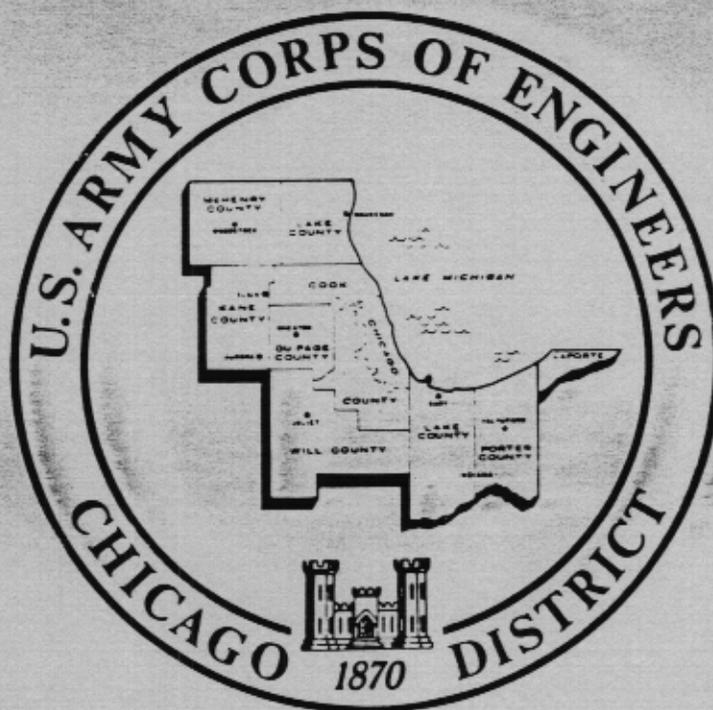




**US Army Corps  
of Engineers**  
Chicago District

# 1985 Annual Report on Lake Michigan Diversion

(Including State of Illinois Water Year 1983  
Accounting Report)



FEBRUARY 1986

## EXECUTIVE SUMMARY

(Krampi Jz)

This document is an annual report of the Chicago District, U.S. Army Corps of Engineers activities in the monitoring and overview of Lake Michigan diversion flows through Chicago, Illinois as directed by 1980 amendments to U.S. Supreme Court decree. The report provides overview and audit of flow measurements and accounting conducted by the State of Illinois.

The 1985 Annual Report on Lake Michigan Diversion departs from previous reports by reporting all events occurring during the year in which the report is published rather than during the water year for which the State of Illinois' accounting report is submitted.

Major events covered in this report include the certification of the State of Illinois' Accounting Report for 1983, the installation of an Acoustic Velocity Meter to measure flow passing through Lockport and the development of a computerized water budget system to account for diversion flows.

The following conclusions were reached:

- a. Annual Lake Michigan Diversion for Water Year 1983 is correctly reported by the State of Illinois as 3,613.1 cfs.
- b. The new accounting system is reasonable in its approach and produces a final accounting product which is reasonable and in agreement with historic trends. The new accounting system produces overall results which are substantiated using state-of-the-art measuring techniques.
- c. Pending a rigorous, detailed analysis, the new accounting system is provisionally certified for future use. The Corps accepts the new accounting system for Water Year 1983. Use in subsequent water years is subject to the results of further review.
- d. Based on Department of Justice letters the State of Illinois' proposal for inclusion of sewer induced groundwater pumpage cannot be allowed as a deduction. The State will continue to account for that component of diversion in their accounting program.

ANNUAL REPORT

MONITORING OF DIVERSION  
OF LAKE MICHIGAN WATER  
AT CHICAGO, ILLINOIS

INCLUDING

ILLINOIS DEPARTMENT OF TRANSPORTATION  
DIVISION OF WATER RESOURCES  
REPORT ON ACCOUNTING OF DIVERSION  
FOR WATER YEAR 1983

FEBRUARY 1986

DEPARTMENT OF THE ARMY  
Chicago District, Corps of Engineers  
219 South Dearborn Street  
Chicago, IL 60604-1797

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ANNUAL REPORT

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INTRODUCTION

BACKGROUND

The City of Chicago, as well as some of its suburbs, have drawn on Lake Michigan for the source of their municipal water supply for practically their entire history. When the flow of the Chicago River was reversed and the Chicago Sanitary and Ship Canal was completed, this flow of water was effectively diverted from the Lake Michigan (St. Lawrence and Atlantic Ocean) Watershed to the Illinois River (Mississippi and Gulf of Mexico) Watershed. This practice continues today, although closely controlled by the State of Illinois, with the oversight of the U. S. Army Corps of Engineers, as decreed by the U. S. Supreme Court. This report is one of a series of Annual Reports prepared by the Corps of Engineers as a report on the monitoring activities of the Corps to the parties to the Supreme Court litigation and to the general public.

This report reviews the Corps findings concerning the computation and measurement of diversion flows for Water Year 1983 (1 October-30 September), as presented by the State of Illinois in its report, Lake Michigan Diversion Accounting for Water Year 1983 (attached as Appendix A). The report discusses the Corps activities, findings and conclusions, and other events concerning Lake Michigan water diversion for the period October 1982 through September 1985 inclusive.

## AUTHORITY FOR REPORT

Under the provisions of the U.S. Supreme Court decree in Wisconsin, et al v. Illinois et al, 388 U.W. 426, 87 S.Ct. 1774 (1967) as modified 449 U.S. 48, 101 S.Ct. 557 (1980), the Corps of Engineers is charged with monitoring the measurement and computation of diversion of Lake Michigan water by the State of Illinois. The responsible state agency is the Illinois Department of Transportation-Division of Water Resources (IDOT). Under the terms of the modified decree, the Corps is required to report annually to the parties of the litigation on the diversion activities of the State of Illinois.

## HISTORY OF LAKE MICHIGAN DIVERSION

Water has been diverted from Lake Michigan at Chicago into the Mississippi River Basin beginning with completion of the Illinois and Michigan Canal in 1848. At that time, diversion averaged about 500 cubic feet per second (cfs). Upon completion of the Chicago Sanitary and Ship Canal in 1900, the flow direction of the Chicago River was reversed and a permit was issued by the Secretary of War for the diversion of 5,000 to 10,000 cfs.

In 1922, the State of Wisconsin, concerned about the effect of diversion on lowering Lake Michigan levels, sought an injunction to prohibit the State of Illinois from diverting Lake Michigan water. The Supreme Court issued a decree in 1930 establishing a phased reduction in the diversion down to an annual average of 1,500 cfs, in addition to domestic pumpage, by 30 December 1938.

Another U.S. Supreme Court decree in 1967 limited the diversion of Lake Michigan water by the State of Illinois and its municipalities, this time including domestic pumpage, to an average of 3,200 cfs over a five year period effective 1 March 1970.

The 1967 U.S. Supreme Court decree was amended on 1 December 1980 in response to action brought by the original complainants joined by the states of Minnesota, Ohio and New York. This modified decree extended the period for determining the running average diversion rate allowable from five years to forty years and changed the beginning of the accounting year from 1 March to 1 October.

Three specific provisions of the amended decree affected the role of the Corps of Engineers. First, the Corps may enter into an agreement with the State of Illinois to do the measurement and computation of diversion flows on a cost-sharing basis. The Corps has chosen to not exercise this option due to

the possible dilution of the Corps oversight function and the dependence of the monitoring and accounting on two independent sources of funding. As such an agreement is not in force, the measurement and computations of the diversion are being done by IDOT through its consultants, the Northeastern Illinois Planning Commission (NIPC), the Metropolitan Sanitary District of Greater Chicago (MSDGC), and the United States Geological Survey (USGS).

Second, the supervisory role for the Corps is increased, in that the Corps is responsible for auditing the State's computations and measurements.

Third, every five years the Chief of Engineers shall appoint a three-member Technical Committee to determine if the best current engineering practice and scientific knowledge for measuring the diversion is being employed and to make recommendations as appropriate. The decree stipulates that "...the members should be selected on the basis of recognized experience and technical expertise in flow measurement or hydrology." and be reconvened at least once every five years. The first Technical Committee was convened in June 1981 and completed its work in April 1982.

## DIVERSION MONITORING PROGRAM

### OVERVIEW OF PROGRAM

The Corps' Program Review has concentrated on IDOT's effort, with USGS, to improve the measuring and recording of flows at Lockport, a recommendation of the first Technical Committee, and on IDOT's development and calibration of a new accounting process.

### Flow Measurement

The first Technical Committee questioned the accuracy of flows measured at Lockport and recommended that the flow rating curves be field checked and recalibrated if necessary. The Chicago District retained the Corps' North Pacific Division to prepare an estimate of cost to investigate and upgrade the turbine flow measuring process at the Lockport Powerhouse. The cost of completing this work was found to be prohibitive. The Corps' Waterways Experiment Station (WES) conducted mathematical studies to upgrade the stage-discharge rating curves for the powerhouse sluices and the controlling works sluices. The new stage-discharge curves, as developed by WES, were used to compute total flow at Lockport for the 1983 Water Year.

Rather than incur the expense of revising and recalibrating the several rating curves for the various structures at Lockport, IDOT opted to install an Acoustic Velocity Meter (AVM) in the Sanitary and Ship Canal upstream from Lockport at the Romeoville Bridge. The use of the AVM will resolve a number of issues raised by the first Technical Committee. The device was installed in March 1984 and calibration was completed in March 1985. Flow data from the AVM were used as an independent check on hydrologic trends developed by the new accounting process. IDOT intends to use AVM data for all Lockport measurements beginning with the 1985 water year.

The AVM employs acoustical transducers to measure the velocity of sound through water. The flow is determined from the downstream component of the sound waves. The AVM is positioned at the Romeoville Bridge, approximately six miles upstream of the Lockport facilities. The advantages of this location are that it is on a relatively uniform reach of the Chicago Sanitary and Ship Canal, no major inflows or outfalls exist between the AVM and the controlling works, and it is located far enough from the controlling works that pool drawdown is not a significant factor in the accuracy of measurements. While the AVM does not measure flow at Lockport, as specified by the decree, the flows measured by the AVM are the same flows which pass through the Lockport facilities downstream.

Calibration of the AVM was completed in March 1985. This consisted of seven sets of field measurements taken using standard Price AA current meters. The last set of these measurements was completed on 4 March 1985. Total flows for each set of field measurements were calculated and compared to the flows reported by the AVM for the same time period. The AVM record showed agreement within 2% for five of the seven field tests. The remaining two tests were conducted while the canal level was fluctuating and results varied by (+) 4.0% and (+) 8.8% from AVM records. Calibration checks are to continue quarterly to insure that the accuracy of the AVM is maintained.

A system flaw was found in March 1985 with a breakdown of the AVM device. A passing vessel severed the AVM transducer communications cable rendering the AVM inoperable. No data were gathered for thirty days. Following its repair in April 1985, the AVM was not recalibrated until a field check on 29 August which showed that the AVM was recording only 80% of field measured flow. IDOT reported that USGS is currently addressing the problem.

Under IDOT's direction, the USGS developed a backup system using a regression analysis of Brandon Road Lock flow records to determine flows in the event of AVM malfunction. The Corps plans to evaluate this method as well as alternatives and will

discuss endorsement of and the need for this backup system in the 1986 Annual Report.

### Accounting Procedures

The Corps maintained close contact with IDOT and its agent, the Northeastern Illinois Planning Commission (NIPC), during the development of the new accounting procedure. This new procedure uses a hydrologic model to account for flows throughout the diversion area. The basic model is a variation of the Hydro-Comp Model originally developed by NIPC to conduct Section 208 Water Quality Studies. It has been used for several studies by NIPC and other agencies, including the Corps in its Chicago Underflow Plan (CUP) Study.

Using a form of comparative analysis of historical flows combined with samplings of flow computation checks, the Corps verified the reasonableness of the model. Simulated and reported flows for specific diversion components were compared with historic trends for the respective flow components (figure 2). The AVM data available were also used to determine the reasonableness of the hydrologic model. AVM records for 1985 were plotted with MSD Lockport records (figure 4) and the plots analyzed for trends. These trends were compared against similar plots of the hydrologic model's simulated flows vs. Lockport records for 1983 (figure 5).

In both cases, similar trends were observed. The simulated flows derived from the new accounting system tend to be higher than the Lockport record during low flow conditions. Conversely, during high flow, or storm events, the simulated flows are lower than the Lockport record. This same trend is established by the AVM for the 1985 data, indicating a strong degree of reliability in the hydrologic model. It is important to note that much of the formulation of the new hydrologic model was done prior to the availability of the AVM records; therefore, this type of a comparison is an excellent independent check.

### Other Activities

The Corps finalized its Standard Operation Procedure (SOP) for the measurement of leakage at Lockport Lock. This SOP will be followed in the event that measurement of flow at Lockport is required (as opposed to the measurement of flow by use of the AVM at Romeoville). Copies of the SOP are available at the Chicago District Office of the Corps of Engineers.

## DIVERSION ACCOUNTING REPORT FOR WATER YEAR 1983

On 27 November 1985, the State of Illinois submitted the revised Lake Michigan Diversion Accounting Report for Water Year 1983 to the Corps of Engineers (Appendix A). The report highlighted three areas of interest:

- a. a major modernization of the accounting process,
- b. the inclusion of sewer induced groundwater pumpage as deduction, and
- c. the use of new, Corps-developed, rating curves to modify the recorded flow at Lockport.

### Hydrologic Model

The 1983 Accounting Year Report was developed using the hydrologic model described above. Use of the new model will result in improvement in the bookkeeping and computational areas of the accounting process while not changing the basic formula decreed by the Supreme Court. The model allows actual reported water supply data to be used where the earlier method relied on the previous year's supply data. Additionally, in areas where direct flow measurement is not feasible, the hydrologic modeling provides synthetic flow determination based upon actual rainfall, ground cover, and land use parameters for the ungauged area.

The hydrologic model used is a variation of the Hydro-Comp Model. The model was used to allocate flows entering the Chicago waterways among their various sources. The allocation is made between both point and non-point sources which include Lake Michigan, municipal treatment plants, combined sewers, groundwater, commercial and industrial plants and precipitation runoff.

In 1976, the basic NIPC Hydro-Comp Model was calibrated to local climatic, physiographic and anthropogenic conditions. This involved an adjustment of mathematical relations so that the relevant physical reactions are accurately represented by the model. For diversion accounting purposes, the model was modified by dropping water quality parameters.

Once calibrated, the model was verified for the years 1969 through 1982 by summing the component flows and comparing the sums with the total measured Lockport flow (Table 2). The sums ranged from 6% below to 10.8% above Lockport records. The synthetic (or non-measured) flow components for the annual sums ranged from 6% to 12.4% of the totals.

An integral part of the accounting system is the water budget system employed in the model which allows component verification at various checkpoints. Simulated flows (the sum of individual components) for a watershed sub-area are compared with recorded measurement at metered points such as sewage treatment plants or pumping stations. A variance in the comparison may provide indication of errors in the raw data or in the system itself.

### Sluice Discharge Rating Curves

The first Technical Committee recommended that the flow rating curves for the Lockport facilities be checked and verified. The Corps conducted preliminary investigations on the turbines, powerhouse sluices, and controlling works sluices. The results indicated that the rating curves were inaccurate. In April 1983, the Corps' Waterways Experiment Station, through mathematical model and other analytical studies, developed new flow curves for the powerhouse sluices and controlling works sluices. This work is documented in Lockport Power Plant Sluice Gate and Control Works Discharge Evaluation, dated September 1985, and is available at the Chicago District Office of the Corps of Engineers. The new rating curves were used to modify the MSD Lockport flows by adjusting the flow computations for the sluices. For the 1983 water year, the modifications reduced the diverted flow by 180 cfs.

### Sewer Induced Groundwater Pumpage

The State of Illinois, in a letter dated 7 May 1984, proposed that an unmeasured component of groundwater pumpage be treated as an allowable deduction. This component, termed "Sewer Induced Groundwater Pumpage," was defined by the State as "...that groundwater which would have evaporated or filtered into lower aquifers if not for the presence of the sewer networks."

The State based its proposal on the premise that, as the sewer action requires pumps to move the water from the upper water table to the treatment plants, this component is part of the allowable deduction for groundwater pumpage. For Water Year 1983, IDOT determined this component to be 47 cfs. This factor was not included in any flow computations.

### Flow Computations

The total annual flow at Lockport for Accounting Year 1983 is reported as 3,991.5 cfs. The total reported deductions amounted to 403.5 cfs, as identified in columns 4, 5, 6 and 8 in

Table 1. The net total diversion for Accounting Year 1983 is reported as 3,613.1 cfs. As of 30 September 1983, the long-term average diversion flow is 3,268.8 cfs. (Averaging began with water year 1981). A graphic representation of component portions is given in figure 6.

## FINDINGS CONCERNING DIVERSION ACCOUNTING PROGRAM

### Domestic Pumpage

Domestic pumpage is water pumped from Lake Michigan or from groundwater sources for some purpose. The U. S. Supreme Court decree includes water pumped for industrial use as domestic pumpage. Domestic pumpage from Lake Michigan, and from groundwater sources recharged by Lake Michigan, is diversion when it reaches the river/canal system as sewage. Domestic pumpage from other groundwater sources is deducted from the Lockport flows.

Domestic pumpage is measured directly at the initial supply pump stations. Lake Michigan water is measured at the water intakes and the primary treatment plants. Groundwater withdrawals are measured at the pump stations. The new accounting system uses a consumptive use factor of 0.9 to represent water supply pumped which actually passes Lockport as sewage effluent.

The Corps interprets the language in the decree on domestic pumpage as implying municipal and industrial water supply. The use of the 0.9 factor in the new accounting model to represent a reduction due to consumptive uses appears reasonable.

### Non-Diversion Runoff

Runoff from outside of the Lake Michigan Watershed which reaches Lockport through the sewer system is deducted from the total diversion. The primary source of this flow is from the Des Plaines Watershed. The Des Plaines Watershed is divided into three subareas for which non-diversion runoff flows are calculated. These are the Upper Des Plaines, Lower Des Plaines and Summit Conduit.

#### Upper Des Plaines Watershed

Under the old accounting system, water flows were measured at the Upper Des Plaines Pump Station (UDPPS). A correction factor was used to include areas not tributary to UDPPS. Any Lake Michigan water reaching the UDPPS was subtracted from the flow and the modified flow was deducted from the Lockport flow.

Under the new system, estimated flows based on water supply, precipitation, sewer infiltration and sewer treatment plant flows are used.

The Corps found that the simulated flows failed to match the recorded flows at the UDPPS (figure 7), but did match the flows at the West-Southwest Treatment Plant at Stickney (figure 8). A field inspection by the Corps verified that, during high flow periods, flows were capable of bypassing the UDPPS metering system. Conversely, during low or normal flows, effluent being pumped could leak back into the sump, resulting in double counting and high metered flows. During the 1983 water year, the new system reported 109 cfs of which 77 cfs flowed through the UDPPS. Direct measurements at the UDPPS were 85 cfs, or 10% higher than simulated.

#### Lower Des Plaines Watershed

The configuration of the Lower Des Plaines Watershed prevents the direct measurement of total flow at any single point. Under the old system, flows were measured on the Hart Ditch and substituted for the Lower Des Plaines Watershed. The Hart Ditch Watershed is similar in topography and geology. By multiplying Hart Ditch flows by a factor of .95 to account for a slight difference in area, a representative flow estimate was produced.

The first Technical Committee suggested that land use factors, such as surface cover, percent combined sewer use and population density, be compared to verify the substitution representation. The new system generates an estimate of flow using hydrologic simulation based upon data gathered directly from the Lower Des Plaines Watershed. The hydrologic simulation for Water Year 1983 resulted in a flow of 121 cfs compared to 90 cfs from the Hart Ditch substitution (figure 3). An investigation of precipitation records from the two watersheds showed that the Lower Des Plaines Watershed received approximately 36% more precipitation than the Hart Ditch Watershed. This fact accounts for a significant difference in the runoff of the two watersheds.

In the case of the Lower Des Plaines Watershed, all runoff is deductible since it is intercepted by the Cal-Sag Channel and carried directly to Lockport.

#### Summit Conduit

The Summit Conduit collects sewage and runoff from a small area of the Des Plaines Watershed. In prior years, the conduit was gaged and flows were directly recorded. The first Technical

Committee questioned the accuracy of the gaging system in use. The new accounting system replaces direct measurement with hydrologic simulation based on the characteristics of the drainage area. The hydrologic simulation for Water Year 1983 resulted in an average annual flow of 13.7 cfs. The gage recorded an average annual flow of 14.9 cfs.

### Grand Calumet River

The Grand Calumet River flows into the Little Calumet River above the O'Brien Lock and Dam. The Indiana Canal connects the Grand Calumet with Indiana Harbor, allowing flow directly into Lake Michigan. Flow in the Grand Calumet between the Little Calumet River and Indiana Canal can go either east or west, depending upon the hydraulic gradient. The location of the hydraulic summit between the Indiana Canal and the Little Calumet River is dependent upon the elevation of Lake Michigan. As the lake level rises, the summit moves east, closer to the Indiana Canal. The amount of sewage effluent from the Hammond Indiana treatment plant flowing into the Little Calumet River and then into Illinois is thus dependent upon the level of Lake Michigan. The publication titled Flows Crossing the Lake Michigan Diversion Boundary in Indiana, completed in 1978, documented a method of estimating the quantity of Indiana domestic pumpage which reaches Illinois as sewage effluent base upon the level of Lake Michigan and the record of domestic pumpage. For the 1983 Water Year, that quantity is estimated to be 50.7 cfs.

### Summary

Historical flows at Lockport were plotted against historical runoff component flows (Figure 2). The plots did not result in a linear correlation between total flow at Lockport and runoff component flows. Instead, the plots showed a scattering of data points. The 1983 values for runoff components are reasonable when compared to the range of historical values, as shown in the table below.

Table 3 - Components of runoff

	1983	Historical Range (1969-1982)	% Difference
Lockport recorded	4170	3206 - 3795	+10%
Summit Conduit			
Recorded	14.9	8 - 14	+6%
Simulated	13.7		in range
Lower Des Plaines Watershed			
Hart Ditch Substitution	90	11 - 96	in range
Simulated	121		+25%
Upper Des Plaines			
Recorded	121	49 - 129	in range
Simulated	109		in range
Illinois Watershed			
Recorded	231	51 - 231	in range
Simulated	244		+5%
Total			
Recorded	461.9	119 - 470	in range
Simulated	487.7		+4%

FINDINGS CONCERNING DIVERSION ACCOUNTING REPORT FOR WATER YEAR 1983

The Corps' review of the State of Illinois' Lake Michigan Diversion Accounting Report for 1983 (Appendix A) can be summarized as follows:

- a. the use of a hydrologic model in flow accounting is consistent with state-of-the-art technology and provides reasonable accounting of non-measured flows;
- b. the use of Corps-developed flow rating curves for the Lockport Powerhouse and Controlling works sluices improves

the accuracy of measured flow for these flow components;

c. the inclusion of sewer induced groundwater pumpage as a deduction is not consistent with the U.S. Supreme Court decree and cannot be used; and

d. differences between precipitation data recorded by MSDGC and that provided by the National Oceanographic and Atmospheric Administration (NOAA) exist which may be greater than can be explained by localized meteorology.

### Hydrologic Model

A two-tier approach to the final certification of the new accounting procedure is being taken by the Corps. The first level is a determination of the reasonableness of the simulated flows produced. This determination is based on comparative analysis of the simulated flows versus historical data for the same component flows. Sample procedures and results were discussed earlier in this report.

The second level will be a detailed analysis of the model's algorithms and flow parameters to be done during 1986. This analysis will be the basis for final certification of the accounting system. It is noted that approximately 80% of the flows are directly measured and that in those cases where measured data is in conflict with simulated flows, the measured data was used in the accounting report for Water Year 1983.

### Flow Measurements

The Corps conducted several spot-checks of MSDGC computations of flow through the powerhouse, lock, and controlling works at Lockport. The total flows computed by MSDGC were also graphically compared with the modified (using the Corps-developed rating curves) Lockport flows reported by IDOT (figure 9). A number of differences in daily flows were identified. Those particular daily flows were then analyzed for reasonableness based on the anticipated effect of the new rating curves. Those daily flows which differed from the anticipated result were recalculated by the Corps. Apparent errors in calculations thus identified were reported to IDOT and corrected in the final IDOT Accounting Report.

### Sewer Induced Groundwater Pumpage

IDOT's proposal to include sewer induced groundwater pumpage as a component of the groundwater pumpage deduction is based on an October 1981 study, summarized in Part III of the

Accounting Report for Water Year 1983 (Appendix A). In a May 1985 report, titled Report on a proposal by State of Illinois Department of Transportation, Division of Water Resources to Consider Induced Infiltration as a Deduction in the Lake Michigan Diversion Accounting Procedure, the Corps recognized that "...sewer joints, given surrounding positive head differential, will drain near subsurface flow, some of which would not have reached the Lake Michigan watershed if surface urbanization were as it is today and sewers had not been constructed...".

In a separate action (10 July 1985), the U. S. Department of Justice has rendered an opinion that the inclusion of sewer induced groundwater pumpage as an allowable deduction requires an amendment to the decree.

The State of Illinois has taken exception to the Justice Department's opinion as ignoring the State's allegation that sewer induced groundwater pumpage is a portion of the groundwater pumpage component which is already addressed in the decree. Justice has reaffirmed its position (23 August 1985).

The total quantity in question for Water Year 1983 is 47.1 cfs.

#### Precipitation Data

The Accounting Report for 1983 identifies a concern that precipitation data provided by MSDGC varies significantly from that received from NOAA. After review of the data used in the flow simulations, the Corps found that the precipitation data used by IDOT was significantly lower than the published data for MSDGC gages. While the total effect on diversion flows is small, correcting the precipitation data would result in an increase of deduction runoff and ultimately lower the total diversion for the 1983 water year.

#### Certification of Flows

After review of the Accounting Report for Water Year 1983 and the data from which it was derived, the Corps found the following flows to be correct and are certified:

Total annual average flow at Lockport	3,991.5 cfs
Total deductions from Lockport record	403.5 cfs
Lake Michigan domestic pumpage not reaching canal	25.1 cfs
Total diversion for Water Year 1983	3,613.1 cfs
40-year average	3,268.8 cfs
Total diversion to date (Water Years 1981 - 1983) above 3,200 cfs:	206.4 cfs-years

## FUTURE PROJECTS AND STUDIES BY CORPS OF ENGINEERS

As a result of the recommendations of the first Technical Committee, the Corps is preparing a Master Plan for the Corps review of accounting procedures. The Master Plan is scheduled for completion in 1986.

### Second Technical Committee

The second Technical Committee will be convened in Fiscal Year 1986. The committee is expected to further review the new accounting system and the reliability of the current system of measuring flows. The committee will be charged with providing overall review and recommendations to improve the technical processes used in diversion accounting considering the current best engineering and scientific methods.

### Calibration and Documentation of Flow Components

The Corps will initiate procedures in Fiscal Year 1986 to establish and review calibration procedures and documentation for the primary diversion flow components. Currently, some calibration of primary flow devices is conducted, but little documentation is done. The Corps program will initiate a formal review which will add periodic document review to continuing field monitoring of calibration efforts.

The Corps will evaluate the proposed backup to the AVM. Alternatives will be evaluated based on accuracy, reliability and cost effectiveness.

The need for a gage at the Summit Conduit, discontinued in October 1984, will be evaluated. The previous gage was improperly located. Flow is currently being estimated by hydrologic simulation. The evaluation of a replacement gage will consider accuracy vs. hydrologic simulation as well as cost effectiveness of on-site metering.

### Review of Hydrologic Model

Of immediate concern to the Corps is a comprehensive detailed analysis of the new accounting model. This review will transcend that done for this report in that the specific program logic, flow algorithms, hydrologic parameters and calibration procedures will be analyzed and reviewed by Corps experts on hydrologic modeling for the purpose of verifying the model for continued use as the sole accounting system.

## Phase I TARP Effects on Accounting

The main stem of Phase I of the Tunnel and Reservoir Plan (TARP) was placed in operation on 25 May 1985. The impact of the system on accounting and any required modifications to the accounting program proposed and/or implemented by IDOT will be studied during the coming months.

### RECOMMENDATIONS AND CONCLUSIONS

#### REVIEW OF STATE OF ILLINOIS' RECOMMENDATIONS

Based on IDOT's recommendations as provided in Section VII of the 1983 accounting report, the Corps concludes the following:

a. IDOT Recommendation:

Further investigations into the accuracy of recorded flows at the Controlling Works and Powerhouse at Lockport are needed. Particular attention is needed to quantify submergence at the Controlling Works and its cause.

Corps' Conclusions:

This is needed only if the controlling works and powerhouse at Lockport are used as the backup measurement system.

b. IDOT Recommendation:

The MSDGC should incorporate the revised Corps' ratings for free flow discharge into their calculation of discharge for the Controlling Works and Powerhouse. The MSDGC should also establish a continuous record of tailwater elevations at a suitable location downstream of the Controlling Works.

Corps' Conclusions:

MSDGC should use the revised rating curves. Furthermore, if the controlling works and powerhouse flows are needed as part of a backup measurement system, then tailwater and headwater gages should be installed at the controlling works. The responsibility for accomplishing these changes is IDOT's.

c. IDOT Recommendation:

Further investigation is needed to determine the reasons for imbalances between estimated and recorded flows at the three major MSDGC treatment plants. Areas for investigation include the following:

1. Model assumptions with respect to sanitary return flow and infiltration and inflow quantities.
2. Possible leakage from the Canal through combined sewer overflow structures.
3. Possible unreported major discharges to the plant from groundwater or surface water supply return flows.

Corps' Conclusions:

We agree with IDOT's recommendation. It is expected that IDOT will sponsor such investigations if funding allows.

d. IDOT Recommendation:

The monitoring of flow at the Upper Des Plaines Pumping Station should be discontinued for diversion accounting purposes due to uncertainties in its records which cannot be resolved without significant increase in maintenance and flow monitoring changes.

Corps' Conclusions:

We agree to discontinue the monitoring of this flow; however, it is expected that total flow records at the gage will continue to be maintained by IDOT in order to be used as a system check for any significant shifts in output trends from this service area. Data derived from the records should be provided in tabular format.

e. IDOT Recommendation:

Investigations into the possibility of long-term biases among precipitation gages reporting to NOAA, MSDGC and the City of Chicago should be undertaken based on significant differences noted during the 1998 water year.

Corps' Conclusions:

We support such an investigation by IDOT.

f. IDOT recommendation:

Flow monitoring at the Summit Conduit should be discontinued due to problems with frequent gage malfunctions, the relatively small amount of flow from this area, and the ability to reasonably estimate flows from this area using pumpage data and runoff simulation.

Corps' Conclusions:

The Corps is not convinced that this gage site should be discontinued. The measurement of this component will be a work task to be reviewed by the second Technical Committee in FY 1986.

g. IDOT Recommendation:

The flow transfers from the MSDGC's design O'Hare service area to the Northside Treatment Plant should be metered to provide a better estimate of quantity and flow variations.

Corps' Conclusions:

We support IDOT's implementation of such metering.

#### SUMMARY CONCLUSIONS

The Lake Michigan diversion accounting program is going through significant modifications in the technical methodology used in computing total flows at Lockport and in the computation of the deductions. The main features of these changes are a result of the first Technical Committee review. These features are the concern over the installation and reliability of the AVM, the existing MSDGC total flow measurement procedure and results, and the NIPC water balance methodology.

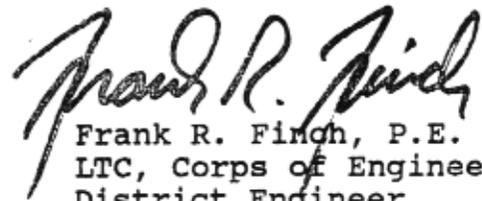
As discussed in both the IDOT report on Water Year 1983 and the Corps review, some minor inconsistencies still exist within the accounting system. Notwithstanding these inconsistencies, the results represent an improvement in the accounting procedures. Just as the physical features of the diversion area are dynamic, so is the accounting system itself.

It is expected that the implementation of the first Technical Committee's recommendations will, over the next several years, continue to improve the diversion monitoring system. The review by the second Technical Committee, scheduled to begin in the spring of 1986, will result in future improvements to the overall system as well.

CORPS OF ENGINEERS' FINDINGS

Based on the review of the State of Illinois' report, Lake Michigan Diversion Accounting for Water Year 1983, data collected by agencies of the State of Illinois, computation sheets, field investigations and special studies conducted by or for the Corps of Engineers, the Corps reaches the following conclusions:

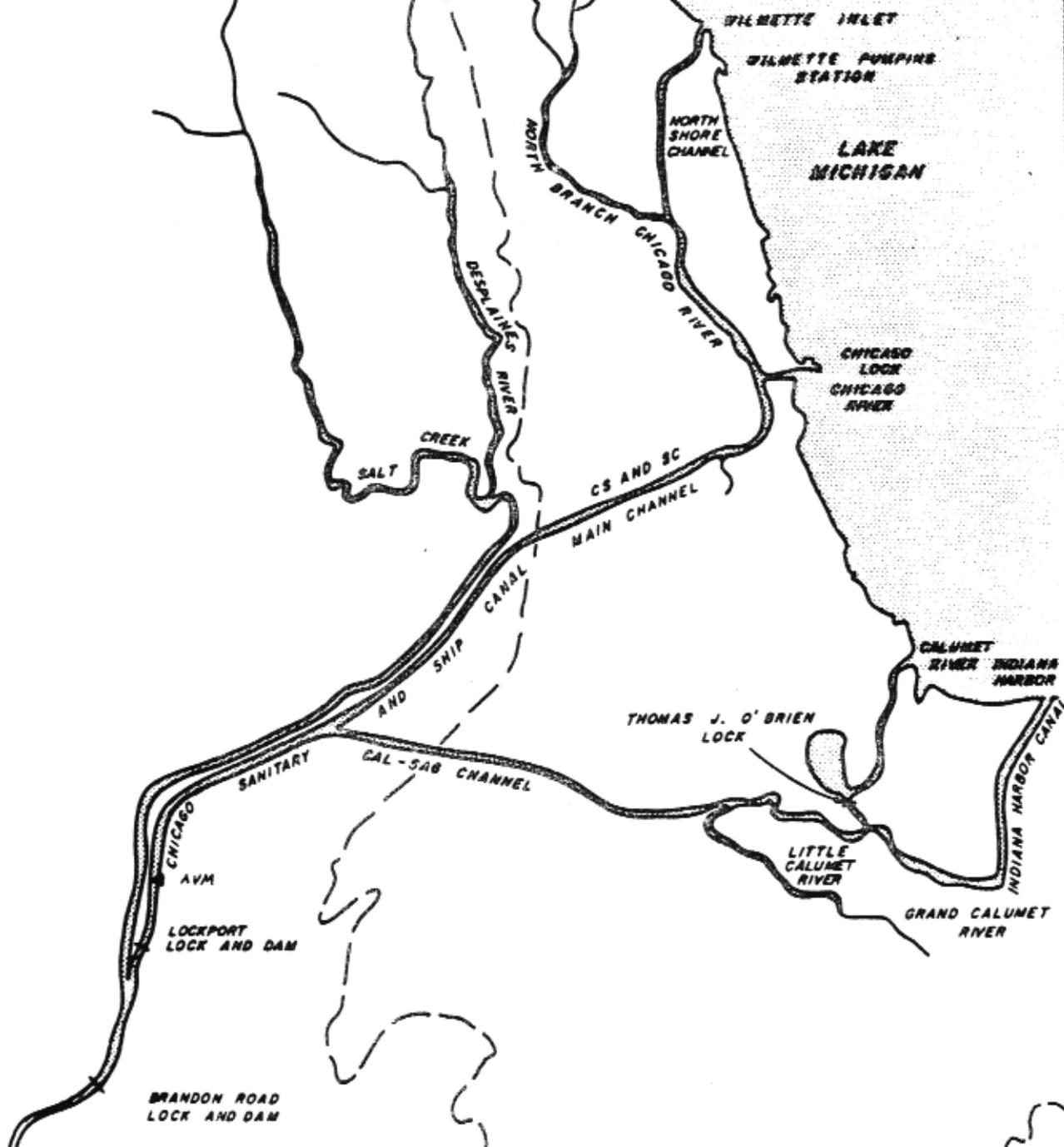
- a. Annual Lake Michigan Diversion for Water Year 1983 is correctly reported by the State of Illinois as 3613.1 cfs. The long-term average diversion flow, as of 30 September 1983, is 3,268.8 cfs.
- b. The new accounting system is reasonable in its approach and produces a final accounting product which is reasonable and in agreement with historic trends. The new accounting system produces overall results which are substantiated using state-of-the-art measuring techniques. Pending a rigorous and detailed analysis, the new accounting system is provisionally certified for future use. The Corps accepts the new accounting system for Water Year 1983. Use in subsequent years is subject to the results of further review.
- c. A backup system to the AVM for measuring Lockport flows is still necessary and should be maintained.
- d. The Department of Justice has taken the position that the proposal by the State of Illinois for "sewer induced groundwater pumpage" cannot be allowed as a deduction. Illinois will continue to report "sewer induced groundwater pumpage" as a component of diversion flow in their accounting program.
- e. It is appropriate to account for the non-diversion flows from the Lower Des Plaines watershed using flow estimates derived from the hydrologic model rather than the substitution method previously used.
- f. Variations in precipitation data gathered from different sources exceed what can be explained by localized meteorology. This may affect the accuracy of non-diversion runoff flows.

  
Frank R. Finch, P.E.  
LTC, Corps of Engineers  
District Engineer

REFERENCES:

1. COE, "Lake Michigan Diversion - Findings of the Technical Committee for Review of Diversion Flow Measurements and Accounting Procedures," October 1981.
2. Harza, An Evaluation of Flow Measurement and Accounting Method for Lake Michigan Diversion, October 1981.
3. Keifer, Flows Crossing the Lake Michigan Diversion Boundary in Indiana, September 1978.
4. COE, Report on a Proposal by State of Illinois Department of Transportation, to Consider Induced Infiltration as a Deduction in the Lake Michigan Diversion Accounting Procedure, May 1985.
5. COE, Lockport Power Plant Sluice Gate and Control Works Discharge Evaluation, September 1985.

GREAT LAKES  
DRAINAGE BASIN  
BOUNDARY



## Lake Michigan Diversion at Chicago

Figure 1 - Location plan

# LOCKPORT VS COMPONENT FLOWS

HISTORICAL FLOWS OF 1969 -1983

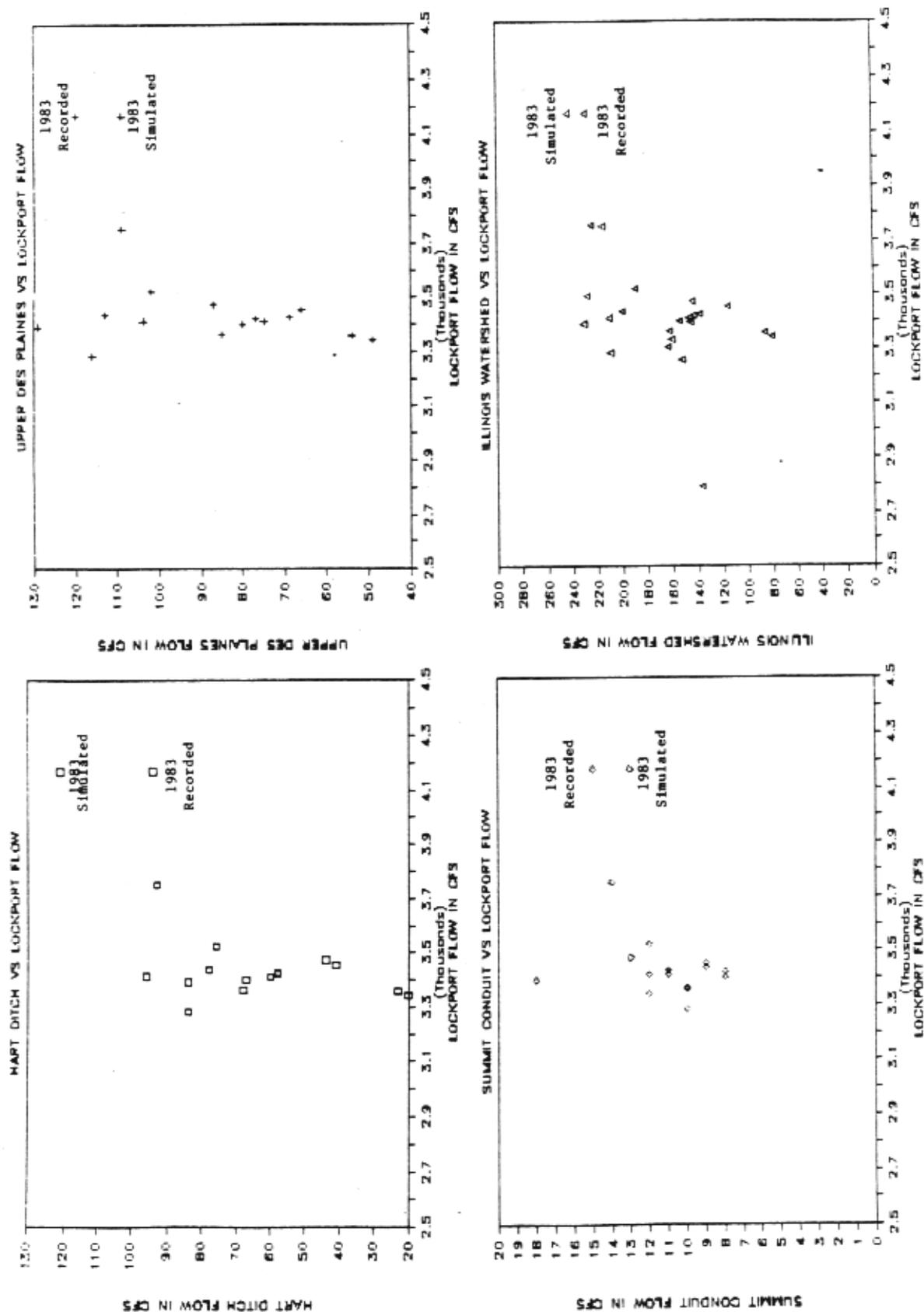
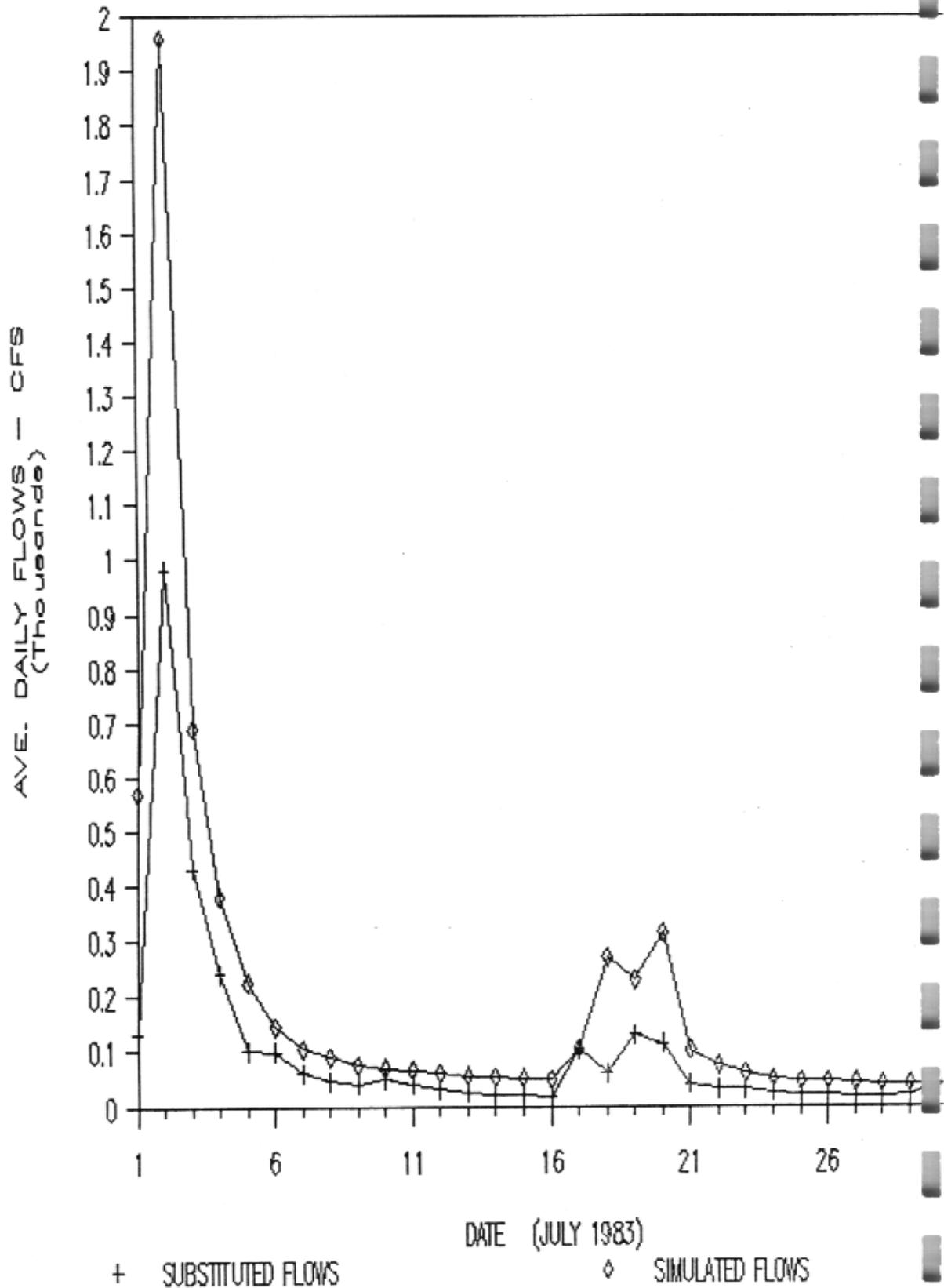


Figure 2

# LOWER DES PLAINES WATERSHED

SIMULATED VS HART DITCH HYDROGRAPHS



Figure

# FLOW AT LOCKPORT - 1985

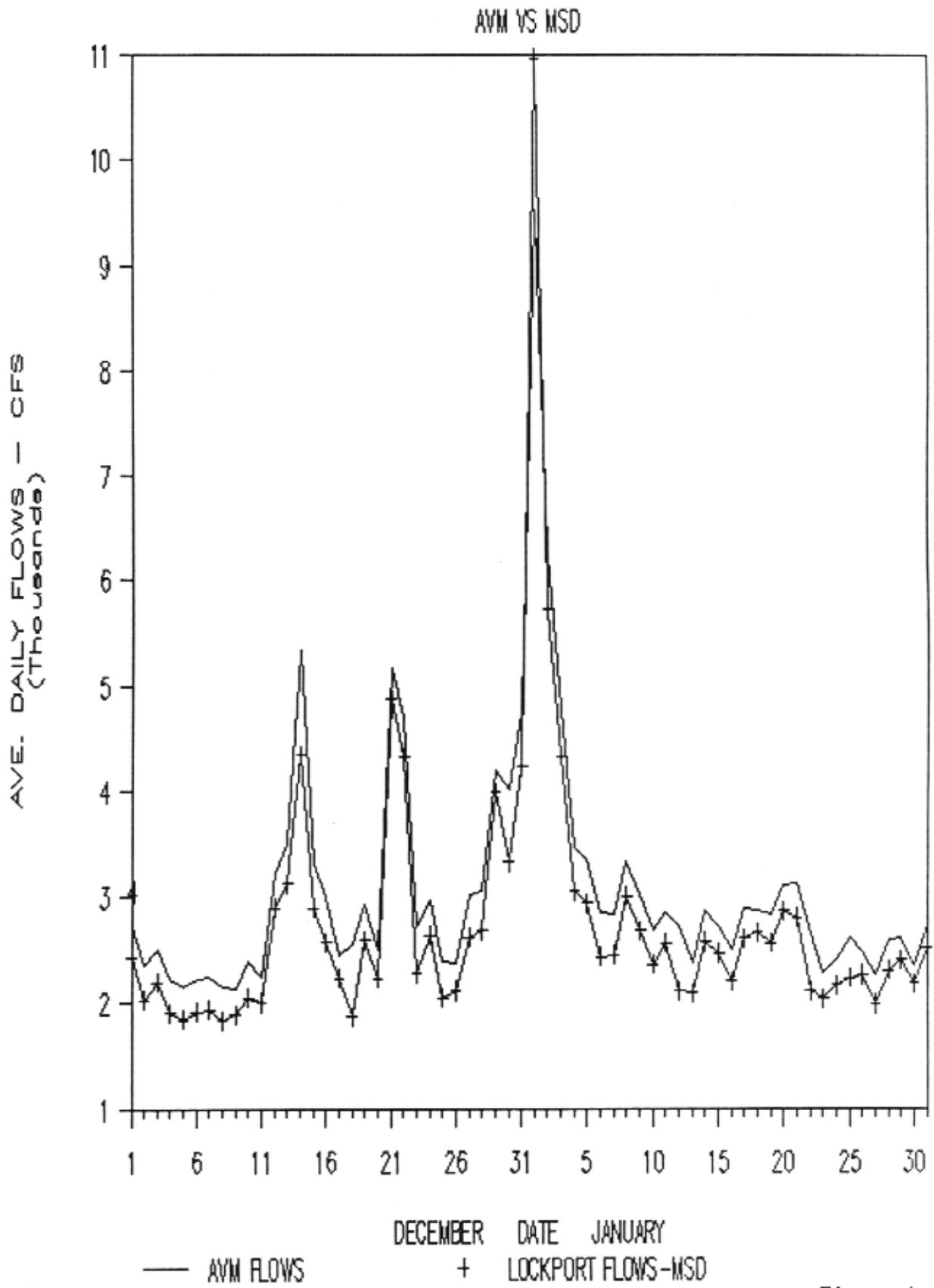
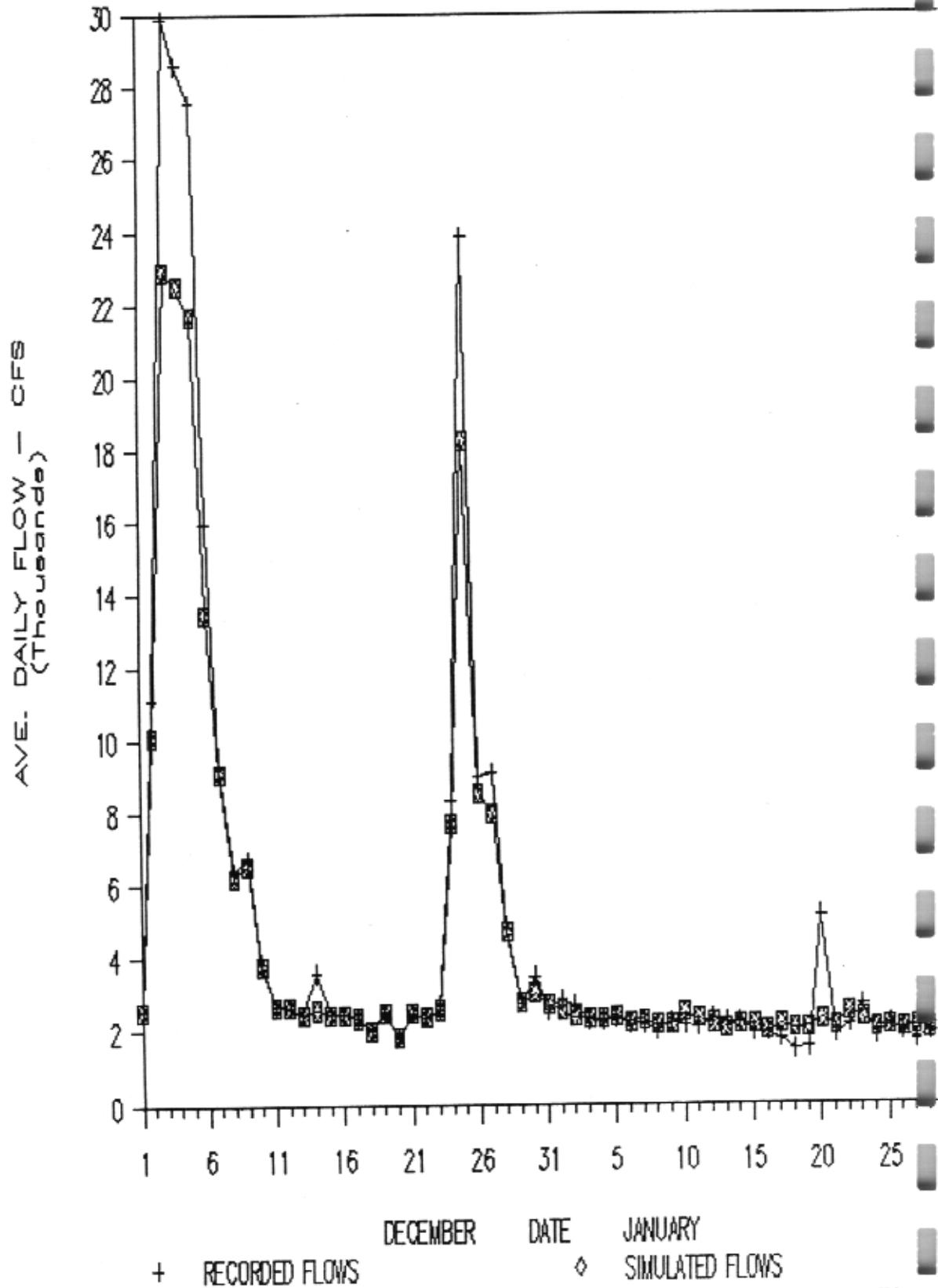


Figure 4

# FLOW AT LOCKPORT - 1983

RECORDED VS SIMULATED FLOW HYDROGRAPHS



Figur

**PRIMARY DIVERSION COMPONENTS  
(ACCOUNTING YEAR 1983)**

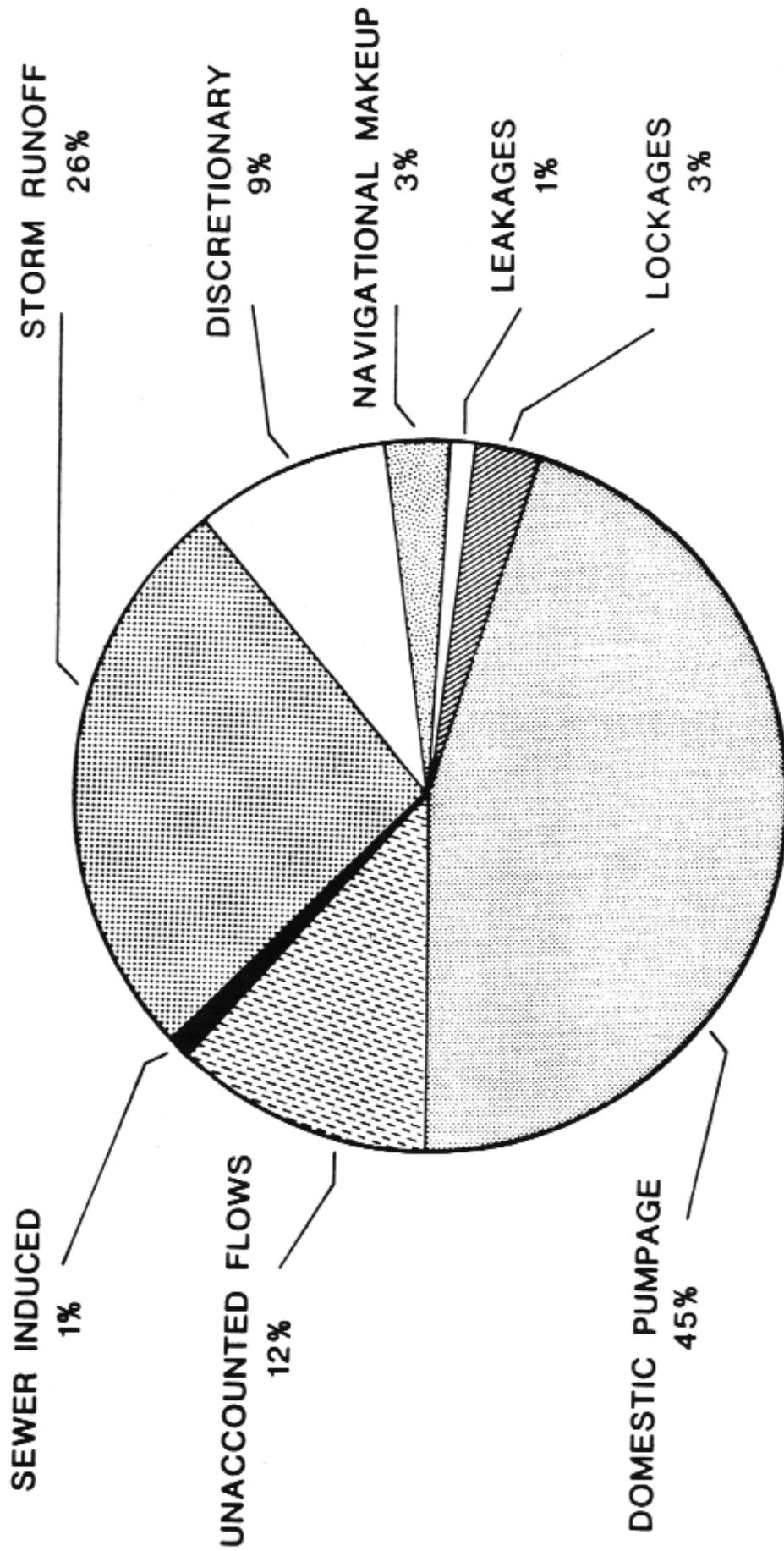


Figure 6

# UPPER DES PLAINES WATERSHED FLOWS

## FLOW HYDROGRAPHS

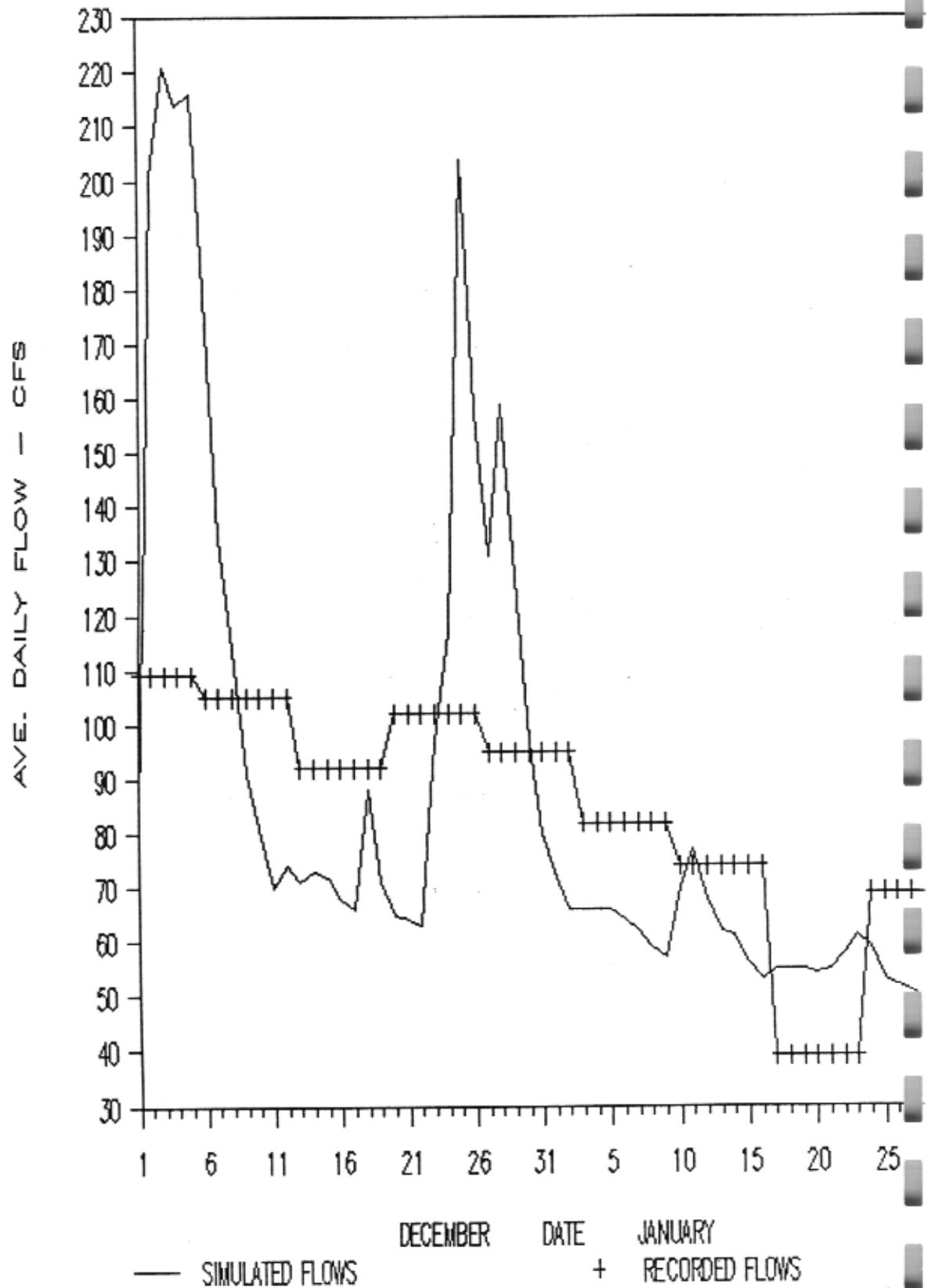


Fig.

# WEST-SOUTHWEST TREATMENT PLANT

## FLOW HYDROGRAPHS

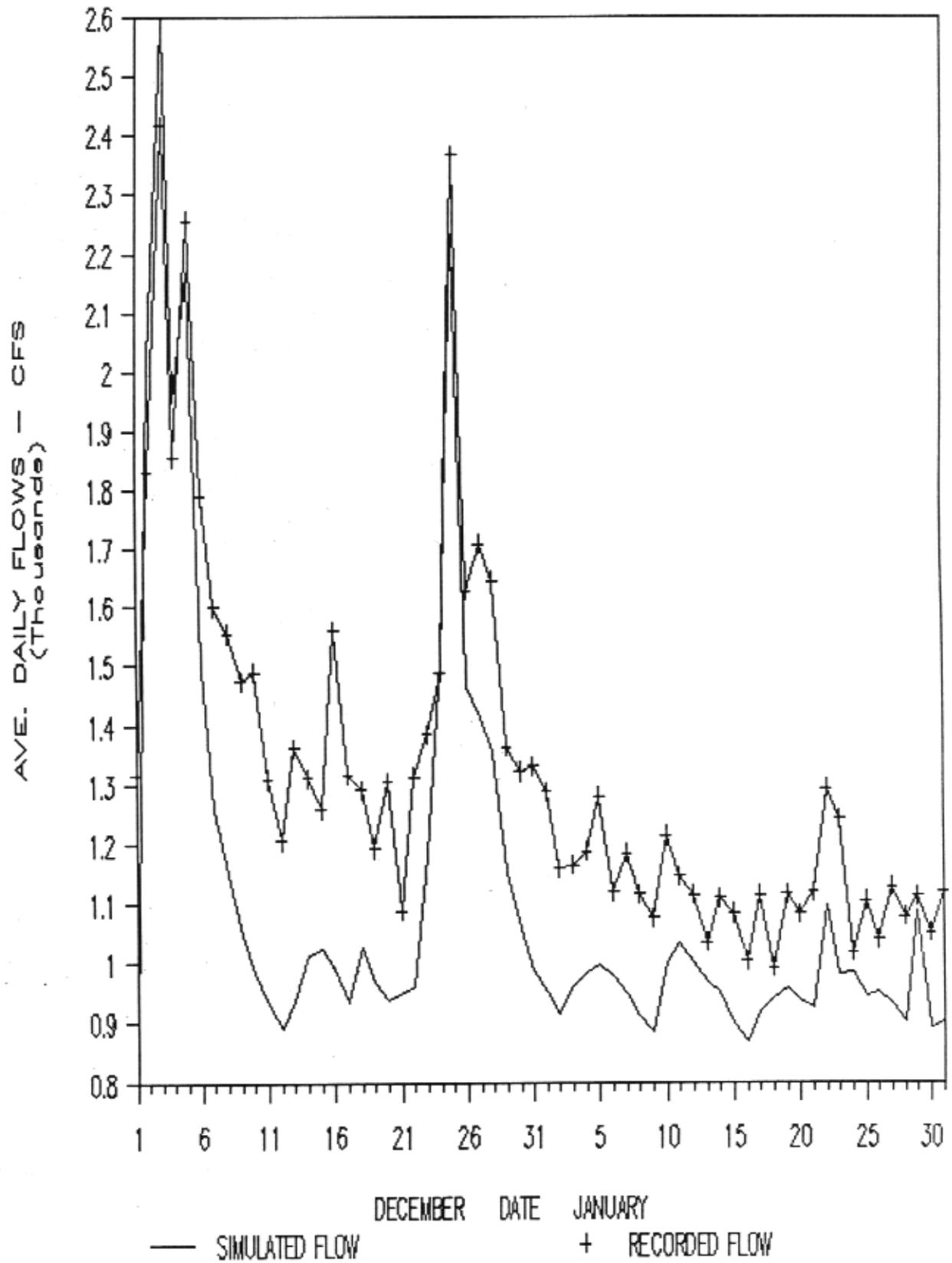


Figure 8

# DAILY LOCKPORT FLOWS

MSD REPORTED VS. NIPC MODIFIED

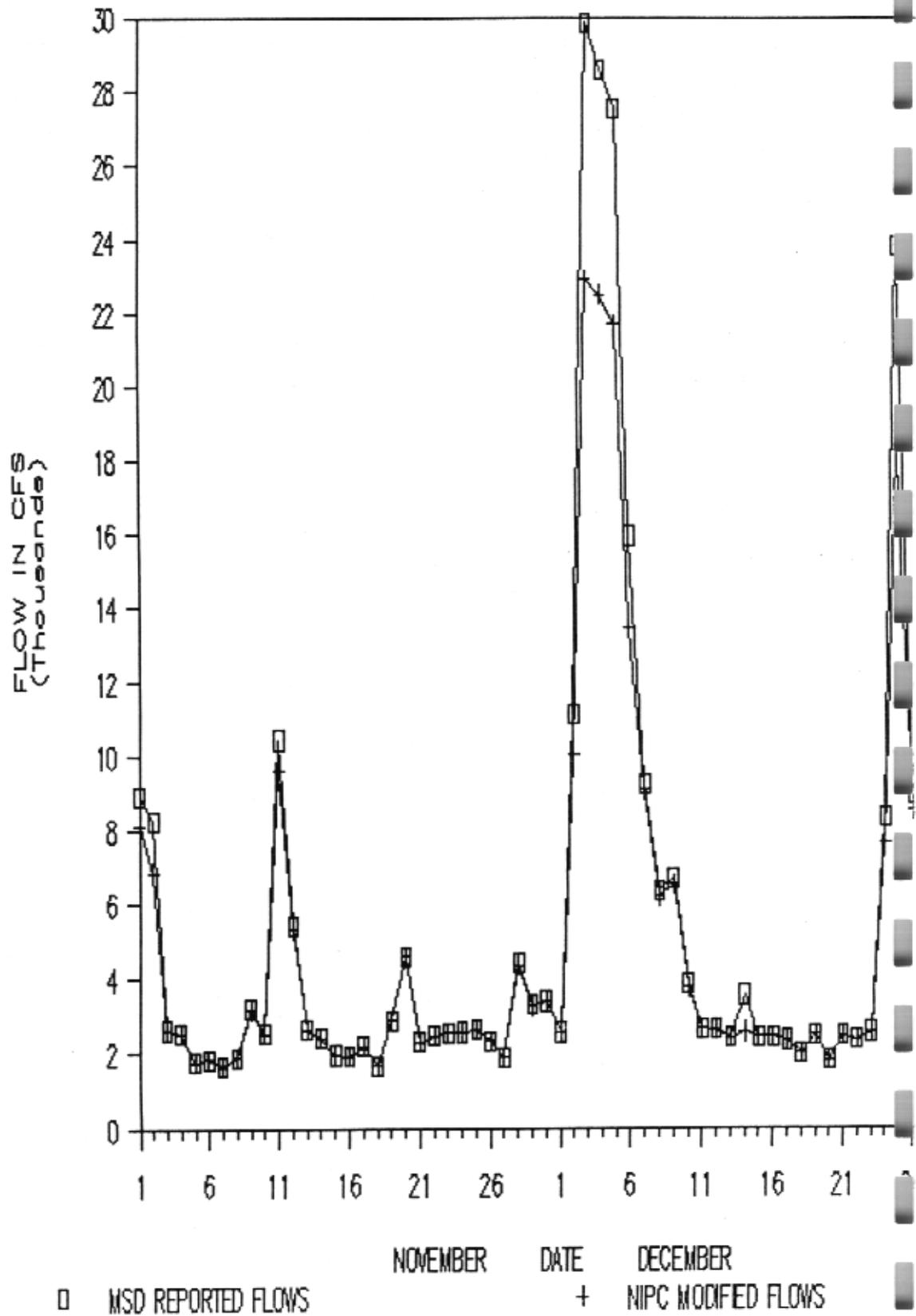


Table 1 - Average flow quantities  
For water year 1983

ILLINOIS DIVISION OF WATER RESOURCES DIVERSION ACCOUNTING REPORT  
FOR THE PERIOD FROM OCTOBER, 1982 TO SEPTEMBER, 1983  
ALL DATA ARE PRESENTED IN CUBIC FEET PER SECOND (CFS)

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	LOCK- BODY RECORD	DIVERSION ABOVE GAGE	TOTAL FLOW THROUGH CANAL (1+2)	GRNDWTR PUMPAGE FROM LAKE MICH. IN ILLINOIS WATERSH	GRNDWTR PUMPAGE FROM PLAINTIFFS WATERSH	WATER SUPPLY PUMPAGE FROM INDIANA REACHING CANAL	SEWER INDUCED GRNDWTR PUMPAGE FROM DIVERTED WATERSH IN INDIANA	RUNOFF FROM PLAINTIFFS WATERSH REACHING CANAL	SEWER INDUCED GRNDWTR PUMPAGE FROM DIVERTED WATERSH IN ILLINOIS	TOTAL DEDUCT- IONS FROM LOCK- BODY RECORD	LAKE MICH. DOMESTIC PUMPAGE NOT DISCHRG TO CANAL (8/ADJ)	TOTAL DIVERSION ***	PUMPAGE FROM LAKE MICH. TO ILLINOIS	RUNOFF FROM DIVERTED WATERSH	DIRECT DIVERSION THROUGH LAKE CONTROL STRUCTS
OCT1982	2559.6	0.6	2560.1	50.2	55.2	26.4	0.6	43.2	1.8	175.0	23.3	248.4	1539.6	93.9	695.6
NOV1982	3214.3	0.4	3214.8	50.2	54.6	27.1	0.7	255.2	42.3	386.5	23.3	281.6	1478.3	983.6	157.1
DEC1982	6637.1	0.2	6637.3	50.2	54.7	27.1	1.7	542.4	239.9	674.3	22.2	596.5	1449.9	2492.1	186.0
JAN1983	2194.3	0.2	2194.5	50.2	55.2	30.1	0.1	129.9	18.7	265.3	20.8	195.7	1456.8	209.2	97.7
FEB1983	2815.3	0.2	2815.5	50.2	55.0	30.2	0.2	102.0	28.6	327.4	22.8	251.0	1451.2	711.4	94.0
MAR1983	3158.8	0.3	3159.1	50.2	54.9	30.2	0.6	297.6	28.3	444.4	22.8	273.7	1447.1	932.1	122.3
APR1983	3747.8	0.2	3748.0	50.2	54.5	41.7	1.3	651.5	79.8	801.3	25.9	498.8	1447.8	232.1	176.7
MAY1983	4277.5	0.7	4278.2	50.2	54.4	65.4	0.9	145.9	33.9	517.4	25.1	3785.6	1463.7	122.9	310.5
JUN1983	3676.8	0.7	3677.5	50.2	55.1	81.6	0.1	130.9	68.6	319.8	27.8	3385.2	1781.4	444.1	924.2
JUL1983	5459.0	0.6	5459.6	50.2	55.0	83.2	2.4	198.8	68.6	387.3	30.2	5102.8	2035.0	100.3	1457.3
AUG1983	3463.3	1.0	3464.3	50.2	54.2	84.2	0.2	188.8	44.2	242.3	71.1	3753.1	2097.4	244.8	1478.5
SEP1983	4082.1	0.5	4082.6	50.2	55.0	61.2	0.3	113.4	25.9	799.8	26.1	3808.8	1699.6	531.7	1145.6
MEAN	3991.0	0.5	3991.5	50.2	55.0	50.7	0.7	247.6	46.4	403.5	25.1	3613.1	1613.7	940.8	874.2

(8) SEWER INDUCED GRNDWTR PUMPAGE (COLUMNS 7 AND 9) NOT INCLUDED AS A DEDUCTION PER U.S. JUSTICE DEPT. OPINION  
(9) CFS - Years Cumulative Sum

STATUS OF ILLINOIS' LAKE MICHIGAN DIVERSION  
UNDER 1980 AMENDED U.S. SUPREME COURT DECREE

Accounting Year	Annual		40 Year		CFS - Years	
	Diversion (% of 3,200 cfs)	Running Avg.	Annual	Cumulative Sum	Annual	Cumulative Sum
1981	3106 cfs (97)	3106	+ 94	+ 94		
1982	3087 cfs (96.5)	3096	+113	+207		
1983	3613 cfs (113)	3269	-413	-206		

Table 2 - Summation of component flows and  
 Recorded Lockport measured flow  
 For water year 1983

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
-----															
Connection to lake															
Wilmette															
Chicago River															
O'Brien															
Total	1441.0	941.0	1129.0	1230.0	639.0	311.0	495.0	527.0	911.0	692.0	745.0	685.0	684.0	549.0	574.0
-----															
Stream flow															
North Branch															
Little Calumet															
Total	311.0	301.0	239.0	348.0	452.0	437.0	312.0	277.0	166.0	317.0	355.0	310.0	360.0	346.0	430.0
-----															
Sewage Treatment Plants															
Northside															
Central															
South															
Lemont															
Total	2107.0	2109.0	2082.0	2161.0	2278.0	2215.0	2124.0	2421.0	2000.0	2070.0	2166.0	2061.0	2022.0	2113.0	2137.0
-----															
Other point sources															
Summit Conduit	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
CSO's	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
Tributary area runoff	222.0	254.0	177.0	269.0	258.0	261.0	235.0	212.0	150.0	240.0	355.0	235.0	260.0	250.0	271.0
Sum	99.0	116.0	65.0	109.0	130.0	155.0	110.0	90.0	36.0	112.0	130.0	110.0	130.0	125.0	193.0
-----															
Lockport recorded flow	4203.0	3744.0	3675.0	4140.0	3780.0	3402.0	3299.0	3550.0	3286.0	3454.0	3774.0	3424.0	3479.0	3406.0	3634.0
-----															
Sum - Lockport	3795.0	3416.0	3341.0	3748.0	3590.0	3295.0	3519.0	3318.0	3205.0	3344.0	3664.0	3286.0	3347.0	3308.0	4170.0
% difference	408.0	328.0	334.0	392.0	190.0	107.0	-220.0	232.0	81.0	110.0	110.0	138.0	132.0	98.0	-536.0
Precipitation (O'Hare)	10.8	9.6	10.0	10.5	5.3	3.2	-6.3	7.0	2.5	3.3	3.0	4.2	3.9	3.0	-12.9
	33.2	37.1	27.2	44.0	43.4	32.0	38.2	31.3	39.7	36.0	37.4	37.9	40.5	32.6	53.5

ANNUAL REPORT

MONITORING OF DIVERSION  
OF LAKE MICHIGAN WATER  
AT CHICAGO, ILLINOIS

APPENDIX A

Lake Michigan Diversion Accounting  
For Water Year 1983

(Prepared for IDOT by NIPC)

ANNUAL REPORT

MONITORING OF DIVERSION  
OF LAKE MICHIGAN WATER  
AT CHICAGO, ILLINOIS

APPENDIX B

Significant Events (Hydrologic and General)

Water Years 1983-1985

## SIGNIFICANT HYDROLOGIC EVENTS

The following is a detailed itemization of events of strictly a hydrologic nature which occurred during accounting years 1983-1985 inclusive:

2-3 December 1982 - The Chicago District area experienced heavy rainstorms on the 2nd and 3rd of December 1982 which resulted in flooding. Saturated ground from a wet November and a lack of vegetation to intercept the precipitation contributed to the flooding. During the entire storm event, the gage at O'Hare Airport recorded 5.37 inches of precipitation. As a direct result of this storm and subsequent flooding, backflows into Lake Michigan occurred at all control points in the Chicago area on December 2 and 3 as follows:

- The sluice gate at Wilmette was open from 10:08 P.M. on 2 December until 3:23 A.M. on 3 December, resulting in a discharge of 142.9 million gallons.
- The sluice gate at the mouth of the Chicago River (Chicago River Controlling Works) was open from 12:11 A.M. until 3:40 A.M. on 3 December, resulting in a discharge of 247.6 million gallons.
- The sluice gate at O'Brien Lock and Dam was open from 6:08 A.M. until 8:25 A.M. on 3 December, resulting in a discharge of 124.2 million gallons.
- The bypass at the 95th Street Pumping Station was operating from 8:55 P.M. on 2 December until 4:20 A.M. on 3 December, resulting in a discharge of 151.8 million gallons.
- The bypass at the 122nd Street Pumping Station was operating from 9:05 P.M. on 2 December until 3:55 A.M. on 3 December, resulting in a discharge of 12.0 million gallons.

17 August 1983 - The northwestern portion of Cook County experienced an early morning thunderstorm that resulted in a rainfall measurement of approximately 2 inches over a period of 3 hours. Wilmette experienced 2.12 inches of precipitation. To alleviate flooding conditions, the Metropolitan Sanitary District of Greater Chicago issued a backflow order at the Wilmette Pumping Station. The backflow began on 17 August at 7:50 A.M. and ended at 8:52 A.M. resulting in a discharge of 10.6 million gallons.

22 October 1983 - On 22 October, the Chicago District area experienced a heavy rainstorm. This storm, which was concentrated in the northern and central portions of the area, resulted in average rainfall amounts of 2.53 inches and 1.69 inches, respectively for the total period of the storm. In particular, the gages at the Northside Sewage Treatment Works and Wilmette Pumping Station recorded 1.63 inches of precipitation and 1.30 inches of precipitation respectively, both occurring within a three-hour period. To alleviate flooding conditions, the Metropolitan Sanitary District of Greater Chicago issued a backflow order at the Wilmette Pumping Station. The backflow began on 22 October 1983 at 4:15 P.M. and ended at 8:08 P.M., resulting in a discharge of 112.2 million gallons.

31 December 1984 - 1 January 1985 - Major winter snow storm dumped 4 to 8 inches of snow on the Chicago area. High water levels at Lockport resulted for a three day period.

1 - 5 September 1984 - Diversion was increased approximately 3000 cfs each day over the five day period at the request of the Corps North Central Division (NCD). The increase was required due to critically low levels in the LaGrange Pool of the Illinois Waterway. In the request, the Corps indicated its understanding that the diversion was outside the purposes for which IDOT is authorized to divert Lake Michigan water under the U.S. Supreme Court decree.

22 - 27 February 1985 - A spring rain followed by fog and warm weather melted the 14 inch snow pack over a three day period. High water with localized flooding resulted in the Chicago area. The event resulted in peak flows of over 30,000 cfs as measured at Lockport.

4 March 1985 - On 4 March, the Chicago District area experienced a major rainstorm. The storm was concentrated in the southern portion of the area and resulted in rainfall amounts of 1.15", 1.67", and 1.85" at Kankakee, Lockport, and O'Brien Dam respectively. The average precipitation over the entire Chicago area was 2.00". To alleviate flooding conditions, the Metropolitan Sanitary District of Greater Chicago issued a backflow order at the Wilmette Pumping Station. The total backflow consist of two separate events. The first backflow began on 4 March at 4:15 A.M. and ended at 9:28 A.M. Due to a continuing rise in water levels, a second backflow began at 10:20 A.M. and ended at 2:11 P.M. The total discharge into Lake Michigan was 153 million gallons.

24 March 1985 - Spring storm resulted in three days of high water peaking at 23,000 cfs as measured at Lockport.

6 August 1985 - On 6 August, the Chicago District area experienced a heavy rainstorm. The storm was concentrated in the central and northern portions of the area and resulted in rainfall amounts of 2.64", 1.12", and .50" at Skokie, O'Hare Airport, and Barrington respectively. By comparison, only .11" of precipitation was measured at Kankakee in the southern portion of the area. To alleviate flooding conditions, the Metropolitan Sanitary District of Greater Chicago issued a backflow order at the Wilmette Pumping Station. The backflow began at 2:38 A.M. and ended at 5:08 A.M., resulting in a discharge of 58 million gallons into Lake Michigan.

## OTHER SIGNIFICANT EVENTS RELATING TO THE DIVERSION

The following is a detailed itemization of events of a more general nature affecting the diversion accounting system during accounting years 1983-1985 inclusive:

7 October 1982 - Letter sent from Chicago District, COE, to Illinois Department of Transportation (IDOT) in response to IDOT's 13 September 1982 letter requesting comments concerning the draft proposal submitted to IDOT by the Northeastern Illinois Planning Commission (NIPC) regarding development of the new Lake Michigan diversion accounting system. Letter stated that Corps was in basic agreement with the concepts of the proposal, but also stated some areas of concern.

8 October 1982 - Letter sent from Chicago District to IDOT in response to IDOT's 21 September 1982 letter requesting comments concerning the draft report summarizing the findings and recommendations of the AVM study committee. Letter stated that Corps was in basic agreement with the concepts of the report, but also stated some areas of concern.

26 October 1982 - Coordinated draft letter between the Chicago District and IDOT concerning the recommendations of the first three-member technical committee and development of improved plan for diversion measurements and accounting procedures forwarded to Office of the Chief of Engineers (OCE) through Corps' North Central Division (NCD).

1 November 1982 - NCD forwards above 26 October coordinated draft letter to OCE for review.

16 November 1982 - Meeting held between Corps, IDOT and United States Geological Survey (USGS) for discussion of the installation and backup system for the acoustical velocity flowmeter (AVM) to measure total flow at Lockport. Topics discussed included data needs, storage capabilities, and potential backup system.

20 December 1982 - Letter sent from OCE to State of Wisconsin summarizing the development of an improved plan for Lake Michigan diversion measurements and accounting procedures.

3 January 1983 - Letters sent from OCE to remaining parties of the Lake Michigan diversion litigation with identical information as described in 20 December letter above.

19 January 1983 - Letter sent from USGS to IDOT (copy furnished to Chicago District) providing guidelines for estimate of Lockport daily discharges in the event of equipment malfunction of the AVM system.

31 January 1983 - Meeting held between Corps, IDOT, and NIPC for discussions involving development of new Lake Michigan diversion accounting system.

3 February 1983 - First draft report submitted by Corps' Waterways Experiment Station (WES) to Chicago District regarding development of new discharge rating curves for determining flow rates through Lockport Controlling Works.

7 February 1983 - Letter sent from Chicago District to USGS (copy furnished to IDOT) in response to above 19 January letter. Letter suggested consideration of adopting the current accounting system used by the Metropolitan Sanitary District of Greater Chicago (MSDGC) as a backup system in the event of AVM failure.

25 April 1983 - First draft report submitted by WES to Chicago District regarding development of new discharge rating curves for determining flow rates through Lockport Powerhouse sluice gates.

15 June 1983 - Meeting held between Corps, IDOT, and MSDGC for discussion of Corps' annual report on Lake Michigan diversion (accounting years 1981 and 1982).

16 June 1983 - Letter sent from IDOT to Chicago District (copy furnished to MSDGC) relating that average diversion for 1983 accounting year through April 1983 was averaging substantially above normal due to above average precipitation during first six months of the accounting year. Letter expressed concern regarding possibility of average diversion flows for the entire accounting year exceeding limitations set by modified Supreme Court decree.

7 July 1983 - Letters sent from Chicago District to NCD, MSDGC, USGS, and IDOT with draft reports prepared by WES (controlling works and powerhouse sluice gates) as enclosures. Letter requested comments on the reports by 22 July 1983.

19 July 1983 - Letter sent from USGS to Chicago District in response to above 7 July letter. Letter stated that approach and equations used in developing new rating curves were reasonable.

20 July 1983 - Letter sent from NCD to Chicago District in response to above 7 July letter. Letter expressed concern over possibility of submergence with respect to the controlling works and requested an evaluation of impact.

21 July 1983 - Letter enclosing explanatory memorandum sent from Chicago District to IDOT in response to above 16 June letter. Letter stated that close surveillance of running diversion averages would be continued in order to determine any conditions having a potential effect on the provisions of the modified Supreme Court decree.

1 August 1983 - Chicago District provides draft of Corps' annual report on Lake Michigan diversion covering accounting years 1981 and 1982 to NCD, IDOT, and MSDGC for review and comment. Comments were requested to be returned by 31 August 1983.

4 August 1983 - Letter sent from MSDGC to Chicago District in response to above 7 July letter. Letter stated that WES rating curves for powerhouse sluices and controlling works sluices indicated lower flows, in general, than the MSDGC rating curves for these structures. Letter also stated that WES curves for the controlling works did not account for submergence and, as a result, tend to yield higher values than actual flows when six or seven controlling works gates are in the open position.

8 August 1983 - Letter sent from IDOT to Chicago District in response to above 7 July letter. Letter had no comments regarding technical aspects of WES reports but expressed concern over possibility of submergence at the Controlling Works. Additional letter sent from MSDGC to Chicago District providing comments on Corps' draft annual report (as requested in 1 August letter above).

24 August 1983 - NCD provides comments regarding Corps' draft annual report, as requested in 1 August letter above.

25 August 1983 - Meeting held between Corps, IDOT, and NIPC for discussion of new Lake Michigan diversion accounting system.

31 August 1983 - Letter sent from IDOT to Chicago District providing comments on Corps' draft annual report, as requested in 1 August letter above.

30 September 1983 - Letter sent from Chicago District to IDOT providing assessment of material and documentation received from IDOT and NIPC at 25 August meeting. Letter stated that methodology presented in the documentation was technically sound, but requested additional information concerning the computation of Lake Michigan diversion.

20 October 1983 - Letter sent from Chicago District to Corps' WES with comments inclosed from COE, USGS, IDOT and MSDGC concerning first drafts of new rating curves (controlling works sluices and powerhouse sluices) developed by WES. Letter stated that Chicago District would contact WES for discussion of the comments.

18 November 1983 - Chicago District provides final distribution of Corps' initial annual report on Lake Michigan diversion covering accounting years 1981 and 1982. Distribution of the report was made to the Supreme Court through the NCD and OCE. Additionally, the report was provided to all parties of the diversion litigation as well as other involved agencies and individuals.

29 November 1983 - Letter sent from Chicago District to IDOT concerning IDOT's production schedule for calculation of diversion flows for the 1983 accounting year as well as associated annual summary to be completed by IDOT. Letter emphasized the need for establishment of definitive schedules and requested any actions that could be taken on the part of IDOT to expedite the diversion accounting process.

12 December 1983 - Letter sent from Chicago District to MSD with regard to new WES rating curves for Lockport Controlling Works. Letter stated that WES reviewed comments provided by MSD and was in agreement that the submergence effect should be considered in the evaluation of flow computations. Letter stated that Chicago District would be taking action to incorporate a tailwater consideration into the computational procedure. Letter also expressed opinion of WES technical staff that the present location of the tailwater gage was probably in a zone of high turbulence with a recommendation to relocate the gage approximately 150 feet downstream of the gates. Letter also expressed concern of WES staff with regard to possibility of headwater gage being located within zone of drawdown. Finally, letter requested views of MSD with respect to enhancing the measurement system.

13 December 1983 - Letter sent from Chicago District to IDOT acknowledging Corps' review of the final report and recommendations of the AVM study committee. Letter requested specific coordination between involved agencies concerning AVM calibration procedures and establishment of a backup system. Letter also requested proposed schedule for the above items.

16 January 1984 - Letter sent from MSDGC to Chicago District in response to above 12 December letter. Letter stated that Sanitary District was not in a position to take any action or to fund relocation of the gages at the Lockport Controlling Works.

1 February 1984 - Letter sent from IDOT to Chicago District in response to above 29 November and 13 December letters. Letter provided information concerning status of AVM gaging station, planned calibration procedures and proposed backup system. Letter also addressed IDOT's schedule for completion of 1983 accounting report. Additionally, letter requested a re-evaluation of cost on the part of the Corps to assume all diversion accounting responsibilities.

3 March 1984 - IDOT provides initial version of Operations Manual detailing the new diversion accounting system to the Corps for review and comment.

23 March 1984 - Two letters sent from Chicago District to IDOT in response to above 1 February IDOT letter. The first letter addressed the technical concepts associated with the AVM installation. Letter acknowledged field measurements to be performed by USGS. Additionally, letter recommended a thirty day overlap between AVM and current measurement system. Letter also stated Corps' concurrence with concept of using the existing measurement system as backup for the AVM. The second letter addressed the potential for Corps' takeover of the entire diversion accounting program. Letter emphasized the developmental state of the new accounting system and the many associated costs that could not be determined as a result. Letter stated that Corps favored a one year operation of the new system with subsequent data review and evaluation before cost estimates for takeover of the accounting program could be prepared.

26 March 1984 - Second draft report (Lockport Controlling Works) submitted by WES to Chicago District.

9 April 1984 - Letter sent from Chicago District to IDOT providing Corps' comments on initial version of Operations Manual. A major concern was expressed by the Corps concerning the addition of a new deduction termed "induced infiltration."

12 April 1984 - Letters sent from Chicago District to NCD, IDOT, MSD and USGS with above second draft report as an inclosure to each letter. Letters requested comments by 9 May 1984.

26 April 1984 - Meeting between Corps and IDOT for mutual discussion of Corps' comments on Operations Manual and other topics related to development of the new accounting system.

4 May 1984 - Letter sent from IDOT to the Corps outlining expected completion dates for preparation and completion of a draft hydraulic report for the 1983 accounting year using the new diversion accounting system. Letter was requested of IDOT by the Corps at above 26 April meeting.

7 May 1984 - Letter sent from IDOT to the Corps providing additional background information concerning topic of induced infiltration and its use as a potential deduction. Additionally, letter requested a meeting between IDOT and Corps for further discussion of the matter. Letter was requested of IDOT by the Corps at above 26 April meeting.

14 May 1984 - Letter sent from USGS to Chicago District in response to above 12 April 1984 letter. Letter stated that approach and equations were reasonable but that the maximum total error of about  $\pm 10$  percent was too low, especially for high flows. Letter also stated that the lowest estimate for maximum total error for submerged weir flow was at least  $\pm 17$  percent.

21 May 1984 - Letter sent from MSD to Chicago District in response to above 12 April 1984 letter. Letter stated that general methodology used, the submerged crest coefficient graph and the flow computations followed accepted hydraulic practices.

25 May 1984 - Letter sent from NCD to Chicago District in response to above 12 April 1984 letter. Letter stated that computed rating curves should be checked against actual discharge measurements in the field. Letter also expressed concern about c values greater than 3.07 in terms of reasonableness.

1 June 1984 - Meeting held between Corps and IDOT as requested by IDOT in above 7 May letter. Purpose of the meeting was to discuss the topic of induced infiltration in greater detail and, more specifically, to allow IDOT to express its views on the subject to the Corps. Matter was taken under advisement by Corps at conclusion of the meeting.

5 July 1984 - Letter sent from Chicago District to WES with above comments from NCD, USGS and MSDGC as enclosure. Letter stated that WES would be contacted for further discussions.

27 July 1984 - Letter sent from Chicago District to NCD regarding topic of induced infiltration and intention of IDOT to use this component as a deduction. Letter stated that such a departure from the existing practice would require confirmation from other interested parties in order for the Corps to accomplish its monitoring role.

17 August 1984 - Letter sent from NCD to the Department of Justice (DOJ) with above described 7 May 1984 IDOT letter and 27 July 1984 Chicago District letter as enclosures. Letter requested advice from the DOJ concerning IDOT's intention to use the component of induced infiltration as a deduction. Concurrent letter also sent from NCD to Chicago District requesting District to solicit comments from parties of litigation on induced infiltration topic.

29 August 1984 - Letter sent from DOJ to NCD in response to 17 August letter above. Letter stated that IDOT's proposed change in accounting procedure to include induced infiltration as a deduction would necessitate a modification to the Supreme Court decree.

10 September 1984 - Letter sent from Chicago District to parties of litigation with above described 7 May 1984 IDOT letter as enclosure. Letter requested comments from parties of litigation on the issue of induced infiltration. Letter stated that Corps would consolidate any comments received and forward them to DOJ for further review and consideration.

10 October 1984 - Letter sent from State of Michigan to Chicago District in response to District's 10 September 1984 letter requesting comments on induced infiltration issue. Letter requested additional documentation for evaluation purposes.

11 October 1984 - Letter sent from MSDGC to Chicago District in response to District's 10 September 1984 letter requesting comments on induced infiltration issue. Letter supported position of IDOT with regard to use of induced infiltration as a deduction.

31 October 1984 - Letter sent from WES to Chicago District in response to above 5 July letter. Letter addressed comments from NCD, USGS and MSDGC.

1 November 1984 - Letter sent from State of Wisconsin to Chicago District in response to District's 10 September 1984 letter requesting comments on induced infiltration issue. Letter stated opposition to position of IDOT with regard to use of induced infiltration as a deduction.

2 November 1984 - Letter sent from Chicago District to State of Michigan providing additional documentation as requested in 10 October 1984 letter above.

9 November 1984 - Letter sent from State of Ohio to Chicago District in response to District's 10 September 1984 letter requesting comments on induced infiltration issue. Letter stated opposition to position of IDOT with regard to use of induced infiltration as a deduction.

3 December 1984 - Memorandum for Record (MFR) dated 28 November 1984 sent from WES to NCD. MFR stated that additional uncertainties were evident regarding rating curve accuracy for Lockport Controlling Works. Specifically, MFR stated that three items needed to be resolved by some type of field calibration:

(a) upstream total head-upstream gage reading is not a true measure of total head in the approach flow; (b) submergence-the downstream gage reading is not a true measure of submergence; (c) extremely shallow weir - the 1 ft. weir height is not large relative to the possible effects of aging and sediment and debris accumulation or erosion. MFR additionally stated that only when these uncertainties are resolved is a confidence level comparable to that of the laboratory - based rating (+8-10%) achieved.

4 December 1984 - Letter sent from State of Wisconsin to Chicago District in response to District's 10 September 1984 letter requesting comments on induced infiltration issue. Letter stated opposition to position of IDOT with regard to use of induced infiltration as a deduction.

21 January 1985 - Letter sent from State of Wisconsin to Chicago District as a follow-up to 1 November 1984 letter above. Letter emphasized Wisconsin's continuing review of induced infiltration issue and requested additional documentation for evaluation. Additionally, letters sent from Chicago District to MSDGC and USGS (copies to IDOT) forwarding replies by WES to comments made by above agencies with regard to effects of submergence on Lockport Controlling Works rating curves (as provided in 31 October letter above).

25 January 1985 - Coordination meeting held between IDOT, NIPC, and Chicago District for discussion of topics relating to development of new diversion accounting system.

30 January 1985 - Letter sent from Chicago District to State of Wisconsin providing additional documentation as requested in 21 January 1985 letter above.

1 February 1985 - Letter sent from State of New York to Chicago District in response to District's 10 September 1984 letter requesting comments on induced infiltration issue. Letter stated opposition to position of IDOT with regard to use of induced infiltration as a deduction.

11 February 1985 - Letter sent from State of Pennsylvania to Chicago District in response to District's 10 September 1984 letter requesting comments on induced infiltration issue. Letter stated opposition to position of IDOT with regard to use of induced infiltration as a deduction.

19 February 1985 - Coordination meeting held between IDOT, NIPC, NCD, and Chicago District. Principal topics of the meeting included induced infiltration, IDOT's 1983 annual diversion summary, recommendations of the three-member technical committee, NIPC's new diversion accounting system, and AVM status.

5 March 1985 - Chicago District convenes in-house ad-hoc committee to study topic of induced infiltration in detail.

20 March 1985 - AVM malfunctioned; cause unknown.

19 April 1985 - Based on above ad-hoc committee review, preliminary investigation report prepared by Chicago District and forwarded to NCD.

22 April 1985 - AVM repaired and online. Breakdown the result of a broken cable.

31 May 1985 - Letter sent from Chicago District to IDOT requesting additional information regarding use of AVM system. Letter requested specific information concerning type of backup measurement system planned. Letter also requested information regarding time frame during which MSDGC would continue providing flow measurement computations at Lockport.

14 June 1985 - Letter sent from IDOT to Chicago District forwarding copy of Lake Michigan Diversion Accounting Report for 1983 water year along with copy of Operations Procedure Manual describing methodology used to compute diversion. Letter also stated State's intention to begin using the AVM as a primary measurement station at Lockport beginning with October 1984 and addressed plans for backup system.

1 July 1985 - Letter sent from Chicago District to NCD forwarding final version of status report regarding recommendations made by the first three-member technical committee.

10 July 1985 - Letter sent from DOJ to NCD regarding IDOT's intention to take a deduction for induced infiltration. Letter stated that any change in the approved method of calculating the diversion would require a modification of the Supreme Court decree.

25 July 1985 - Letter sent from NCD to IDOT regarding induced infiltration issue. Letter emphasized Corps' technical review and advice rendered by DOJ in above 10 July letter. Letter additionally stated that Corps would not accept a deduction for induced infiltration and requested IDOT's 1983 diversion accounting report to be revised.

30 July 1985 - Letter sent from IDOT to Chicago District forwarding letter reports from USGS regarding AVM calibration checks and backup system.

5 August 1985 - Letter sent from IDOT to DOJ regarding induced infiltration issue. Letter conveyed IDOT's opinion and comments regarding acceptability of the sewer induced groundwater pumpage component as a deduction under terms of Supreme Court decree. Letter encouraged continuation of discussions on the issue (Copy of this letter furnished to NCD).

7 August 1985 - Letter sent from Chicago District to IDOT regarding Corps' review of IDOT's 1983 diversion accounting report. Letter emphasized mathematical errors determined during review process, particularly as found in Lockport sluice discharge calculations. Letter also emphasized discrepancies regarding precipitation values used in NIPC simulation. Letter requested IDOT to furnish Corps with detailed computations and an analysis of the impact which the precipitation discrepancies would have on the final report.

15 August 1985 - Letter sent from Chicago District to NIPC regarding IDOT's 1983 diversion accounting report (above 7 August letter enclosed). Letter requested errors in report to be corrected. Letter also requested copies of computations and worksheets to be forwarded to Chicago District.

19 August 1985 - Letter sent from IDOT to MSDGC (copy furnished to Chicago District) requesting a meeting to be convened (between IDOT and MSD) for discussion of precipitation discrepancies as described in 7 August letter above.

23 August 1985 - Letter sent from DOJ to IDOT (copy furnished to NCD) in response to 5 August letter above. Letter expressed DOJ's continued adherence to views expressed in 10 July letter above (with regard to induced infiltration issue).

26 August 1985 - Letter sent from Chicago District to IDOT (copy furnished to USGS) regarding trend reversal in AVM flow record versus MSD Lockport record for normal flow conditions. Letter expressed the fact that, prior to March 1985, the AVM record tended to be 300-500 cfs higher than MSD Lockport record for normal flows. Letter continued on to discuss trend reversal since April 1985. Letter requested expediting of AVM field check and reactivation of MSD system for streamflow measurements at Lockport until above situation was resolved.

27 August 1985 - Letter sent from NCD to IDOT regarding drawdown of Lockport pool (at Corps' request) for purposes of lock maintenance. Lowering of pool was effective for period of 27-28 August and resulted in increase in diversion (10-15 cfs) on annual basis. Corps recommended drawdown not be charged to diversion.

9.5 computed

29 August 1985 - USGS conducted field check showing AVM recording 80% of field calculated flow.

4 September 1985 - Letter sent from NIPC to Chicago District (copy furnished to IDOT) in response to 7 August and 15 August letters above. Letter stated that computations for adjustments to flow at Lockport Powerhouse and Controlling Works were rechecked and enclosed copy of results. Additionally, as requested, letter enclosed copies of computation sheets used in the development of discharge estimates at Lockport. Letter finally stated that hydraulic report for accounting yr. 83 would be modified in accordance with above findings after confirmation of accuracy from Corps.

25 September 1985 - WES provides final report on newly developed rating curves for Lockport Powerhouse sluice gates and Lockport Controlling Works sluice gates to Chicago District.



ANNUAL REPORT

MONITORING OF DIVERSION  
OF LAKE MICHIGAN WATER  
AT CHICAGO, ILLINOIS

APPENDIX C

Correspondence



# Illinois Department of Transportation

Division of Water Resources  
300 North State Street/Room 1010  
Chicago, Illinois 60610  
Telephone 312/793-3123

May 7, 1984

LTC Christos A. Dovas  
District Engineer  
Chicago District  
U.S. Corps of Engineers  
219 South Dearborn-Room 604  
Chicago, IL 60604

RE: Diversion Accounting - Induced Infiltration

Dear Colonel Dovas:

We need additional discussions regarding our position that induced infiltration in the Lake Michigan basin is a legitimate deduction under the current United States Supreme Court Decree.

Induced infiltration, as we have defined it, is a component of groundwater which would not have entered Lake Michigan or any other body of surface water in the area if urbanization had not occurred and sewers had not been constructed. It is a component of groundwater pumpage which is not recharged by Lake Michigan and, hence, is an eligible deduction. Induced infiltration, as we have defined it, does not include components of sewer flow which are not eligible deductions, i.e., infiltration attributable to water main leakage, inflow (runoff related, which is accounted for separately), and that quantity of infiltration to the sewer network which would have become base flow to a surface water system. It is essentially that amount of groundwater which, under pre-development conditions, would have been either evapotranspired or recharged to groundwater aquifers.

The derivation of an estimate of induced infiltration for both the combined sewer area and separately sewered areas within the Lake Michigan basin is difficult, since this flow component cannot be directly measured. However, we believe that the simulation modelling of the Northeastern Illinois Planning Commission and their analysis to determine the additional 'induced' yield of the combined sewer areas is a technically sound procedure, and gives a realistic estimate of the magnitude of induced infiltration. Enclosed with this letter

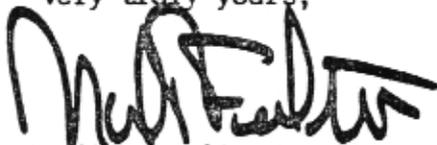
LTC Christos A. Dovas  
May 7, 1984  
Page 2

is a copy of the report NIPC prepared for Harza Engineering as part of our diversion accounting study. Also, the procedure we plan to use to develop the amount of induced infiltration in the combined sewer area and separately sewered area is described on pages 32-34 of the draft Hydraulic Report Manual (pages attached).

I would appreciate the opportunity to further discuss this issue with the District and Division. It is my understanding that your determination that induced infiltration within the Lake Michigan basin is not an eligible deduction stems from a legal interpretation of the wording in the Supreme Court Decree. I would therefore request that both technical and legal staff attend the meeting.

Please feel free to call me to set up an acceptable date for this meeting.

Very truly yours,



Neil R. Fulton  
Chief

BUREAU OF RESOURCE MANAGEMENT

NRF:DI:pz

Enclosure

cc: Sandy Solomon, Central Division



LFC:JRA:AFW  
90-1-2-595

U.S. Department of Justice  
Office of the Solicitor General

2, DE-  
DP-  
1, ED-

Washington, D.C. 20530

July 10, 1985

Shy

Brigadier General Jerome B. Hilmes  
Commanding  
North Central Division  
U.S. Army Corps of Engineers  
536 South Clara Street  
Chicago, Illinois 60606-1592

Dear General Hilmes:

Re: Wisconsin v. Illinois, Nos. 1, 2, 3,  
Orig.

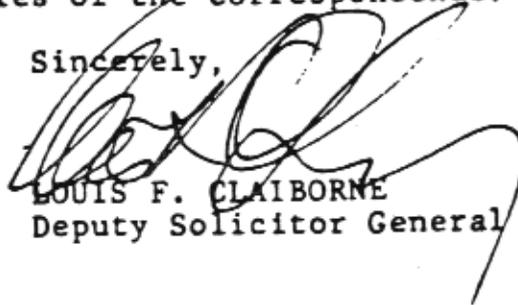
We are in receipt of your recent letter advising us of Illinois' intent to "take a deduction for induced infiltration for the 1983 water year" and requesting our advice on the matter. You also transmitted the comments of the states of Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin--each of which was opposed to the proposed method of calculating the diversion--and the Metropolitan Sanitary District of Greater Chicago and the Illinois Water Survey Division, both in support of the proposal.

We adhere to our previous advice to you of August 29, 1984 that any change in the approved method of calculating the diversion would require a modification of the decree. In our view, that would be true even if all parties to the litigation agreed to the proposed change. All the more so, of course, if there is not general agreement. As it happens, none of the states involved agrees. Accordingly, we believe that the prudent course for the Corps to follow, once it confirms that the State has put into operation this method of calculating the diversion, is to advise Illinois that its action in changing the approved accounting procedure requires modification of the decree. Inquiry should be made as to Illinois' intentions with regard to seeking such a modification.

We are not taking a position on the merits of the proposal by the State of Illinois, but simply advising that procedurally the proper course for the State to follow is to secure modification of the decree.

As before, we ask that you keep us advised of the communications between the parties, with copies to be sent to Andrew F. Walch of the Lands Division. It will be appreciated if you will also send me copies of the correspondence.

Sincerely,



LOUIS F. CLAIBORNE  
Deputy Solicitor General



# United States Department of the Interior

## GEOLOGICAL SURVEY

Champaign County Bank Plaza  
102 East Main Street  
Fourth Floor  
Urbana, IL 61801  
July 16, 1985

Mr. Daniel Injerd  
Lake Michigan Management Section  
Illinois Department of Transportation  
Division of Water Resources  
310 S. Michigan Avenue  
Room 1606  
Chicago, IL 60604

Dear Mr. <sup>Don</sup>Injerd:

RECEIVED  
JUL 19 1985

DIVISION OF WATER RESOURCES  
BUREAU OF RESOURCE MANAGEMENT

The calibration test of the acoustic velocity meter (AVM) on the Chicago Sanitary and Ship Canal at Romeoville is a continual process. Occasional discharge measurements are to be made to verify that the flowmeter is functioning as designed and no changes have occurred in the canal cross-section.

Discharge measurements 1-4 and 6-7 were within a range of -0.6 to 4.0 percent of the discharge values obtained from the AVM. This is within our ability to measure flow using a standard Price AA current meter. Measurement 5 (+8.8%) exceeded this range and a discussion of this measurement is in a following section.

A summary listing of discharge measurements, form 9-207, is attached. Measurement #1 used the two-point method of measuring stream velocities, observations are made in each vertical at 0.2 and 0.8 of the depth of water below the surface. The two-point method is the one generally used by the U.S. Geological Survey to measure stream discharge. This measurement was made to verify the discharge output of the flowmeter during installation.

Measurements 2-7 used the vertical-velocity curve method, a series of vertical observations at points well distributed between the water surface and the stream bed. The velocity observations are taken at 0.1 depth increments between 0.1 and 0.9 of the depth. A vertical-velocity curve for each vertical is based on the observed velocities plotted against depth. The mean velocity in the vertical is obtained by measuring the area between the curve and the ordinate axis with a planimeter. This method gives more consistent results and is considered more accurate than the two-point method.

The discharge value, listed in the remarks column on form 9-207, was computed by adding the 15 minute discharge readings from the AVM printout and dividing by the number of 15 minute periods during the time of the discharge measurement.

The accuracy of the measured discharge compared to the flowmeter value is listed in the percent difference column. The percent difference is computed by subtracting the AVM discharge from the measured discharge and dividing by the measured discharge. The percent difference of measurement 1-4 and 6-7 range from -0.6 to 4.0 percent and are within the rating accuracy when using a Price AA current meter. Measurement 5 was made during periods of plus and minus stage fluctuations and a barge passing through the measurement section in a downstream direction.

The AVM operates on a one minute cycle obtaining velocity and stage readings every 2 to 3 seconds which are stored and the 15 minute summary values are printed on the deckwriter. Only one point value of velocity is obtained for one depth elevation in one vertical during a discharge measurement compared to 7 to 14 stage and velocity readings of the whole cross-section obtained by the flowmeter. The AVM discharge is more representative of the canal flow than the discharge measurement during stage fluctuations, closing of the Control Works downstream, and barge traffic through the discharge measurement section.

The cross-sectional area stored within the flowmeter used in the discharge calculation was checked. A stage-area graph (attached) for the AVM was drawn and the area from the discharge measurements was plotted on this relationship. The maximum difference in area found for one measurement (3) was 2.2%.

Our Hydrologic Instrumentation Facility has recently run tests on the water-level sensing device used in the type flowmeter installed at Romeoville. Stage readings were found to be less than 0.10 ft in error.

Based on the analysis of the discharge, cross-sectional area, and water surface elevations obtain from the AVM, we recommend October 1, 1984 as the starting date for publication of the daily discharge values obtained with the AVM.

Sincerely,

  
Larry G. Woler  
District Chief

AWN:LGT:bw  
Enclosures



# United States Department of the Interior

GEOLOGICAL SURVEY

Champaign County Bank Plaza  
102 East Main Street  
Fourth Floor  
Urbana, IL 61801  
July 18, 1985

Mr. Daniel Injerd  
Lake Michigan Management Section  
Illinois Department of Transportation  
Division of Water Resources  
310 S. Michigan Avenue, Room 1606  
Chicago, IL 60604

Dear Dan,

A procedure to estimate daily discharge values for missing-record periods at Chicago Sanitary and Ship Canal at Romeoville gaging station was established. The procedure uses stage data from the Rock Island Army Corps of Engineers Illinois River Hydraulic Daily Report for Des Plaines River at Brandon Road Lock and Dam, stage data obtained for Des Plaines River at Riverside gaging station, and a regression analysis.

The Hydraulic Daily Report lists 5 readings per day of pool elevation, tainter, and headgate openings. The stage-discharge relation for Brandon Road site (Mades, 1981) is used to convert the stage readings with gate openings into discharge for a time period. These values are added for the day and converted into a daily discharge value. The discharge rating does not include leakage through the headgates which is approximately 850 cfs.

The daily discharge for Des Plaines River at Riverside gaging station is obtained by use of the stage record with the station's discharge rating table and the results of the current discharge measurement.

The discharge value from the Riverside gage is subtracted from the Brandon Road value, the resulting discharge approximates the flow in the Chicago Sanitary and Ship Canal at Romeoville.

A log regression analysis was made using a SAS Institute computer program with 42 concurrent discharges at Romeoville with the discharge at Riverside subtracted from the Brandon Road value (fig. 1). The SAS program lets the user split the sample into two regressions as described

**RECEIVED**  
JUL 22 1985

**DIVISION OF WATER RESOURCES  
BUREAU OF RESOURCE MANAGEMENT**

in a report "Use of Qualitative Variables in Regression Analysis" by Wilbert O. Thomas, USGS, Water Resources Division Bulletin, May-August, 1982. The following regression equations were obtained to estimate discharge for the period March 21 to April 17 (Table 1).

If flow at Brandon Road is less than 3980 cubic feet per second (cfs)

$$v_2 = \text{Antilog} (0.565 \log v_1 + 1.56)$$

If flow at Brandon Road is more than 3980 cfs

$$v_2 = \text{Antilog} (1.121 \log v_1 - 0.41)$$

$$R_2 = 0.971 \text{ with a standard error of estimate of } 9.2\%$$

where,

$v_1$  = Daily discharge at Brandon Road minus Riverside value

$v_2$  = Estimated Daily discharge at Chicago Sanitary and Ship Canal at Romeoville

To test the above equations the May 7 to June 6 period was estimated and compared to the daily discharge obtained from the flowmeter. The results show a maximum daily error of 34 to -38 percent with an average error for the period of -1.2 percent. The individual error may be large for only one day comparison but for extended periods an average error of 1.2 percent is acceptable. Table 2 lists the discharge figures used and estimated for this study.

In the future for periods of no record this procedure will be used after testing a few discharge values before and after the missing record period to see if the regression analysis is valid or a new analysis will be developed using the above procedures.

#### Reference

Mades, D.M., 1981, Stage-discharge relation at dams on the Illinois and DesPlaines Rivers in Illinois: U.S. Geological Survey open-file report, 81-1009, 56 p.

Sincerely,

*Allen W. Noehre*

Allen W. Noehre  
Surface Water Specialist

AWN:bw  
Enclosure



Illinois Department of Transportation  
Division of Water Resources

310 South Michigan Avenue / Room 1606  
Chicago, Illinois 60604

August 5, 1985

Mr. Andrew S. Walch  
Lands Division  
Office of the Solicitor General  
U.S. Department of Justice  
Main Justice Building  
10th & Constitution Avenue, N.W.  
Washington, D.C. 20530

Dear Mr. Walch:

I recently received a copy of a July 10, 1985 letter from the Department of Justice to Brigadier General Hilmes directing the Corps of Engineers to inform the State of Illinois that one element of our new diversion accounting procedures (induced infiltration, or more properly, sewer induced groundwater pumpage) cannot be included without modifying the United States Supreme Court Decree.

I am disappointed that the State of Illinois was not involved in the discussions and negotiations between the Corps of Engineers and the Department of Justice in this matter. I deeply regret that we were unable to offer our comments and opinions regarding the acceptability of the sewer induced groundwater pumpage component prior to the Department of Justice taking a position. Nevertheless, I would still like to convey our reasons why we believe this hydrologic component needs to be included in our accounting system and is appropriate for us to do so in compliance with the decree.

Subsequent to the approval of the amended decree in 1980 and the followup work of the Corps of Engineers' Three Member Committee and our own consultants, Illinois has invested a tremendous amount of time and money aimed at improving the accuracy with which we measure and compute our diversion of water from Lake Michigan. Building on many of the recommendations of the Three Member Committee and of our consultant, we have developed an improved diversion accounting system. This accounting system incorporates state of the art technology in flow measurement and in computer simulation of complex urban watershed areas. For example, in cooperation with the U.S. Geological Survey, we have installed an acoustic velocity flowmeter system to measure total flows passing the Sanitary and Ship Canal near Lockport. We have also contracted with the Northeastern

Illinois Planning Commission to take advantage of their computer capabilities to develop a system of checks and balances to ensure that the many hydraulic components which are necessary to compute our diversion are accurate and representative of the hydraulic characteristics of this heavily urbanized area.

In consultation with the Corps of Engineers, the State of Illinois decided to use this improved diversion accounting system beginning with the 1983 accounting year. Recently we sent the Corps a revised manual of procedures for measuring and accounting Illinois' diversion along with a annual hydraulic report for the 1983 water year.

I would like to emphasize that the development of these improved diversion accounting procedures are entirely consistent with the general accounting guidelines specified in paragraph 2 of the decree. Furthermore, our efforts to improve diversion accounting reflect a desire to implement the guidance contained in paragraph 3 that states:

"all measurements and computations required by this decree shall be made by the appropriate officers, agencies or instrumentalities of the State of Illinois . . . using the best current engineering practice and scientific knowledge."

I believe that the improvements incorporated into the 1983 diversion accounting report follow this guidance.

After 1-1/2 years of reviewing the subject of sewer induced groundwater pumpage, the Corps of Engineers has concluded that our method of calculating the quantity of this component is technically sound, and more importantly, that this hydrologic component is not Lake Michigan water. Since they have concluded that sewer induced groundwater pumpage is not Lake Michigan water but rather is groundwater, I don't see how the decree can be interpreted so that this component should be overlooked, or ignored by the state in its diversion accounting procedures.

I believe this would set a new precedent that clearly is contrary to the intent of the decree by not allowing Illinois to claim as a deduction a specific component of groundwater flow. In fact, it is our opinion that by not properly accounting for sewer induced groundwater pumpage (a deduction to the total flow at Lockport) we are being directed by the Corps and the Department of Justice to violate the decree.

It has been our belief that the decree specifies a general accounting framework designed simply to require Illinois to report

Mr. Andrew S. Waich  
Page 3  
August 5, 1985

as diversion all Lake Michigan water withdrawn from the lake and not returned and the stormwater runoff which has been prevented from reaching the lake. Over the years, numerous changes and improvements have been made to the accounting procedure to reflect changing hydraulic conditions and improvements in the ability to measure and account for both diversion and non-diversion flows. In the past, these changes have been recommended by the State of Illinois and approved by the Corps of Engineers without any formal approval process being forwarded to either the Department of Justice or to the other parties to the decree. Rather we, and I assume the other parties, have assumed this to be a proper exercise of the Corps supervisory role.

By abdicating this supervisory role over this particular flow component, they cast serious questions about the propriety of all the previous changes that have been made to the accounting procedure. Of more concern to Illinois, however, is the obvious inconsistency of singling out one minor component of our new diversion accounting procedures and concluding that legally this revision requires specific court approval while at the same time an entirely upgraded diversion accounting system has been incorporated which has not gone through the same level of review to the other parties or to the Department of Justice that the sewer induced groundwater pumpage component has.

I believe that the decree shows a clear indication by the Court that they do not wish to be involved in the technical matters pertaining to specific components of Illinois diversion. Rather they have assigned that role to the Corps of Engineers, and we believe it most appropriate for them to make these decisions based on the technical merits of whether it is or is not a component of Illinois' diversion.

I urge the Department of Justice to review their position on this matter. At a minimum I would request a more detailed legal explanation as to why the Department of Justice feels that sewer induced groundwater pumpage is not an eligible deduction under the decree.

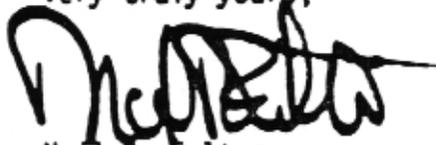
The magnitude of the sewer induced groundwater pumpage deduction is small compared to the overall diversion. However, we are extremely reluctant to manage a diversion accounting program that does not represent our best efforts at diversion accounting and which is not reflective of the best scientific knowledge and engineering practice available to us.

Mr. Andrew S. Walch  
Page 4  
August 5, 1985

I believe it would be in our best collective interests to continue our discussions on this issue. I would welcome the opportunity to meet with you on this issue. Please feel free to call me at (312) 793-3123 if you need additional information or to set up a meeting.

I urge the Department of Justice to review their position on this matter.

Very truly yours,



Neil R. Fulton  
Chief

BUREAU OF RESOURCE MANAGEMENT

NRF:DI:dn

cc: Zane Goodwin, NCD ✓

08411

August 23, 1985

Mr. Neil K. Fulton, Chief  
Bureau of Resources Management  
Illinois Department of Transportation  
Chicago, Illinois 60604

Dear Mr. Fulton:

Re: Nos. 1, 2, 3, Orig., Wisconsin v. Illinois.

We have given careful consideration to your letter of August 5, 1985 to Andrew F. Walch and continue to adhere to the views expressed in our letter of July 10, 1985 to the Corps of Engineers.

One of the bases for the modification of the 1967 decree adopted by the parties in 1980 was a 30% imperviousness factor to approximate the conditions of the entire Lake Michigan diversion watershed at that time due to urbanization, with provision for exceeding the allowable diversion of 3200 cfs by 15% due to uncertainties created by the short period of record and "the likelihood of increased runoff resulting from urbanization". Wisconsin v. Illinois, 449 U.S. 48, 53 (Statement of Intent and Technical Basis for Proposed Amendments to 1967 Decree). The "induced infiltration" deduction is just one of several components of urbanization which impacts on the runoff hydrology of the basin, an extremely complex phenomena that is incapable of precise measurement. By singling out one factor as a deduction without relating "induced infiltration" to other factors effecting the runoff hydrology or to the 30% imperviousness factor previously agreed to as a basis for the 1980 modification to the decree is, in our view, an impermissible increase in the amount of diversion from Lake Michigan. Absent a further modification of the decree, Illinois should not deduct the amount of calculated induced infiltration from Lockport flows. We also note that each of the States in these proceedings has objected to a unilateral deduction by the State of Illinois.

We appreciate the efforts taken by the State of Illinois, working in close cooperation with the Corps of Engineers, to better quantify and account for the water diverted from Lake Michigan. "Induced infiltration" is precisely the type of factor impacting the diversion with which the Supreme Court has concerned itself in the past. We trust that our views will assist you in determining whether to seek modification of the decree to allow for this deduction.

Sincerely,

Louis F. Claiborne  
Deputy Solicitor General

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