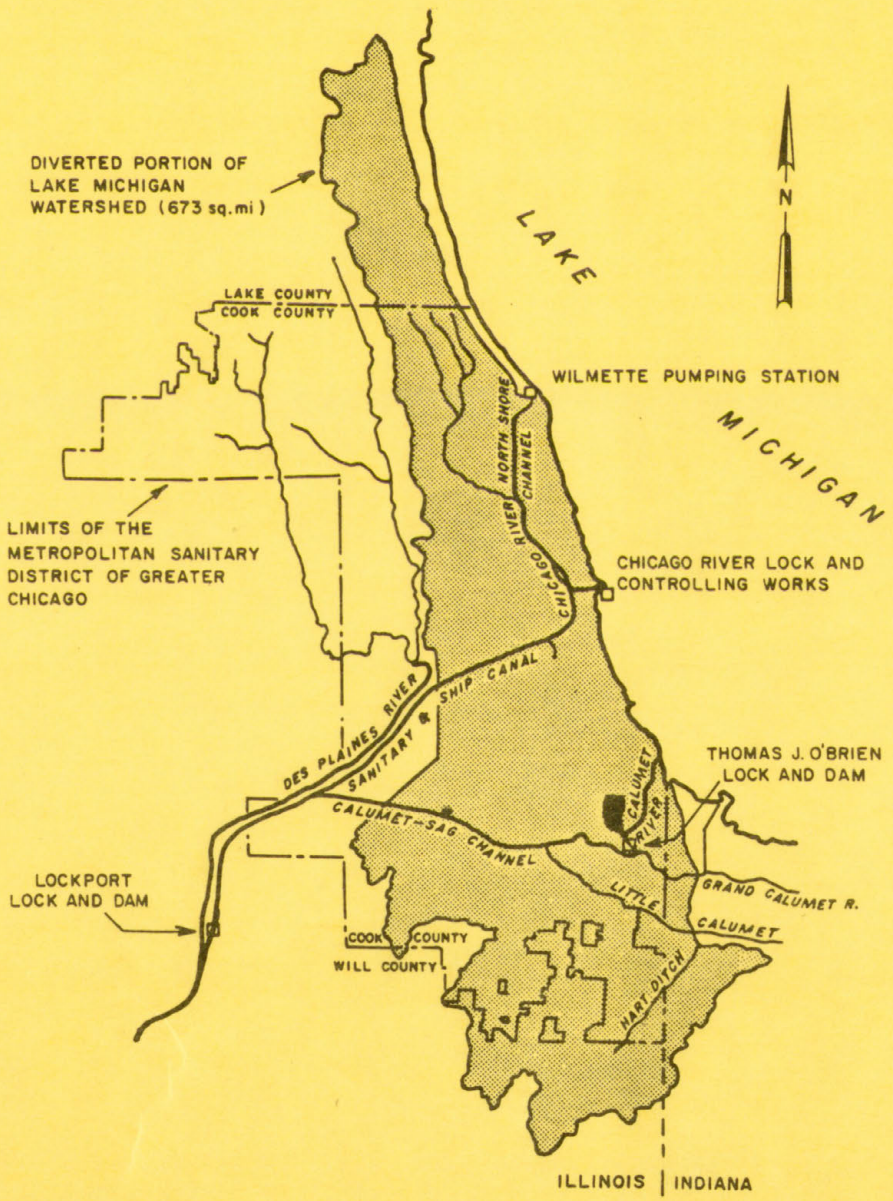
US Army Corps
of Engineers
Chicago District

Lake Michigan Diversion Accounting-1988 Annual Report



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ANNUAL REPORT

MONITORING OF DIVERSION OF LAKE MICHIGAN WATER AT CHICAGO, ILLINOIS

INTRODUCTION

1.1 EXECUTIVE SUMMARY

This document is an annual report of the Chicago District, U. S. Army Corps of Engineers activities in the monitoring and review of the accounting of Lake Michigan diversion flows through Chicago, Illinois as directed by 1980 amendment to the U.S. Supreme Court decree. Additionally, this report serves to summarize the Corps' major accomplishments with respect to a new mission as mandated by the Water Resources Development Act of 1986, PL 99-662, Section 1142. This act gave the Corps complete responsibility for diversion accounting effective 1 October 1987. This report provides an overview and audit of flow measurements and accounting conducted by the Corps of Engineers through 30 September 1988. Accounting year 1988 represented a transition period for diversion accounting, during which time responsibility for the task has been gradually shifted to the Corps of Engineers offices located in the State of Illinois. Transition period activities are discussed in this report. It is anticipated that coordination and transitional activities will continue throughout the 1989 accounting year.

The 1988 Annual Report on Lake Michigan Diversion includes a summarization of all events occurring during the 1988 water year (1 October 1987 - 30 September 1988). Since completion of the 1987 accounting year, the second Three-Member Technical Committee completed its report. As a result of the committee's findings, the Corps is reviewing and modifying hydrologic modeling parameters used in the diversion accounting. The parameters are a critical element to the accounting and must be reviewed prior to certification of any additional accounting reports. As these modeling revisions are scheduled to be completed in FY 89, the 1988 Annual Report does not include an analysis of the 1984 accounting report which was completed during the year.

Major events covered in this report include accounting procedures and methodologies, revision of modeling parameters, measurement procedures, acoustic velocity meter (AVM) performance, and development of an AVM backup system.

Additionally, the report discusses implementation of recommendations made by the second Three-Member Technical Committee.

The following conclusions were reached during the year:

a. Continuing problems with the existing AVM resulted in the need for installation of a new AVM system to measure flow at Lockport.

b. Diversion accounting certification was suspended in FY88 pending the revision of the hydrologic modeling parameters, currently scheduled for completion in FY89.

1.2 BACKGROUND

The City of Chicago, as well as some of its suburbs, have drawn on Lake Michigan as the source of their municipal water supply for almost their entire history. When the flow of the Chicago River was reversed and the Chicago Sanitary and Ship Canal was completed (in 1900), this flow of water was diverted from the Lake Michigan (St. Lawrence and Atlantic Ocean) watershed to the Illinois River (Mississippi and Gulf of Mexico) watershed. This diversion procedure is still in effect today and is closely controlled by the State of Illinois. As directed by the modified Supreme Court decree, the U. S. Army Corps of Engineers is responsible for supervising the activities of the State of Illinois. Additionally, as discussed in the previous section, the Corps was given total responsibility for diversion accounting effective 1 October 1987. Thus, a dual role for the Corps has been created with respect to management of the accounting program. This report is the fifth in a continuing series of Annual Reports prepared by the Corps beginning with the FY83 report. The reports are distributed to the Great Lakes states and the Department of Justice as well as other involved concerns. This report covers the Accounting Year from 1 October 1987 through 30 September 1988 inclusive.

1.3 AUTHORITY FOR REPORT

Under the provisions of the U.S. Supreme Court decree in Wisconsin, et al v. Illinois et al, 388 U. S. 426,87 S. Ct. 1774 (1967) as modified by 449 U.S. 48, 101 S. Ct. 557 (1980), the Corps is responsible for monitoring the measurement and computation of Lake Michigan water by the State of Illinois. Under the terms of the modified decree, the Corps is required to prepare an annual report covering the diversion accounting activities as well as actions taken by the involved agencies.

1.4 HISTORY

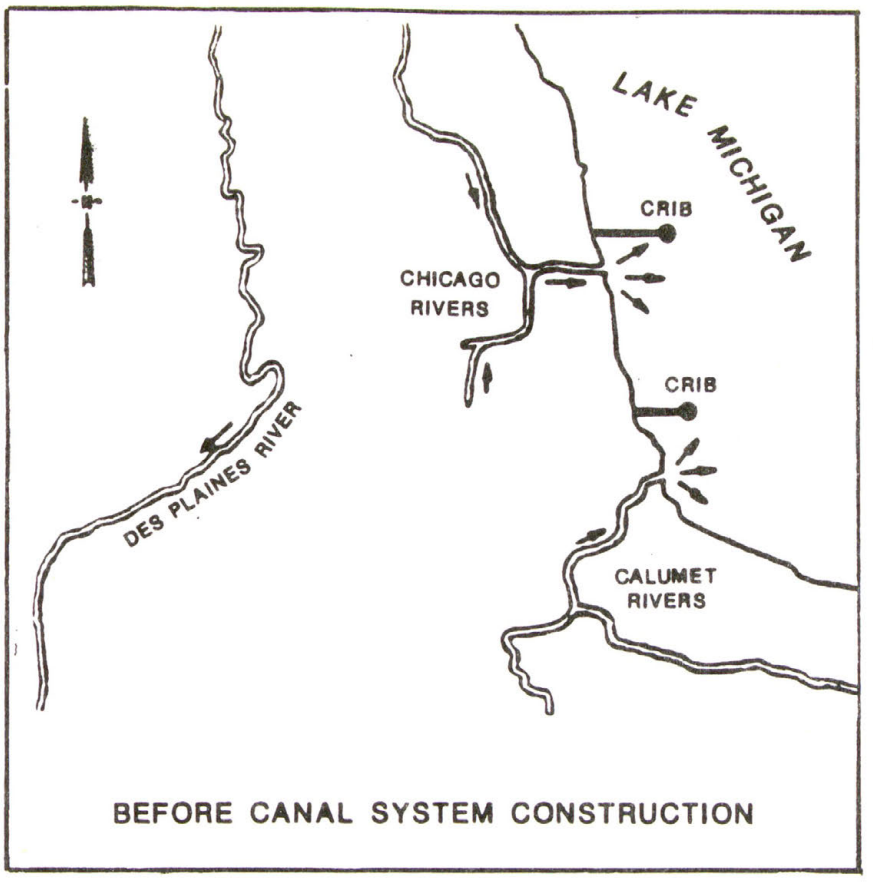
Water has been diverted from Lake Michigan at Chicago into the Mississippi River Basin since the completion of the Illinois and Michigan Canal in 1848. The diversion, at that time, averaged approximately 500 cubic feet per second (cfs). Upon completion of the Chicago Sanitary and Ship Canal in 1900, the flow direction of the Chicago River was reversed (away from Lake Michigan) and a permit was issued by the Secretary of War for the diversion of 4,167 cfs. In 1908 and again in 1913, the United States brought actions to enjoin the Metropolitan Sanitary District of Greater Chicago (MSDGC) from diverting more than the 4,167 cfs previously authorized in 1901. The two actions were consolidated and the Supreme Court entered a decree on 5 January 1925 allowing the Secretary of War to issue diversion permits. In March 1925, a permit was issued to divert 8,500 cfs which was about the average then being used. Figure 1-1 is a schematic of the flow reversal and Figure 1-2 shows the affected watershed.

In 1922, 1925, and 1926, several Great Lakes States filed similar original actions in the U.S. Supreme Court seeking to restrict the diversion at Chicago. A Special Master, appointed by the Court to hear the combined three suits, found the 1925 permit to be valid and recommended dismissal of the action. The Supreme Court, however, reversed the Special Master's finding. Subsequently, the Court instructed the Special Master to determine the steps necessary for Illinois and MSDGC to reduce the diversion. Consequently, a 1930 decree reduced the allowable diversion (in addition to domestic pumpage) in three steps: to 6,500 cfs after 1 July 1930; to 5,000 cfs after 30 December 1935; and to 1,500 cfs after 31 December 1938.

In 1967, an additional Supreme Court decree limited the diversion of Lake Michigan water by the State of Illinois and its municipalities, including domestic pumpage, to an average of 3,200 cfs over a five-year period effective 1 March 1970. The 1967 Supreme Court decree gave full responsibility to the State of Illinois for diversion measurements and computations. The role of the Corps of Engineers, as specified in the decree, was to be one of "general supervision and direction."

The 1967 decree was modified on 1 December 1980. This modified decree extended the period for determining the running average diversion rate from five years to forty years. Additionally, the beginning of the accounting year was changed from 1 March to 1 October.

The amended decree contains three provisions that affected the role of the Corps with regard to the diversion accounting program. First, although the State of Illinois was to be primarily responsible for measurement and computation of diversion flows, the decree allowed the Corps to take over this function subject to a cost sharing agreement. Although


LAKE MICHIGAN
CRIB
CHICAGO RIVERS
CRIB
DES PLAINES RIVER
CALUMET RIVERS
BEFORE CANAL SYSTEM CONSTRUCTION

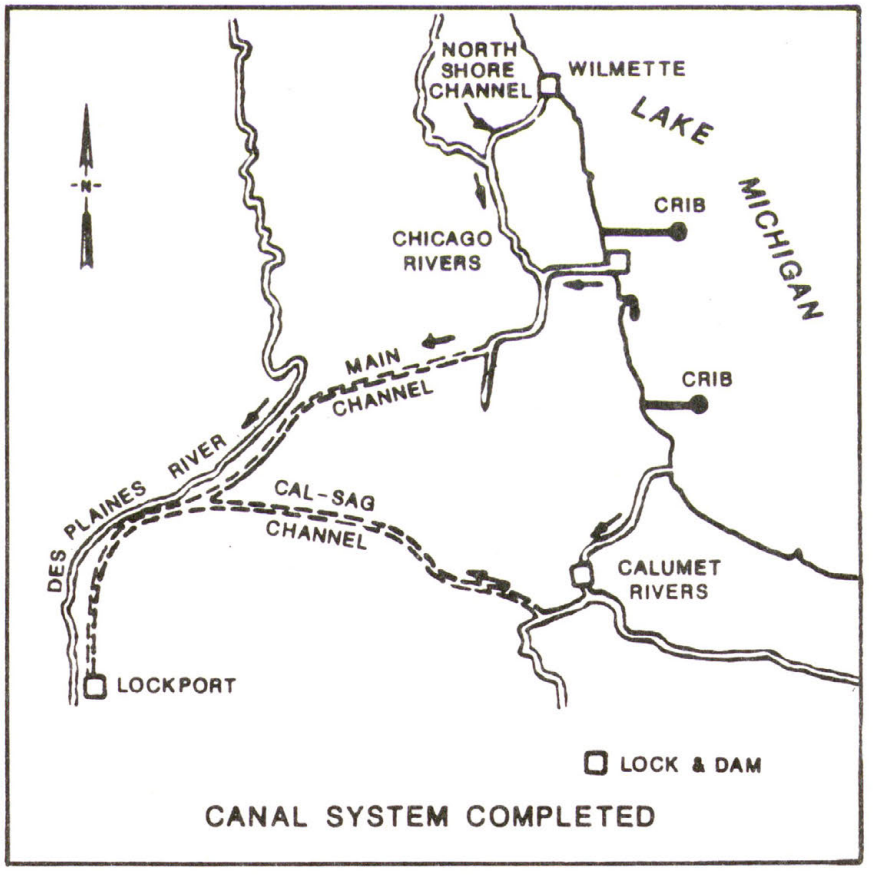
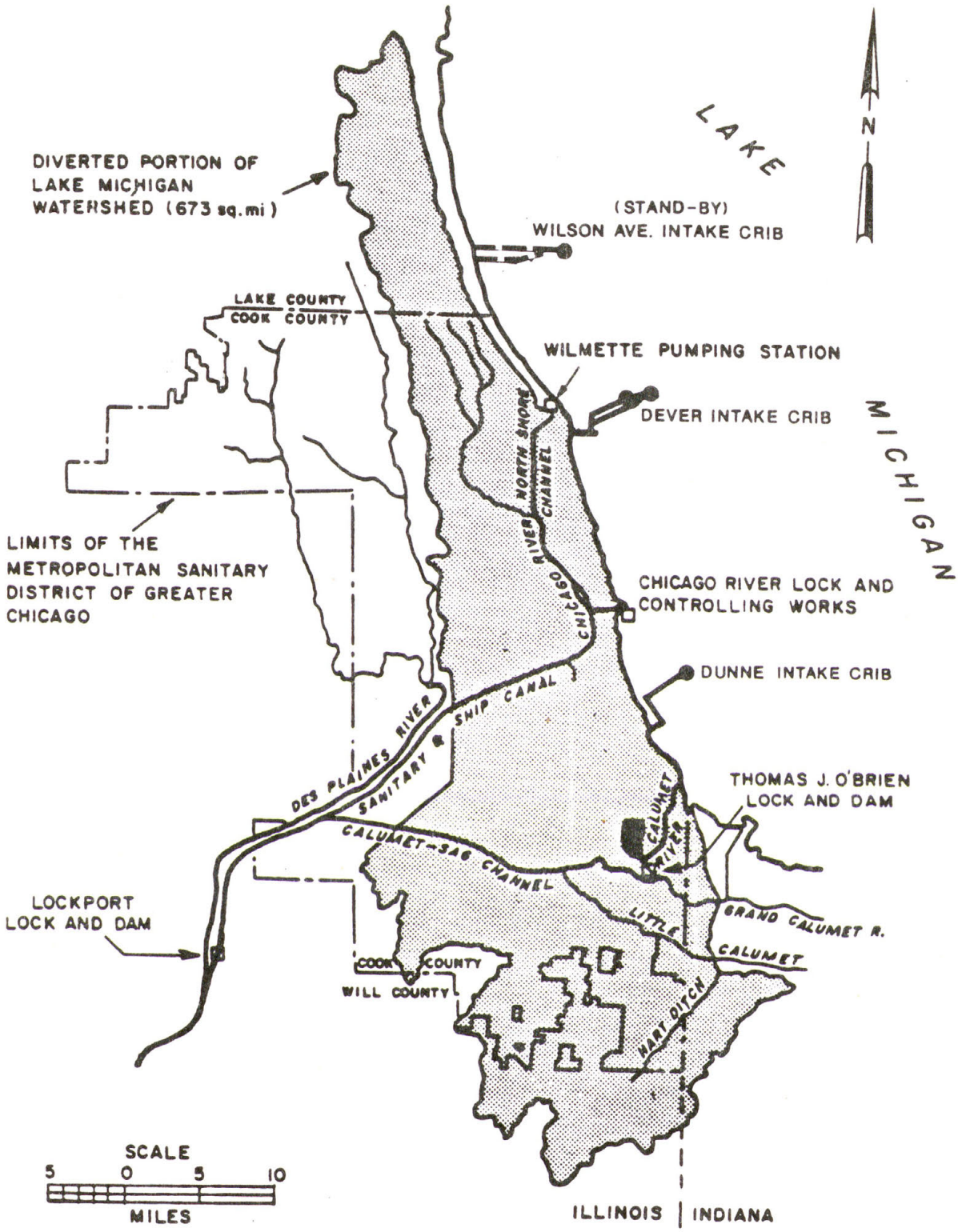

NORTH SHORE CHANNEL
WILMETTE
LAKE MICHIGAN
CRIB
CHICAGO RIVERS
MAIN CHANNEL
CRIB
DES PLAINES RIVER
CAL-SAG CHANNEL
CALUMET RIVERS
LOCKPORT
LOCK & DAM
CANAL SYSTEM COMPLETED

Figure 1-1



LOCATION PLAN-LAKE MICHIGAN DIVERSION AT CHICAGO

Figure 1-2

negotiations were held with the objective of reaching this goal, no agreement was reached due to lack of funding. Therefore, the measurement and computation of the diversion continued to be done by the Illinois Department of Transportation (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). As discussed above, responsibility for diversion accounting was given to the Corps effective 1 October 1987 as a result of the passage of the Water Resources Development Act of 1986.

Second, the supervisory role for the Corps was increased, in that the Corps was now responsible for auditing the computations and measurements performed by the State of Illinois.

Third, the modified decree states that the Chief of Engineers shall appoint a Three-Member Technical Committee to determine the best current engineering practice and scientific knowledge for measuring the diversion and to make recommendations as appropriate. The decree states that "...the members should be selected on the basis of recognized experience and technical expertise in flow measurement or hydrology." A technical committee is to be reconvened at least once every five years. The first Technical Committee was convened in June 1981 and completed its work in April 1982. The second Technical Committee was convened in July 1986, and completed their final report in November 1987. The third Technical Committee is scheduled to be convened in mid 1991.

SIGNIFICANT EVENTS

2.1 HYDROLOGIC EVENTS

No major flooding events occurred during water year 1988. The major hydrologic event of the year was a severe drought accompanied by persistent high temperatures that lasted from the end of May to mid-August. The Chicago metropolitan area experienced 47 days during this period in which temperatures exceeded ninety degrees. During seven of these days, temperatures exceeded one hundred degrees. Both of these statistics represent new records for the area. The combination of the lack of rainfall and high temperatures caused low water levels and resulting navigational problems on several major Midwest waterways, including the lower Mississippi River. Due to the drought, numerous requests and inquiries were made to the Corps regarding an increase in the diversion at Chicago in order to help alleviate low flow conditions on the Lower Mississippi River. No increase in the diversion was allowed for this purpose in water year 1988.

In past annual reports, a separate appendix has been included to describe significant events of a hydrologic nature.

Due to the lack of such events during this accounting year, a separate appendix of this nature is not included in this annual report. Should it be deemed necessary, appendices will again be included in future reports.

2.2 NON-HYDROLOGIC EVENTS

During water year 1988, there were a number of significant non-hydrologic events that transpired. The two major events were as follows: (a) briefing of Congressman Upton of Michigan regarding Lake Michigan diversion on 8 August; and (b) a drawdown of the Chicago Sanitary and Ship Canal in late summer due to required maintenance and repair work. A standard operation procedure (SOP) report detailing the computational methods for non-chargeable diversion flows related to drawdowns for canal maintenance is scheduled for completion during water year 1989. A separate, detailed chronological listing of non-hydrologic events is included in Appendix A.

DIVERSION ACCOUNTING

3.1 STATUS OF ACCOUNTING REPORTS

Lake Michigan diversion flow data is summarized in accounting reports prepared on an annual basis as flows are certified. Since implementation of the modified Supreme Court decree of 1 December 1980, the Corps has certified diversion flows for the 1981, 1982, and 1983 water years. At the time of this report, no other accounting reports were available for certification purposes. A table showing accounting year, certified flows, and cumulative deviation from the allowable diversion (3,200 cfs) is shown below:

TABLE 3-1

LAKE MICHIGAN DIVERSION FLOWS

ACCOUNTING YEAR	CERTIFIED FLOW	CUMULATIVE DEVIATION
1981	3106 cfs	-94 cfs
1982	3087 cfs	-207 cfs
1983	3613 cfs	+206 cfs

An initial review of the water year 1984 accounting report has been completed by the Chicago District. The review concluded that available AVM data and the revised modeling parameters should be used prior to certification. Upon completion of the revision to the modeling parameters, the report will be certified by the Chicago District. Currently, this accounting report is

scheduled for certification by 30 June 1989 and will be distributed at the end of the accounting year.

NIPC has nearly completed the water year 1985 accounting report using the current accounting models. Upon completion of the revision to the modeling parameters, the report will be certified by the Chicago District. Currently, this accounting report is scheduled for certification by 30 August 1989 and will also be distributed at the end of the accounting year.

Data collection and preparation for the FY86 accounting report is scheduled to be performed by NIPC, pending award of a contract. The Chicago District will prepare the contract and work order for this task and coordinate NIPC's activities. The contract is expected to be awarded during FY89. It is anticipated that the accounting for this report will also be completed during FY89. The results of the work will be reviewed for completeness, and certified in FY90.

Data collection and preparation for the FY87 accounting report is scheduled to be performed on a second work order with NIPC. The Chicago District will prepare the contract and work order for this task and coordinate NIPC's activities. The contract is expected to be awarded in FY90. Preparation of this report will also be completed in FY 90. Certification of this report is scheduled for FY91.

Data collection and preparation for the FY88 accounting report will be performed by the Corps. The Chicago District will complete this report in house. Data collection will be performed in FY 89 and preparation of this report will be completed in FY90. Certification is scheduled for FY91.

The report of the second technical committee recommended that the diversion records for water years after 1980 should be reviewed and, if appropriate, revised as necessary to account for new information or to reflect more up to date methods for computation of the diversion flows. The Corps' position regarding this recommendation is that once diversion flows are computed (using best current engineering practice and scientific knowledge) and certified in the annual report, no modifications or revisions will be made to the records. This position was clearly stated in the Corps' letter of 3 June 1988 transmitting the second committee's report to the parties of the litigation. A letter was subsequently received from one of the committee members requesting that the Corps reconsider its position with respect to the above. The Corps, in responding to this request, maintained its position and informed the committee member that certified flows will not be changed at a later point in time. The principal rationale behind the Corps' position is the fact that management of the diversion by the State of Illinois would become virtually impossible. Specifically, the State of Illinois must meet the 3200 cfs, 40 yr. average dictated by the modified

Supreme Court decree of 1 December 1980. Should previously certified flows be revised, a "moving target" would be created and management of the diversion, as described above, would be greatly hindered.

3.2 SOURCES OF DIVERSION

The Lake Michigan diversion is composed of three primary components. These sources are direct diversion through the three lake front structures, domestic pumpage from Lake Michigan which is used for water supply and not returned to Lake Michigan, and stormwater runoff from the Lake Michigan watershed which is diverted from the lake.

Direct diversion locations are at the Chicago River Controlling Works (CRCW), O'Brien Lock and Dam, and Wilmette Controlling Works. These controlling structures are located downtown, at the south end, and at the north end of the Chicago area, respectively.

The direct diversion consists of four components; lockage, discretionary flow, navigational makeup flow, and leakage. The lockage component is the flow that is passed as part of locking vessels to and from the lake. The original purpose of the diversion was for diluting effluent from treatment plants. Occasionally, flow must still be diverted for this purpose and to flush the canal. This component of the direct diversion is known as discretionary diversion. Periodically when large storm events are predicted, the canal is drawndown prior to the event to prevent flooding. If the event fails to materialize, the canal level must be restored. The flow used to restore the canal level is called navigational makeup. Leakage is through the locks and the controlling structures at the lake.

3.3 ACCOUNTING PROCEDURE

Diversion accounting is performed through the use of both measured and estimated flows. Beginning with the WY83 accounting report, a new system was developed to perform the accounting. The system uses various meteorological data to simulate those flows that cannot be measured. The system uses the simulated as well as measured flows to compute the diversion. The system also develops a number of water budgets that are used to check the computed diversion and give an estimate of the reliability of the computed diversion.

3.3.1 DIVERSION COMPUTATION

An acoustic velocity meter (AVM) has been installed at Romeoville (five miles upstream of Lockport Powerhouse and three miles upstream of Lockport Controlling Works) for direct measurement of Lockport flows. The majority of the diverted Lake Michigan flows and some non-Lake Michigan flows drain through the

Lockport facilities. The diversion accounting procedure uses the flow measured at Lockport and deducts from that flows not attributable to the diversion. Diversion flows which bypass Lockport are added to the resultant, yielding the net computed diversion of water from Lake Michigan. This procedure represents the accounting technique as required by the modified Supreme Court decree. This method of accounting is used as opposed to computing the sum of the individual components of the diversion described in section 3.2.

The average annual flow measured at Lockport is roughly 110% of the average annual diversion and more than 99% of the diversion passes through Lockport. The remainder of the diverted flow bypasses Lockport through the Des Plaines River. The remainder of the diversion flows are measured whereas virtually all of the deductions are computed through simulation.

The diversion flow which does not pass through Lockport is primarily Lake Michigan water supply pumpage whose effluent is treated and released to the Des Plaines River. This flow is obtained directly through pumping records of the communities involved. This flow accounts for less than 1% of the diversion.

The deductions to the Lockport record include runoff from 217 square miles of the Des Plaines River watershed which is discharged to the canal, groundwater supply whose effluent is discharged to the canal, and Indiana water supply which discharges to the canal via the Calumet River system and the Calumet Sag Channel (see figure 1-2 for locations). The NIPC computer models of the Des Plaines watershed area are used to ascertain the best estimate of the runoff deduction. The groundwater pumpage deductions are obtained directly from pumping records. The Indiana water supply deduction is computed from pumping records and a calculation which determines the portion of the water supply draining west to the Calumet Sag Channel.

3.3.2 DIVERSION BUDGET CHECKS

A series of water budgets are developed to represent the major components of the diversion. These budgets are used to verify the computed diversion. The three primary budgets are the three components of the diversion discussed in section 3.2. The sum of these three budgets, theoretically, should equal the computed diversion using Lockport. Comparison of this sum to the computed diversion establishes confidence in the computed, official value of the diversion.

ACCOMPLISHMENTS DURING FY88

4.1 CONTRACTING

A review of the hydrologic simulation procedures by the involved concerns including the second Technical Committee

determined that revisions to hydrologic modeling parameters were necessary. The Chicago District has awarded a contract to an Architectural/ Engineering (A/E) firm to accomplish this task. The work in revising the parameters is expected to be accomplished during accounting year 1989.

4.2 SOFTWARE CONVERSION

In the past, the Northeastern Illinois Planning Commission (NIPC), as an agent of the State of Illinois, has been performing diversion accounting on a mainframe computer. Currently, the software is being converted by NIPC for use on a microcomputer system. This conversion will allow the Chicago District to perform diversion accounting in-house.

4.3 AVM

The Chicago District, in cooperation with the United States Geological Survey (USGS), has contracted with Accusonic Division, Ferranti O.R.E., Inc. for installation of a new AVM for measurement of flow at Lockport. Continuing problems with the original AVM, installed by Sarasota Automation, Inc. in March 1984, necessitated the procurement of the new system. The continuing unreliability of the original system made installation of a new system mandatory for recording of accurate, reliable flow data. Dissatisfaction with the service provided by Sarasota was another factor that influenced the decision to procure a new system. The new AVM will be installed at the same location as the original system and makes use of the same transducer mounts and equipment shelter. The original AVM will be used as a backup for the new system. The installation will be completed in FY89.

A number of alternative AVM backup systems have been studied. A major accomplishment of the Chicago District, commenced during FY 88, was the completion of a draft report entitled "Acoustic Velocity Meter Regression Analysis." This report, dated August 1988, discusses the development, through regression analysis, of an accurate set of regression equations which will synthesize AVM flows in the event of an AVM malfunction or breakdown. In preparation of this report, the Corps took into consideration regression equations previously developed by the USGS and the second Three-Member Technical Committee. A thorough analysis was made of these equations in preparing the report. As recommended by the second Technical Committee, actual Lockport operating conditions were considered in development of the equations. The draft report was distributed to the USGS for review and comment. Their comments have been reviewed and will be incorporated into a second draft report in FY89. The report will then be distributed to the Corps' Hydrologic Engineering Center (HEC) for final review. The report is scheduled for finalization during accounting year 1989.

As recommended by the second Technical Committee, an annual review of the AVM flow records by all participating agencies will be an on-going activity established and conducted by the Corps. Additionally, as recommended by the committee, the Corps is developing a program for verifying the AVM record using MSDGC Lockport flows and the regression equations previously discussed. This program will be used to review all past AVM records, beginning in 1984, as well as all future records. As part of this program flows will be computed for all days when the AVM was malfunctioning.

During the course of the 1988 accounting year, thirteen sets of field measurements were made. The dates of these measurements were as follows: 9 October 1987, 15 October 1987 (3 measurements), 19 October 1987 (2 measurements), 3 November 1987, 23 November 1987, 30 December 1987, 12 February 1988, 10 June 1988, 27 July 1988, and 16 September 1988. With the exception of the 15 October and 19 October measurements, percentage differences between the discharge measurements and AVM readings ranged from -1.7% to +2.2%. Percentage differences ranging from -10.8% to +4.8% were observed on 15 and 19 October. A system problem during this time period explains these larger differences. For the five measurements done on these two days, a constant adjustment of 450 cfs was added to the AVM measured flows in order to compensate for this problem. An itemization of the thirteen discharge measurements made by the USGS during the 1988 accounting year is shown in table 4-3.

4.4 DATA QUALITY ASSURANCE PROGRAM

The Chicago District, in response to the concerns of the second Technical Committee, is in the process of completing a report on a data quality assurance program that includes procedures and schedules for inspecting and calibrating measuring devices. The program will provide a means with which the accuracy of the diversion accounting can be estimated and elements most in need of improved accuracy can be selected. The completed report will present a comprehensive approach to maintaining the integrity of the various measurement components, assessing the accuracy of the components, and determining the relative importance of the components. The program is designed to assure the quality of the overall measurement and accounting system and to aid in identification of the flow component measurements most in need of improvement. The report is currently scheduled for completion by 30 January 1989. Implementation of the program will occur during FY89.

ACTIVITIES FOR FY89

5.1 ACCOUNTING REPORTS

As discussed previously, the NIPC hydrologic modeling parameters were reviewed and found to be in need of revision.

Table 4-3

DISCHARGE MEASUREMENTS
CHICAGO SANITARY & SHIP CANAL AT ROMEOVILLE
ACCOUNTING YEAR 1988

No.	Date	AVM Discharge(cfs)	Shift Discharge(cfs)	Shift Adjustment(cfs)	Adjusted(cfs)	% Difference
1	9 October 1987	2674	2689	None	2689	+0.6
*2	15 October 1987	2931	2837	450	3287	-10.8
*3	15 October 1987	2457	2116	450	2566	-4.2
*4	15 October 1987	2664	2271	450	2721	-2.1
*5	19 October 1987	2318	1863	450	2313	+0.2
*6	19 October 1987	2551	1983	450	2433	+4.8
7	3 November 1987	2017	1993	None	1993	+1.2
8	23 November 1987	2814	2847	None	2847	-1.2
9	30 December 1987	3837	3803	None	3803	+0.9
10	12 February 1988	2077	2111	None	2111	-1.6
11	10 June 1988	4111	4181	None	4181	-1.7
12	27 July 1988	3008	2942	None	2942	+2.2
13	16 September 1988	5228	5228	None	5228	0

* Shift adjustment of 450 cfs required due to system problem

The Chicago District has awarded a contract for completion of this work.

Completion of the work in revising the modeling parameters will have a direct impact on the completion dates for diversion accounting reports. Since inception of the new diversion accounting system, only flows for the 1983 accounting year have been certified. Accounting for subsequent years is now in the process of being completed. The current status of the reports in progress is described briefly below.

As discussed in section 3.1 above, the water year 1984 and 1985 accounting reports will be finalized in FY89, subject to revision of modeling parameters. These reports will be certified in FY89.

As also discussed in section 3.1, the water year 1986 report will be prepared by NIPC pending award of a contract. It is expected that accounting for the water year 1986 report will be completed during FY89.

5.2 AVM BACKUP SYSTEM

A principal goal of the Chicago District during FY89 is the completion of the AVM backup system. Implementation of a backup system was a major concern of the second Technical Committee. As discussed previously, a new AVM system is scheduled for installation at Romeoville in November 1988. The first level of backup will involve a complete set of replacement circuitry boards for the new system. A second level of backup will be achieved by activating the old AVM system. A third level of backup will be attained by use of the regression equations previously discussed. It is anticipated that the regression equations will be used to generate synthetic AVM flows for any gaps in the recording of data or system down time due to required maintenance or repairs. Specifically, the regression equations will be used to compute missing AVM data for FY84 through FY88 inclusive. The regression equations will be reviewed and revised periodically so as to insure that the most up to date hydraulic conditions are reflected in the components of the equations. The backup system will be reviewed by HEC and finalized in FY89.

5.3 PRECIPITATION NETWORK

A precipitation gage network will be installed and maintained by the Illinois State Water Survey (ISWS). The Chicago District will prepare the contract for this task and coordinate ISWS's activities. Pending award of the contract, the network will be installed during FY89 and become operational (data collection to commence) on 1 October 1989.

5.4 INDIANA FLOWS

The Chicago District will review and evaluate the Grand Calumet flow split calculations for the deduction from the Indiana watershed. Alternatives for improving the accuracy of this calculation will be developed. Implementation of alternatives presented in the report will be performed in accounting year 1990. This task is currently scheduled for completion by 30 September 1989.

5.5 INCLUDE MAINSTREAM TARP IN DIVERSION ACCOUNTING PROCEDURE

The Mainstream Tunnel and Reservoir Plan (TARP) system was brought on line at the beginning of FY86. The addition of Mainstream TARP does not change the amount of the diversion but may have a slight impact on the amount of runoff from the Des Plaines River watershed flowing past Lockport. TARP will be incorporated into the diversion accounting procedure prior to performing FY86 accounting.

PROJECTED ACTIVITIES

6.1 ACCOUNTING REPORTS

As discussed previously, certification for water year 1986 will be completed in FY90. Certification for water years 1987, 1988, and 1989 will be completed in FY91. Commencing in FY92, the previous year's accounting report will be certified and included with the annual report (one report will be certified during each accounting year). An updated 5 yr. Master Plan detailing scheduled activities is included in Appendix B.

6.2 REVIEW O'HARE BASIN TRANSFER

The O'Hare Water Reclamation Plant is located in the Des Plaines River Watershed. A portion of the discharge from the plant is diverted to the Northside Water Reclamation Plant in the Lake Michigan watershed. The current procedure for estimating the diversion from the O'Hare Plant to the Northside Plant will be evaluated and alternatives for improving the procedure developed in FY90.

6.3 THIRD TECHNICAL COMMITTEE

In accordance with the provisions of the modified Supreme Court decree of 1 December 1980, the third Technical Committee for review of Lake Michigan diversion flow measurements and accounting procedures will be convened in accounting year 1991. Procurement procedures for this committee will begin in mid-1990. It is anticipated that this committee will review the reports of the first two committees as well as evaluate current accounting

procedures to insure that measurement of diversion is conducted according to "best current engineering and scientific knowledge" as required by the decree.

6.4 INCLUDE DES PLAINES TARP IN DIVERSION ACCOUNTING PROCEDURE

The Des Plaines TARP system is scheduled to be brought on-line in FY90. The addition of the Des Plaines TARP does not change the amount of the diversion but greatly impacts the amount of Des Plaines River watershed runoff flowing past Lockport. The Des Plaines TARP will be incorporated into the diversion accounting procedure prior to performing the accounting report for the year of installation.

CONCLUSIONS

7.1 SUMMARY

The Lake Michigan diversion accounting program has been going through significant modifications of the technical methodology used in computing the total flows at Lockport and in the computation of the deductions. As discussed in the Corps' review, some minor inconsistencies still exist within the accounting system. Revision of the hydrologic modeling parameters and implementation of the new AVM and backup system, scheduled for completion in accounting year 1989, will have a significant impact in improving the accuracy of diversion accounting. As the physical features of the diverted watershed are dynamic, the accounting system itself must be representative of current conditions in the system, but flexible enough to accommodate any required modifications.

It is expected that the implementation of the second Technical Committee's recommendations, already begun, will continue to improve the diversion accounting system. It is the goal of the Corps of Engineers to have the accounting reports on schedule and the accounting procedure up to the highest reasonable engineering standards by commencement of the third Technical Committee.

7.2 PROGRAM REVIEW

Based on the review of the entire FY 88 accounting program, 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. The current accounting procedures are consistent with "best current engineering practice and scientific knowledge" as required by the modified Supreme Court decree. However, the

current parameters used in the hydrologic simulation process may be outdated and in need of revision.

b. An accurate and reliable measurement system at Lockport is of paramount importance in maintaining credibility for the entire diversion accounting program. An essential component for achievement of this goal is an AVM that measures flow accurately and reliably.

c. A backup system for the AVM is necessary with a multiple-level backup representing the optimal situation. The backup system is in the process of being developed at the current time.

REFERENCES

1. Espey, Dr. W.H., Barnes, Harry H., and Westfall, David. November 1987. Lake Michigan Diversion Findings of the Second Technical Committee for Review of Diversion Flow Measurements and Accounting Procedures.

2. Chicago District. July 1988. Lake Michigan Diversion Accounting 1987 Annual Report.

3. Northeastern Illinois Planning Commission. June 1985. Lake Michigan Diversion Accounting Manual of Procedures.

APPENDIX A
SIGNIFICANT EVENTS (NON-HYDROLOGIC)

SIGNIFICANT EVENTS - WY 88
NON-HYDROLOGIC

8 October 1987 - Chicago District forwards comments on second draft of committee report to committee members for their review.

9 October 1987 - United States Geological Survey (USGS) performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

15 October 1987 - USGS performs three discharge measurements in Chicago Sanitary and Ship Canal at Romeoville.

19 October 1987 - USGS performs two discharge measurements in Chicago Sanitary and Ship Canal at Romeoville.

27 October 1987 - Diversion accounting meeting held between Corps, Northeastern Illinois Planning Commission (NIPC) and State of Illinois (IDOT). Discussions at meeting involved adoption of Corps' LANDS and SCALP model parameters for the Des Plaines system.

3 November 1987 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

6 November 1987 - Letter sent from USGS to Chicago District providing listings of provisional daily discharges and summaries of discharge measurements for the 1987 and 1988(to current date) water years. Letter also summarized revisions being made to the acoustic velocity meter (AVM) record for the 1985 and 1986 water years.

23 November 1987 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

4 December 1987 - Final report of second three-member technical committee forwarded to Chicago District.

7 December 1987 - Letter sent from Chicago District to NIPC in response to request for information made at 27 October meeting above. Letter provided data used in the LANDS and SCALP modeling for the Chicagoland Underflow Plan (CUP).

30 December 1987 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

12 February 1988 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

7 March 1988 - Letter sent from IDOT to Chicago District regarding completion of 1984 and 1985 diversion accounting reports. Letter stated that NIPC had completed review of information provided concerning Corps' model representation of

Upper Des Plaines watershed and its use by second three-member committee.

16 March 1988 - AVM system malfunction; AVM out of service until 25 May 1988

19 March 1988 - Letter sent from USGS to Chicago District regarding operation of the AVM station at Romeoville. Letter detailed costs including salaries, travel, transportation, supplies, and equipment needed for operation and maintenance of the gage and the preparation of data for publication.

31 March 1988 - Chicago District commences procedures for obtaining necessary microcomputer system for performing diversion accounting.

31 March 1988 - Chicago District commences procedures for preparation of sole source - indefinite delivery contract with NIPC for analysis and evaluation of Lake Michigan diversion accounting.

11 May 1988 - Meeting held between Corps and IDOT for discussion of NIPC modeling procedures/preparation of accounting reports.

18 May 1988 - Field trip to AVM site and Lockport by Corps, USGS personnel and Sarasota Automation to inspect facilities and discuss options for repair of metering system.

25 May 1988 - AVM back on-line and recording data after malfunctioning 16 March 1988

3 June 1988 - Letters sent from Chicago District to all parties of diversion litigation forwarding copies of final report produced by second three-member technical committee for informational purposes. Letter discussed proposed procedures for implementation of committee's recommendations.

10 June 1988 - Letter sent from Chicago District to Office of the Chief of Engineers (OCE) through North Central Division (NCD) forwarding final report of second three-member technical committee for informational purposes.

10 June 1988 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

15 June 1988 - Letter sent from Chicago District to Northeastern Illinois Planning Commission (NIPC) forwarding final report of second three-member technical committee for informational purposes. Letter discussed proposed procedures for implementation of committee's recommendations.

17 June 1988 - Letter sent from Chicago District to United States Geological Survey (USGS) regarding meeting held at AVM

site on 18 May. Letter documented events of the meeting and requested information regarding past and future maintenance requirements for the AVM and potential AVM replacement and backup systems.

6 July 1988 - Meeting held between Chicago District and NIPC regarding modeling parameters, transmittal of simulation models to the Corps and the 1984 and 1985 accounting reports.

7 July 1988 - Chicago District personnel visit O'Brien Controlling Works, Calumet Sewage Treatment Plant and Stickney Sewage Treatment Plant. Purpose of visits was to observe systems and modes of operation of flow metering devices at each respective site.

26 July 1988 - Chicago District personnel visit Northside Sewage Treatment Works to view flow measurement facilities, and discuss maintenance and calibration program for the flow measurement devices. Visits also made to Wilmette Pumping Station and Chicago River Controlling Works to inspect sluice gates and flow measurement.

27 July 1988 - Meeting held between Chicago District and USGS to discuss installation of a new AVM at Romeoville site.

27 July 1988 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

2 August 1988 - Letter sent from NIPC to Chicago District in response to 15 June letter above forwarding comments on final report of second three-member technical committee.

2 August 1988 - Letter sent from Chicago District to MSDGC detailing errors found in the monthly lockage reports. Letter stated that revised reports would be forwarded shortly.

4 August 1988 - Chicago District personnel visit Upper Des Plaines Pumping Station to inspect facilities and current flow measurement techniques. Visit also made to O' Hare Treatment Plant to discuss flow from O' Hare to Northside Sewage Treatment Plant via Upper Des Plaines area.

8 August 1988 - Chicago District personnel provide briefing to Congressman Upton from State of Michigan regarding Lake Michigan Diversion Accounting.

10 August 1988 - Chicago District obligates funds to USGS for purchase and installation of new AVM at Romeoville site.

10 August 1988 - Letter sent from Chicago District to MSDGC forwarding lockage revisions as discussed in 2 August letter above.

11 August 1988 - Chicago District personnel visited Northside Sewage Treatment Works to discuss possibilities of measuring flow in Howard #6 sewer interceptor.

12 August 1988 - Letter sent from Chicago District to Illinois State Water Survey (ISWS) regarding design, installation, and maintenance of a precipitation gage network for the Chicago area. Precipitation network was to be used in the performance of diversion accounting.

17 August 1988 - Letter sent from Chicago District to USGS forwarding draft report on regression analysis for review. Purpose of report was to review past regression analyses and develop a new series of regression equations which can be used to synthesize AVM flows in the event of an AVM malfunction or breakdown.

17 August 1988 - Letter sent from Chicago District to MSDGC regarding investigation of potential flow measurement sites and requesting information on Upper Des Plaines Pumping Station.

17 August 1988 - Letter sent from IDOT to Chicago District in response to 3 June letter above forwarding comments on final report of second three-member technical committee.

30 August 1988 - Letter sent from Chicago District to MSDGC forwarding lockage reports for the months of May, June, and July 1988.

1 September 1988 - Letter sent from MSDGC to Chicago District in response to 3 June letter above forwarding comments on final report of second three-member technical committee.

6 September 1988 - Letter sent from Chicago District to USGS forwarding tables and graphs comparing the AVM flows and the MSDGC flows adjusted using the Corps' latest regression equations for water year 1988 through 31 May 1988.

6 September 1988 - Meeting held between Chicago District, IDOT, and NIPC for discussion of incorporation of Tunnel and Reservoir Plan (TARP) into diversion accounting/modeling procedures.

7 September 1988 - Letter sent from Chicago District to Corps' Hydrologic Engineering Center (HEC) forwarding draft report on regression analysis for review (same draft report provided to USGS as described in 17 August letter above).

8 September 1988 - Letters sent from Chicago District to all parties of diversion litigation forwarding final copies of Corps' 1987 Annual Report on Lake Michigan Diversion for informational purposes.

8 September 1988 - Letter sent from Chicago District to NIPC forwarding final copy of Corps' 1987 Annual Report on Lake Michigan Diversion for informational purposes.

8 September 1988 - Letter sent from Chicago District through NCD to Office of the Chief of Engineers (OCE) forwarding final version of Corps' 1987 Annual Report on Lake Michigan Diversion for informational purposes.

12 September 1988 - Drawdown of Chicago Sanitary and Ship Canal due to required maintenance and repairs immediately upstream of Lockport.

16 September 1988 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Lockport.

19 September 1988 - Drawdown of Chicago Sanitary and Ship Canal due to required maintenance and repairs immediately upstream of Lockport (drawdowns continued from 20 through 28 September 1988).

22 September 1988 - Letter sent from Chicago District to MSDGC forwarding lockage report for month of August 1988.

APPENDIX B
MASTER PLAN

LAKE MICHIGAN DIVERSION MASTER PLAN
5 YEAR PLAN

ACCTG. YR.	SCHEDULED ACTIVITY
1989	Prepare and Transmit 1988 Annual Report
	Complete Revision of NIPC Modeling Parameters
	Install New AVM
	Complete Report on AVM Regression Backup Procedure
	Complete Report on Data Quality Assurance Procedures
	Complete Certification of 84 Accounting Report
	Complete Certification of 85 Accounting Report
	Complete Preparation of 86 Accounting Report
	Complete SOP on Drawdown of Canal for Maintenance
	Implement Improvements to Upper Des Plaines Pump Station Instrumentation
	Incorporate TARP into Diversion Accounting Procedure
1990	Prepare and Transmit 1989 Annual Report
	Implement Procedure for Estimating Flow Transfer from O'Hare Basin
	Complete Report on Grand Calumet Flow Deduction Computation
	Complete Certification of 86 Accounting Report
	Complete Preparation of 87 Accounting Report
	Complete Preparation of 88 Accounting Report
	Complete Preparation of 89 Accounting Report
	Commence procurement process for third technical committee

ACCTG. YR.	SCHEDULED ACTIVITY
1991	Prepare and Transmit 1990 Annual Report
	Convening of Third Technical Committee
	Complete Certification of 87 Accounting Report
	Complete Certification of 88 Accounting Report
	Complete Certification of 89 Accounting Report
	Complete Preparation of 90 Accounting Report
	Review Procedure For Modeling TARP
1992	Prepare and Transmit 1991 Annual Report
	Review Report of Third Technical Committee and Develop Plan for Implementing Recommendations
	Complete Certification of 90 Accounting Report
	Complete Preparation of 91 Accounting Report
1993	Prepare and Transmit 1992 Annual Report
	Begin Implementing Recomendations of Third Technical Committee
	Complete Certification of 91 Accounting Report
	Complete Preparation of 92 Accounting Report