZ

416-336-4965

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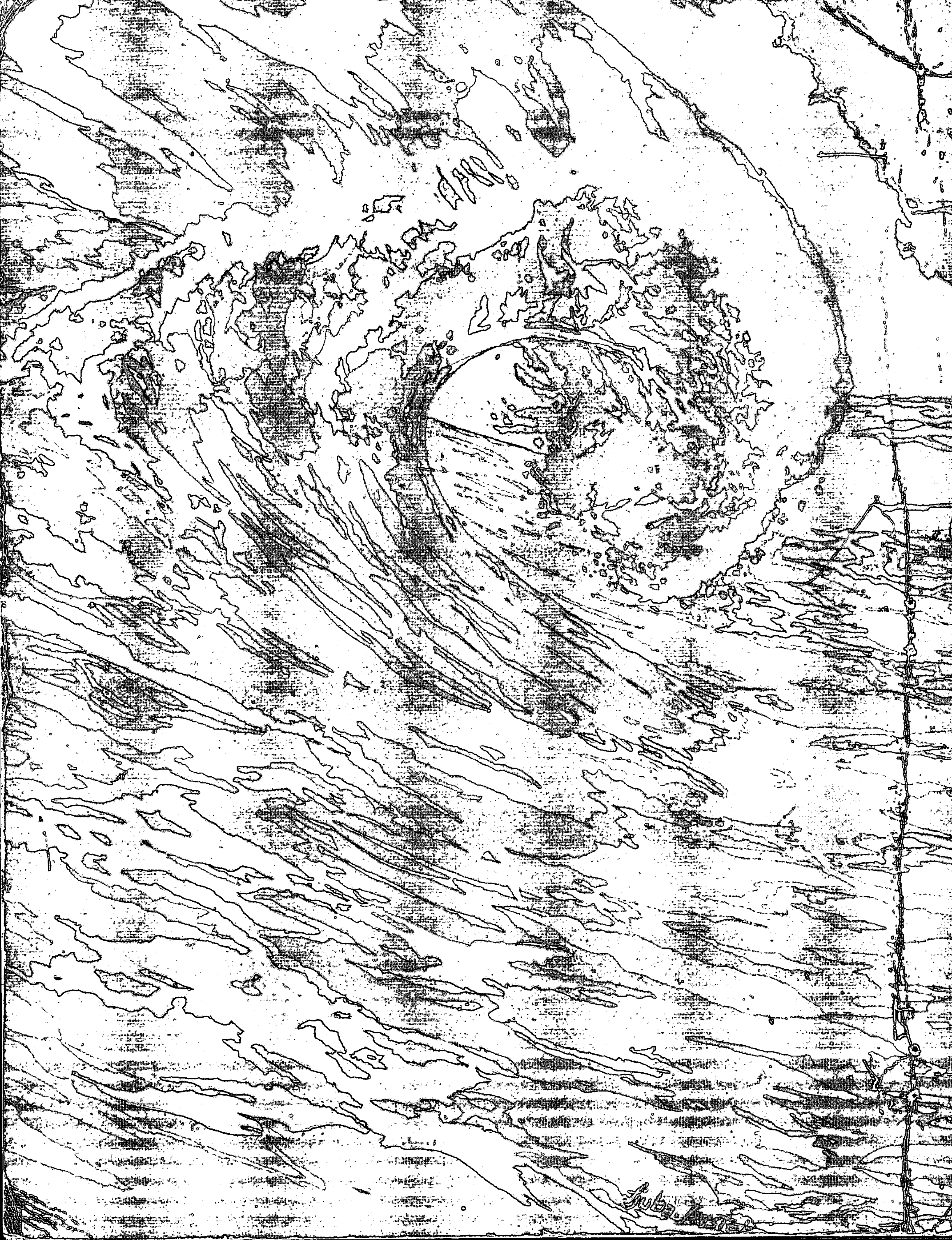
Liuba