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# Supreme Court of the United States

OCTOBER TERM 1966

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STATES OF WISCONSIN, MINNESOTA, OHIO and PENNSYLVANIA, *Complainants*,
*v.*
STATE OF ILLINOIS and THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO, *Defendants*,
UNITED STATES OF AMERICA, *Intervenor*.
**No. 1 Original**

STATE OF MICHIGAN, *Complainant*,
*v.*
STATE OF ILLINOIS and THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO, *Defendants*,
UNITED STATES OF AMERICA, *Intervenor*.
**No. 2 Original**

STATE OF NEW YORK, *Complainant*,
*v.*
STATE OF ILLINOIS and THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO, *Defendants*,
UNITED STATES OF AMERICA, *Intervenor*.
**No. 3 Original**

STATE OF ILLINOIS, *Complainant*,
*v.*
STATES OF MICHIGAN, OHIO, PENNSYLVANIA, MINNESOTA, NEW YORK and WISCONSIN, *Defendants*,
UNITED STATES OF AMERICA, *Intervenor*.
**No. 11 Original**

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# Report of Albert B. Maris, Special Master

December 8, 1966

THE LEGAL INTELLIGENCER, 10 S. 37TH ST., PHILA. 19104

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# Preliminary Statement

## Background of the Litigation

The first of these bills of complaint was filed by the State of Wisconsin on July 14, 1922, as No. 23, Original, October Term 1922. It is now designated as No. 1, Original, on the docket of this Court. The bill sought an injunction to restrain the State of Illinois and the Sanitary District of Chicago from diverting water from Lake Michigan at Chicago. The diversion in controversy had begun in 1900 when the Sanitary District completed the construction of a drainage canal connecting the south branch of the Chicago River in Chicago with the Des Plaines River at Lockport, Illinois. By deepening the Chicago River and reversing its direction of flow the Sanitary District had caused water to flow from the lake through the Chicago River and the canal into the Des Plaines River and thence into the Illinois River and ultimately the Mississippi. While the construction of the canal facilitated navigation between the Great Lakes and the Mississippi River system of waterways, its primary purpose was to provide a stream into which to discharge the sewage of the Sanitary District which would not carry it into Lake Michigan, from which Chicago drew its domestic water supply.

During 1922 and for a number of years prior thereto the Sanitary District had been diverting from Lake Michigan substantially more than the 4,167 cubic feet per second allowed by the then effective permit from the Secretary of War issued under section 10 of the Act of March 3, 1899 [30 Stat. 1151]. Cubic feet per second will be abbreviated hereinafter as cfs. At the time the suit was brought by the State of Wisconsin there was pending in the United States District Court for the Northern District of Illinois an action brought by the United States to enjoin the Sanitary District from diverting water from Lake Michigan in excess of the 4,167 cfs allowed by that permit. On January 5, 1925 this Court affirmed a decree for an injunction entered by

the district court in that case, without prejudice, however, to any permit that might be issued by the Secretary of War according to law [266 U. S. 405].

On application of the Sanitary District alleging its need for more water to eliminate offensive conditions in the Illinois River and to keep the Chicago River from reversing its flow and discharging raw sewage into the lake during storm periods, the Secretary of War on March 3, 1925 issued a permit for an annual average diversion of 8,500 cfs from Lake Michigan through the Sanitary District's canal and channels. The permit was conditioned, however, inter alia, upon the Sanitary District carrying out a specified program of sewage treatment and submitting plans for controlling works to prevent the discharge of the Chicago River into Lake Michigan in times of heavy storms. The permit, unless previously revoked or extended, was to expire on December 31, 1929.

## Amended Complaint of Wisconsin, Minnesota, Ohio and Pennsylvania

On October 12, 1925 the State of Wisconsin filed an amended bill of complaint which brought in the States of Minnesota, Ohio and Pennsylvania as additional plaintiffs. The amended bill of complaint alleged that as the result of the defendants' diversion of water from Lake Michigan the mean level of Lakes Michigan, Huron, Erie and Ontario, their connecting waterways, and the St. Lawrence River above tidewater had been lowered not less than six inches below the level that would otherwise have existed thereby seriously diminishing the utility of lake ports and harbors and substantially reducing the amount of cargo which lake vessels could carry to and from such ports. The diversion was alleged to be in violation of the right of plaintiff States and their people to the unobstructed use for purposes of navigation, trade and commerce of Lakes Michigan, Huron, Erie and Ontario and the navigable waters between them and from them into the Mississippi River

and the Atlantic Ocean free from interference with their natural navigable capacity. The amended complaint sought an injunction restraining the defendants from diverting more water than reasonably required for navigation in the canal of the Sanitary District and connecting waters, and from dumping into the canal sewage in such quantities as to render the canal and its connecting waterways unsanitary and dangerous to the health of the people of the plaintiff States navigating those waterways.

On February 1, 1926 the States of Missouri, Kentucky. Tennessee and Louisiana were permitted to intervene in the suit as parties defendant and on November 23, 1926 the States of Arkansas and Mississippi were given similar leave to intervene.

## Complaints of Michigan and New York

On March 8, 1926 the State of Michigan filed a bill of complaint against the State of Illinois and the Sanitary District of Chicago as No. 27, Original, October Term 1925. On October 18, 1926 the State of New York filed a similar bill of complaint as No. 14, Original, October Term 1926. These suits are now designated as Nos. 2 and 3, Original, respectively, on the docket of this Court.

The bills of complaint filed by the States of Michigan and New York each contained allegations similar to those contained in the amended bill of complaint of the States of Wisconsin, Minnesota, Ohio and Pennsylvania. In addition, they each alleged that the defendants' diversion had injured the rights of riparian owners, with incidental destruction of the usefulness of docks, wharves, shipyards, boat houses, warehouses, and landing places, had been destructive of the fisheries, and had violated the rights of the plaintiff States and their people to have the natural waters maintained for their pleasure and convenience. Each bill of complaint sought an injunction restraining the defendants from reversing the flow of the Chicago River or permanently diverting any water from the Great Lakes watershed.

Paragraph III of the bill of complaint filed by the State of New York asserted that the right to use the water of the Great Lakes waterway for the development of power in the Niagara River and the international section of the St. Lawrence River is a property right of the State of New York and its citizens which neither the defendants nor the Congress of the United States may destroy or impair by abstracting or diverting water from the Great Lakes waterway into the Mississippi River system. However, because it was not alleged that there was any present use of the waters for such purposes or any definite project for so using them this Court on May 31, 1927 struck out paragraph III of the bill of complaint filed by the State of New York "without prejudice, so that the plaintiff State, if later on in a position to do so, may be free to litigate the questions which the paragraph is intended to present" [274 U. S. 488, 490].

## Reference to Special Master Hughes

On June 7, 1926 Hon. Charles Evans Hughes was appointed special master to take evidence and report to this Court his findings of fact, conclusions of law and recommendations for a decree in the suit being prosecuted by the States of Wisconsin, Minnesota, Ohio and Pennsylvania [now No. 1, Original]. By the same order the parties in the related suit brought by the State of Michigan [now No. 2, Original], were permitted to participate in the taking of evidence and in the hearing before the special master in like manner and with the same effect as if the two suits had been consolidated [271 U. S. 650]. Subsequently, by order entered November 23, 1926, this Court gave similar permission to the parties in the suit brought by the State of New York [now No. 3, Original] [273 U. S. 642.] The plaintiffs in all three suits are sometimes referred to collectively in this report as the "Lake States."

The report of the special master was filed on November 23, 1927. He found that the diversion of Lake Michigan

water by the Sanitary District at Chicago operated to lower the levels of Lakes Michigan and Huron approximately six inches and the levels of Lakes Erie and Ontario approximately five inches, and had similarly lowered the connecting rivers, bays and harbors. He also found that the plaintiff States had established that the diversion through the Chicago drainage canal had caused substantial damage to their navigation and commercial interests, to their fishing and hunting grounds and to the availability and conveniences of beaches at their summer resorts and parks. The special master found, however, that the sewage of Chicago in its then untreated condition could not safely be returned to Lake Michigan nor could the diversion of water from Lake Michigan through the drainage canal be immediately cut down without serious risk to the health of the people of Chicago. He concluded that since it appeared that a diversion of 4,167 cfs was not sufficient to keep the Chicago River reversed at all times the Secretary of War was justified in authorizing an increase in the amount of the diversion from 4,167 cfs to 8,500 cfs upon the conditions imposed by the permit of March 3, 1925 which he found were designed, when complied with, to make possible a future reduction of the amount of the diversion. The special master accordingly recommended that the bills of complaint be dismissed without prejudice to the right of the plaintiff States to institute suit to prevent any unauthorized diversion of water from Lake Michigan.

## First Opinion on the Merits and Rereference to Special Master Hughes

Exceptions to the report were filed and argued and on January 14, 1929 this Court announced its opinion [278 U. S. 367]. The Court considered the effect and operation of the permit of March 3, 1925 and the scope of the authority of the Secretary of War to authorize an increase in the diversion from 4,167 cfs to 8,500 cfs. The Court called attention to the fact that if the reduction of the diversion to

4,167 cfs had been enforced the port of Chicago would have become practically unusable because of the deposit of sewage without a sufficient flow of water through the canal to dilute it and carry it away. The Court observed that except for the flow needed for the maintenance of navigation, the Secretary's permit derived its support entirely from a situation produced by the Sanitary District in violation of the rights of the plaintiff States. The Court concluded that insofar as the diversion was not for the purpose of maintaining navigation it was without legal basis because made for an inadmissible purpose and that the plaintiff States were entitled to a decree to bring the unwarranted part of the diversion to an end by reducing the diversion to a point where it rested on a legal basis thus restoring the navigable capacity of Lake Michigan to its proper level. Though the restoration of the rights of the plaintiff States would have to be gradual in order to give the Sanitary District time to provide other means for disposing of its sewage, it was to be continuous and as speedy as practicable. The Court accordingly referred the cases back to the special master to determine the practical measures needed to effect this objective and the period required for their completion and to report the form of an appropriate decree.

## Second Opinion on the Merits and Decree of April 21, 1930

The special master's report on rereference was filed on December 17, 1929. He recommended that the Sanitary District should be directed to construct controlling works to be completed and operating within two years after authorization by the Secretary of War. He also recommended that the Sanitary District should be directed to complete its program for sewage treatment by December 31, 1938 and that the direct diversion, exclusive of domestic pumpage, should be reduced on July 1, 1930 to an annual average of 6,500 cfs; upon construction of the controlling works to

an annual average of 5,000 cfs; and upon completion of all the sewage treatment works to an annual average of 1,500 cfs. Exceptions to the report were filed and argued and on April 14, 1930 the Court announced its opinion [281 U. S. 179] and on April 21, 1930 entered its decree pursuant thereto. The decree contained the following provisions:

"1. On and after July 1, 1930, the defendants, the State of Illinois and the Sanitary District of Chicago, their employees and agents, and all persons assuming to act under the authority of either of them, be and they hereby are enjoined from diverting any of the waters of the Great Lakes-St. Lawrence system or watershed through the Chicago Drainage Canal and its auxiliary channels or otherwise in excess of an annual average of 6,500 cubic feet per second in addition to domestic pumpage.

"2. That on and after December 31, 1935, unless good cause be shown to the contrary, the defendants, the State of Illinois and the Sanitary District of Chicago, their employees and agents, and all persons assuming to act under the authority of either of them, be and they hereby are enjoined from diverting any of the waters of the Great Lakes-St. Lawrence system or watershed through the Chicago Drainage Canal and its auxiliary channels or otherwise in excess of an annual average of 5,000 cubic feet per second in addition to domestic pumpage.

"3. That on and after December 31, 1938, unless good cause be shown to the contrary, the defendants, the State of Illinois and the Sanitary District of Chicago, their employees and agents, and all persons assuming to act under the authority of either of them, be and they hereby are enjoined from diverting any of the waters of the Great Lakes-St. Lawrence system or watershed through the Chicago Drainage Canal and its auxiliary channels or otherwise in excess of the annual average of 1,500 cubic feet per second in addition to domestic pumpage.

"4. That the provisions of this decree as to the diverting of the waters of the Great Lakes-St. Lawrence system or watershed relate to the flow diverted by the defendants exclusive of the water drawn by the City of Chicago for domestic water supply purposes and entering the Chicago River and its branches or the Calumet River or the Chicago Drainage Canal as sewage. The amount so diverted is to be determined by deducting from the total flow at Lockport the amount of water pumped by the City of Chicago into its water mains and as so computed will include the run-off of the Chicago and Calumet drainage area.

"5. That the defendant the Sanitary District of Chicago shall file with the clerk of this Court semi-annually on July first and January first of each year, beginning July first, 1930, a report to this Court adequately setting forth the progress made in the construction of the sewage treatment plants and appurtenances outlined in the program as proposed by the Sanitary District of Chicago, and also setting forth the extent and effects of the operation of the sewage treatment plants, respectively, that shall have been placed in operation, and also the average diversion of water from Lake Michigan during the period from the entry of this decree down to the date of such report.

"6. That on the coming in of each of said reports, and on due notice to the other parties, any of the parties to the above entitled suits, complainants or defendants, may apply to the Court for such action or relief, either with respect to the time to be allowed for the construction, or the progress of construction, or the methods of operation, of any of said sewage treatment plants, or with respect to the diversion of water from Lake Michigan, as may be deemed to be appropriate." [281 U. S. 696]

The decree did not enjoin the diversion of domestic pumpage or direct that the purified effluent from the

sewage treatment works of the Sanitary District be returned to the lake. As to this the Court stated in its opinion: "If the amount withdrawn [from the lake for domestic uses] should be excessive, it will be open to complaint." The Court further stated: "Whether the right for domestic use extends to great industrial plants within the District has not been argued but may be open to consideration at some future time" [281 U. S. 179, 200]. The Court specifically retained jurisdiction of the suits for the purpose of any order or direction, or modification of the decree, or any supplemental decree, which it might deem at any time to be proper in relation to the subject matter in controversy.

On June 26, 1930 the Secretary of War issued a permit to the Sanitary District of Chicago to divert water from Lake Michigan through its main drainage canal and auxiliary channels as specified in the decree of April 21, 1930. On July 3, 1930 Congress authorized an appropriation for the improvement of the Illinois Waterway from Lake Michigan to Utica, Illinois and provided that "the water authorized at Lockport, Illinois, by the decree of the Supreme Court of the United States, rendered April 21, 1930 . . . is hereby authorized to be used for the navigation of said waterway." [46 Stat. 929]

## Reference to Special Master McClennen and Enlargement of Decree

On October 3, 1932 the plaintiffs requested an order that the State of Illinois and the Sanitary District of Chicago show cause why they had not taken appropriate steps to effect compliance with the requirements of the decree of April 21, 1930. Thereafter the cases were referred to Edward F. McClennen, Esq., as special master with directions and authority to make summary inquiry and report to this Court [287 U. S. 578]. Special Master McClennen filed his report on March 13, 1933 giving his findings and recommendations. Exceptions to the report were filed and argued and on May 22, 1933 this Court announced its

opinion [289 U. S. 395] and on the same day entered an order enlarging the decree of April 21, 1930 by adding thereto the following provision:

> "That the State of Illinois is hereby required to take all necessary steps, including whatever authorizations or requirements, or provisions for the raising, appropriation and application of moneys, may be needed in order to cause and secure the completion of adequate sewage treatment or sewage disposal plants and sewers, together with controlling works to prevent reversals of the Chicago River if such works are necessary, and all other incidental facilities, for the disposition of the sewage of the area embraced within the Sanitary District of Chicago so as to preclude any ground of objection on the part of the State or of any of its municipalities to the reduction of the diversion of the waters of the Great Lakes-St. Lawrence system or watershed to the extent, and at the times and in the manner, provided in this decree." [289 U. S. 710]

The reports required by paragraph 5 of the decree of April 21, 1930 to be filed semi-annually by the Sanitary District with the Clerk of this Court were filed up to and including January 2, 1939. The last report recited that the works referred to in the decree were completed and that "therefore this will be the final semi-annual report unless this Court shall otherwise direct". No further reports were directed or filed.

## Reference to Special Master Lemann

On January 11, 1940 the State of Illinois petitioned for a modification of the decree of April 21, 1930 to permit a temporary increase in the diversion of 5,000 cfs, in addition to domestic pumpage, until December 31, 1942. It appears that, although the defendants were reducing the water diversion, completion of the sewage treatment program had been delayed and in consequence a condition had

been created in the Sanitary Canal and Illinois waterway which was claimed by the defendants to be dangerous to the public health. On April 3, 1940 this Court appointed Monte M. Lemann, Esq., as special master to make summary inquiry and report on the condition of the Illinois waterway [309 U. S. 569, 636]. Pursuant to stipulation entered into by counsel upon suggestion of the special master, this Court on November 25, 1940 entered an order authorizing the Sanitary District to temporarily increase its diversion to 10,000 cfs, in addition to domestic pumpage, for ten days beginning December 2, 1940, in an experimental effort to flush the waterway [311 U. S. 107]. Special Master Lemann filed his report on April 2, 1941 recommending that a decree be entered dismissing the petition for modification of the decree of April 21, 1930. Exceptions to the report were filed and argued and on May 26, 1941 the exceptions were overruled and the report confirmed [313 U. S. 547].

To meet emergencies in navigation caused by low water in the Mississippi River, the State of Illinois was permitted by this Court temporarily to increase its diversion to 8,500 cfs, plus domestic pumpage, from December 17, 1956 to February 28, 1957 [352 U. S. 945, 983].

## Applications for Reopening of Decree

On December 23, 1957 the plaintiffs filed an application for a reopening and amendment of the decree of April 21, 1930 so as to require the defendants to return to Lake Michigan the treated effluent derived from domestic pumpage. The application and a motion for modification of the decree which the State of New York had filed on December 20, 1957 were denied by this Court on March 3, 1958, with leave to renew them with allegations made more definite and certain as a basis for the relief sought [355 U. S. 944]. Thereafter, on November 3, 1958 the plaintiffs filed an amended application for the same relief. The amended application did not question the right of Illinois to take the domestic pumpage from Lake Michigan provided its effluent was returned to the Great Lakes basin, but demanded

a cessation of its permanent diversion from the basin in view of the fact, as it alleged, that the direct diversion of 1,500 cfs allowed by the decree of April 21, 1930 was adequate to maintain navigation in the port of Chicago and the Illinois waterway. The amended application alleged that Chicago now permanently diverts more than 1,800 cfs from Lake Michigan as domestic pumpage which amount has increased and will continue to increase beyond the limits which were estimated in 1930 and will become more and more excessive to the irreparable injury of the plaintiffs. It further alleged that the cessation of the permanent diversion of water from Lake Michigan as domestic pumpage will not injure or impair the health of the people of the Chicago area or the navigability of the port and waterways in that area. The amended application further averred that substantial damage to the plaintiffs has been and is being caused by the permanent diversion of water from Lake Michigan as domestic pumpage with the resultant artificial lowering of the levels of all of the Great Lakes below Lake Superior and their connecting channels and the St. Lawrence River above Montreal. It was alleged that such damage falls into four general classes, namely, (1) damage to navigation and commercial interests, (2) damage to riparian property of a non-navigational character, (3) damage to the proprietary and quasi-sovereign rights of the plaintiff States, and (4) damage and loss caused to the State of New York and her citizens by the defendants' diminution of the flow of the waters of the Niagara and St. Lawrence Rivers which are used for the generation of hydroelectric power at power sites on the Niagara River, which were then under construction, and on the St. Lawrence River, where the New York power project was then substantially completed and in operation. Parenthetically, it should be stated that both these power projects are now in full operation. The diversion by decreasing the carrying capacity of the large lake vessels, was claimed to result in an annual loss amounting to $4,000,000 in revenues and in an annual loss to New York's power project in the amount of more than $1,000,000.

By their amended application filed November 3, 1958 and their motion, filed April 30, 1959, to amend its prayer for relief, the plaintiffs asked this Court to require the defendants to return the treated effluent emanating from their sewage and industrial treatment facilities to the Great Lakes basin from which it originally came in the form of domestic pumpage or, if it should be determined that measures other than the return to Lake Michigan of the Chicago domestic pumpage effluent can be put into effect so that such measures will either reduce the direct diversion or limit or restrict the Chicago domestic pumpage to the end that the total amount of diversion of water from the Great Lakes at Chicago will be reduced or restricted, the Court should enter a supplemental or modified decree to that effect. Finally, they prayed that the Court grant such other relief in accordance with equity and good conscience as will insure to the greatest possible degree the future integrity and development of the Great Lakes reservoir so that the maximum use and benefit of its waters may be assured to the plaintiff States. Alternatively, they sought the appointment of a special master to hold hearings and make recommendations as to such modifications of the decree, and also the appointment of a permanent master with authority to maintain surveillance over the operating facilities of the Sanitary District. In opposition to the plaintiffs' application the defendants contended that Congress had authorized the present diversion and, therefore, no justiciable controversy was presented, and, moreover, that the plaintiff States had not shown adequate grounds for modification of the decree. The United States, in a brief filed as amicus curiae upon invitation from this Court, suggested, inter alia, the appointment of a special master to reevaluate the needs of all the parties in the light of new studies to be made and to recommend possible solutions to the conflicting problems presented.

## Complaint of Illinois on Behalf of Elmhurst-Villa Park-Lombard Water Commission

On January 21, 1959 the State of Illinois requested leave to file in this Court a complaint as No. 15, Original, October Term 1958, now designated as No. 11, Original, against the States of Michigan, Ohio, Pennsylvania, Minnesota, New York and Wisconsin. The complaint asserted the urgent need of the communities of Elmhurst, Villa Park and Lombard for water for domestic use in addition to the limited supply available from underground sources and the formation of the Elmhurst-Villa Park-Lombard Water Commission, an instrumentality of the State of Illinois, to obtain the needed water from Lake Michigan. The average amount of domestic pumpage required by the Commission was estimated at approximately 25 to 30 cfs during the next 20 years, with an estimated daily average withdrawal of 50 cfs by the year 2000. The communities proposed to be served are not located in the Great Lakes basin and their sewage effluent is presently discharged into the Mississippi watershed.

The complaint further alleged that the States of Michigan, Ohio and Pennsylvania had threatened legal action to halt the proposed abstraction of water from the Great Lakes. It further averred that the State of Illinois had the right to withdraw water from Lake Michigan for domestic purposes, that there is no legal obligation to return to the lake the sewage effluent resulting from the domestic use of the water, and that in any event the Commission has no function or power with respect to the disposition of wastes, the question of the return of sewage effluent to the lake being involved in other pending litigation. The complaint accordingly prayed for a judgment declaring the plaintiff, and its instrumentality, the Commission, entitled to proceed with its proposed program and to withdraw water from Lake Michigan for the domestic purposes of the Commission's sponsor municipalities and customers, and restraining the defendants from interfering therewith.

In answer to the complaint of the State of Illinois, the defendant State of Wisconsin asks that the complaint be dismissed as against it, or, that the case be treated as consolidated with the pending litigation since a common issue is involved, namely, whether water may be diverted from the Lake Michigan watershed to the Mississippi watershed for a purpose other than in aid of navigation.

The defendant State of New York also filed an answer claiming in affirmative defense, that the proposed diversion from the Great Lakes watershed would cause a lowering of the levels of the Great Lakes-St. Lawrence system in violation of federal law and United States-Canadian boundary-water treaties, and in violation of New York's proprietary and sovereign rights and would result in injury to its waterways and various recreational and commercial interests, especially to its hydroelectric power plants located on the Niagara and St. Lawrence Rivers where a diversion of 30 cfs would cause a loss in revenue in the amount of $34,400 annually. Additionally, New York alleged in affirmative defense that the authorization of the proposed diversion may become a precedent for similar diversions by numerous municipalities along and adjacent to the Great Lakes, which diversion in the aggregate could amount to large flows of water. Therefore, the State of New York counterclaimed for affirmative relief and prayed that the complaint be dismissed, and that judgment be entered enjoining Illinois and its instrumentality from diverting any waters from the Great Lakes watershed unless the effluent, after proper purification, is returned thereto, or, in the alternative, that this Court determine the extent of the injury to the State of New York and its citizens resulting from such diversion, insofar as the injury can be measured in monetary terms, and require Illinois and its instrumentality to make compensation therefor.

The defendant States of Michigan, Ohio and Pennsylvania answered, denying, inter alia, that the de minimis doctrine was here applicable and contending, also, that the proposed diversion of lake water would result in a lowering

of the levels of the Great Lakes to the injury of their commercial and recreational interests. In counterclaims for affirmative relief they prayed that the State of Illinois and its instrumentality be enjoined from diverting any lake water to the Mississippi River watershed, unless conditioned upon the return to Lake Michigan of the treated effluent, or, in the alternative, that the defendant States be compensated either in money or in other substituted water. They further prayed that the issues here raised be adjudicated with the pending litigation to the end that the rights, duties and obligations of the State of Illinois in the waters of Lake Michigan and the Great Lakes basin be determined as a whole and that the Court grant such further relief as will insure to the greatest possible degree the maintenance of the natural flow and volume of the waters belonging to the Great Lakes basin.

The State of Illinois has replied to these counterclaims contending, inter alia, that the States of Wisconsin, Michigan and New York presently divert waters naturally included in the Great Lakes watershed in such a manner as to affect the levels of Lakes Michigan, Huron and Erie; and that the withdrawals in each of these states far exceed the minimal withdrawal here proposed.

## Reopening of Decree of April 21, 1930 and Reference to the Present Special Master

On June 29, 1959 this Court entered an order granting the amended application for a reopening of the decree of April 21, 1930 in the cases now designated as Nos. 1, 2 and 3, Original, granting leave to file the complaint in the case now designated as No. 11, Original, and appointing the undersigned as special master in each of these cases, with authority to summon witnesses, issue subpoenas, and take such evidence as might be introduced and such as I might deem it necessary to call for. I was directed to hold hearings with all convenient speed and to submit such reports as I might deem necessary [360 U. S. 712].

On January 11, 1960 the Sanitary District of Chicago filed a suggestion of the change of its name to the Metropolitan Sanitary District of Greater Chicago, and on February 23, 1960 the latter was substituted as a party defendant in the cases now designated as Nos. 1, 2 and 3, Original [361 U. S. 956].

## Intervention by United States

On December 18, 1959 the United States moved to intervene in all four cases in support of its interests in (1) navigation on the Great Lakes, the St. Lawrence Seaway, and the Illinois waterway, (2) maintenance of friendly relations with Canada, (3) hydroelectric power development on the Niagara and St. Lawrence Rivers within the United States, (4) protection of the property belonging to the United States in and adjacent to the Great Lakes and connecting rivers and waterways, (5) protection of public health and control of pollution of the Great Lakes and related interstate waters, and (6) promoting the general welfare of all the United States in the utilization of the Great Lakes-St. Lawrence system as one of the great natural resources of the Nation. The intervention was granted by this Court on February 23, 1960 [361 U. S. 956] and the petitions for intervention and the answers thereto were referred to me as special master [362 U. S. 957, 958].

## Supplemental and Amended Complaint by New York

On October 21, 1959 the State of New York had moved for leave to file a supplemental and amended complaint in the action now designated as No. 3, Original, to plead the damage from defendants' diversion resulting to its production of hydroelectric power at its operating plant on the St. Lawrence River and to its prospective production of hydroelectric power at its plant under construction on the Niagara River, and otherwise to revise and bring its original bill of complaint down to date. In addition to alleging the damage suffered by the State of New York to its produc-

tion of hydroelectric power and restating the other elements of damage set out in the original complaint, the supplemental and amended complaint averred, inter alia, that the combined domestic and industrial pumpage of the City of Chicago now averages approximately 1,800 cfs, in addition to the direct diversion of 1,500 cfs, and is expected to increase rapidly in the immediate future due to expansion of population and industries and that the equitable considerations of relative hardship which precluded this Court from requiring an immediate termination of such diversion in 1930 are no longer applicable and were never applicable to the diversion of water from the watershed for the use of industrial plants. The supplemental and amended complaint asserted that the domestic and industrial pumpage could be materially reduced by reducing water waste, that the sewage effluent could be safely treated and returned to the Great Lakes watershed or purified to a degree where all or part of it might be used to support navigation in the Sanitary Canal and the present direct diversion of 1,500 cfs from Lake Michigan for that purpose discontinued. The supplemental and amended complaint prayed that any diversion of water from the Great Lakes for domestic or industrial purposes be enjoined unless the effluent, after proper purification, be utilized in whole or in part for navigation purposes in lieu of all or part of the 1,500 cfs presently being diverted for such purposes, or if this Court should determine that such diversion should not be absolutely enjoined, that the extent of the injury to the plaintiff resulting from the diversion be determined, insofar as the injury can be measured in monetary terms, and that the diversion be enjoined unless the defendants compensate the plaintiff for the injury. The motion to file such a supplemental and amended complaint was referred to me as special master on January 11, 1960 for an expression of my views as to the relationship of the matters presented therein to the issues of the case [361 U. S. 927]. On March 7, 1960 my report was filed and on the same day this Court granted the State of New York leave to file its supple-

mental and amended complaint [362 U. S. 908], which, together with the answer of the defendants and the response of the United States were referred to me as special master [362 U. S. 972].

## Proceedings of the Special Master

I held prehearing conferences on August 4, 1959 in Philadelphia and on October 19 and 20, 1959 in Chicago. On October 20, 1959 I made a prehearing order, a copy of which is included in the Appendix to this Report. Among other things, the prehearing order directed that the testimony-in-chief of expert witnesses should be reduced to writing, preferably in question and answer form, and copies thereof, including any exhibits proposed to be offered in evidence, should be furnished to opposing counsel and to me not less than two weeks in advance of the dates on which the witnesses were to be called upon to testify. All such witnesses appeared personally, were sworn, and testified orally from their prepared testimony, thus affording to counsel and to me an opportunity to observe them and hear their testimony and to make and dispose currently of any objections thereto. At the conclusion of the testimony-in-chief of each witness an opportunity was given to opposing counsel to ask clarifying questions but cross-examination was deferred, if so requested by counsel, for a reasonable period of time in order that counsel and their experts might first have an opportunity to study and check the testimony of the witness.

Thirty-seven separate sessions of hearings for the receipt of evidence were held, beginning October 21, 1959 and ending July 11, 1963, aggregating 158 hearing days. Testimony was taken in Chicago, Cleveland, Detroit, Duluth, Massena, Niagara Falls and Sault Ste. Marie. 158 witnesses were heard and approximately 1,300 exhibits received in evidence. In addition certain exhibits and stipulations of facts were received in evidence by me after July 11, 1963. The transcript totals 30,681 pages. Although

the procedure which was followed necessitated spacing the sessions of hearings several weeks apart with the result that they covered nearly four years, I am satisfied that the testimony, both that in chief and that adduced on cross-examination, was rendered much more concise and helpful by the procedure which was followed than it would have been if the witnesses had been required to testify in chief extemporaneously and if opposing counsel had been required to cross-examine them immediately thereafter. The latter procedure is, of course, that which is usually followed but if it had been followed here the transcript of the testimony, in view of the wide range of factual issues involved in these cases, might well have run to many thousands of additional pages.

Physical inspections were made by me, accompanied by counsel, of the sewage treatment works, canal system, locks and controlling works of the Metropolitan Sanitary District of Greater Chicago and the water filtration plants of the City of Chicago, the harbor, sewage treatment works and filtration plant of Milwaukee, the St. Marys River and the locks at Sault Ste. Marie, the harbors at Duluth and Superior and a taconite plant and harbor at Silver Bay, Minnesota, the Detroit Harbor, the Detroit River, Lake St. Clair and the St. Clair River, the Cleveland Harbor, the hydroelectric power generating plants and facilities of the New York State Power Authority on the Niagara River at Niagara Falls and Lewiston and on the St. Lawrence River at Massena, and the dams and locks on the St. Lawrence River which form part of the St. Lawrence Seaway. In addition, I made an automobile reconnaissance of the Fox River in Wisconsin from Portage to Green Bay.

Throughout the hearings and the subsequent proceedings involved in the preparation of my Report I have been greatly aided by the able and distinguished counsel who have appeared for the parties in this litigation. Their excellent work and their cooperation with me and with each other in adducing the many facets of facts which are involved and in reaching agreement upon many of them has

rendered my task less burdensome than it might otherwise have been. Their work has accorded to the highest standards of the profession and I wish to acknowledge it with gratitude.

From the evidence which I have received, illumined by the physical inspections which I have made, I make the findings of fact which follow in this report.

# Findings of Fact

## I. Geography of Great Lakes–St. Lawrence River Basin

### A. Great Lakes Basin

I-1. The Great Lakes-St. Lawrence River basin extends a distance of some 2,000 miles from the western end of the Lake Superior basin in Minnesota to the Gulf of St. Lawrence on the Atlantic Ocean. A map of the Great Lakes-St. Lawrence River basin, in its natural state, Lake States Exhibit 19B,* is included in the Appendix to this Report.

I-2. The total area of the Great Lakes basin, both land and water, above the head of the St. Lawrence River at the eastern end of Lake Ontario is approximately 295,000 square miles.

I-3. The five Great Lakes, Superior, Michigan, Huron, Erie, and Ontario, together with their connecting rivers and Lake St. Clair, have a water surface area of 95,000 square miles above the head of the St. Lawrence River.

I-4. The international boundary between Canada and the United States passes through all of the Great Lakes and their connecting channels, with the exception of Lake Michigan which is entirely within the United States, and follows the center of the St. Lawrence River to a point near Cornwall, Ontario, where the boundary turns eastward to continue along a line between the State of New York and the Province of Quebec. Downstream (northeast) of this point, the St. Lawrence is entirely within Canada.

I-5. Eight States of the United States border on the Great Lakes-St. Lawrence River basin. They are Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and New York. The Canadian Province of Ontario borders on all of the Great Lakes, except Lake Michigan,

* Hereinafter Lake States Exhibits will be referred to as L. S. Ex.; Illinois Exhibits as Ill. Ex.; United States Exhibits as U. S. Ex.

and on the St. Lawrence River to a point near Cornwall, Ontario. At this point, the St. Lawrence flows into the Province of Quebec and finally discharges into the Atlantic. Cities bordering on the lakes include Duluth, Minnesota; Milwaukee, Wisconsin; Chicago, Illinois; Gary, Indiana; Detroit, Michigan; Toledo, Ohio; Cleveland, Ohio; Erie, Pennsylvania; Buffalo, New York; Rochester, New York; and Toronto, Ontario. On the St. Lawrence is Montreal, Quebec.

I-6. As shown on L.S. Ex. 19B the perimeter of the Great Lakes drainage basin runs close to the lakes. The minimum distance between Lake Ontario and the perimeter of the drainage basin is about 35 miles in New York. The minimum distance between Lake Erie and the perimeter of the drainage basin is about four miles in New York, about four miles in Pennsylvania, and about 20 miles in Ohio. The minimum distance between Lake Michigan and the perimeter of the drainage basin is about ten miles in Indiana, about two miles in Illinois and about three miles in Wisconsin. The minimum distance between Lake Superior and the perimeter of the drainage basin is about 24 miles in Wisconsin and about 20 miles in Minnesota. The State of Michigan is entirely within the Great Lakes drainage basin.

## B. Lakes and Connecting Channels

### 1. *In General*

I-7. The datum for lake levels of the Great Lakes was, until recently, based on mean tide New York and was known as United States Lake Survey Datum, 1935 (U.S.L.S. 1935 Datum). As of January 1, 1962 a new datum for lake levels became effective. The new datum is based on mean water level at Father Point, Quebec, and is known as the International Great Lakes Datum, abbreviated as IGLD (1955). The change in datum has no effect on existing water levels, available drafts, or channel and harbor depths. Unless otherwise indicated, the levels used throughout these Findings will be based on U.S.L.S. 1935 Datum.

I-8. Low Water Datum (hereinafter abbreviated as LWD) is a plane of reference to which design dredged depths and the depths recorded in charts and navigational aids are usually related. The actual levels of the lake surface may be higher or lower than the LWD plane. For example, a channel dredged to a design channel depth of 27 feet would provide a minimum depth of 27 feet between the LWD plane and the bottom of the channel. If the channel depth at a given point were 27 feet below the LWD plane, the actual depth at that same point would be 26 feet if the water level were one foot below the LWD plane; similarly, if the water level were one foot above the LWD plane at the same point, the actual depth at that point would be 28 feet. Since Lake Erie has usually been about 0.5 foot higher with respect to its LWD plane than Lakes Michigan, Huron and Superior have been with respect to their LWD planes, the United States Corps of Engineers has taken this fact into account when designing navigation channels influenced by Lake Erie levels.

2. *Lake Superior*

I-9. Lake Superior, the uppermost and largest of the Great Lakes, has an average water surface elevation of about 602 feet above mean tide New York and a water surface area of about 31,800 square miles. Discharge from the lake flows through the St. Marys River into Lake Huron, the level of which is some 22 feet lower than Lake Superior. During the period 1860 to 1954 the average rate of discharge from Lake Superior was about 75,000 cubic feet per second (cfs).

I-10. The natural supply of water to Lake Superior has been increased by diversions by Canada of water naturally tributary to Hudson Bay from the Albany River basin through the Long Lake and Ogoki projects in Ontario, Canada, which diversions began in 1939 and 1943, respectively. From 1945 through 1964 the sum of these diversions has been at an average rate of about 5,390 cfs. The Long

Lake-Ogoki diversions into Lake Superior increase the water supply to all the Great Lakes.

I-11. Mean monthly diversions into Lake Superior from the Albany River basin via the Long Lake and Ogoki projects from their beginning through December 1964, expressed in cfs, were as follows:

| Year | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | OCTOBER | NOVEMBER | DECEMBER | YEARLY AVG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1939 | | | | | | | 105 | 365 | 369 | 190 | 0 | 0 | |
| 1940 | 0 | 0 | 0 | 0 | 578 | 847 | 1122 | 1281 | 881 | 0 | 0 | 0 | 392 |
| 1941 | 212 | 723 | 612 | 668 | 1489 | 1621 | 1402 | 1216 | 1288 | 1205 | 1737 | 1550 | 1144 |
| 1942 | 1235 | 939 | 725 | 724 | 1780 | 2307 | 1927 | 1607 | 1270 | 550 | 2092 | 1876 | 1419 |
| 1943 | 1466 | 1143 | 866 | 705 | 1607 | 2281 | 3152 | 4209 | 5053 | 5468 | 5316 | 4530 | 2983 |
| 1944 | 3978 | 3380 | 2668 | 2435 | 4666 | 8028 | 7366 | 2960 | 2317 | 3837 | 2811 | 2564 | 3918 |
| 1945 | 2882 | 2052 | 1937 | 2574 | 3608 | 7113 | 8696 | 6388 | 3767 | 3733 | 3980 | 3697 | 4202 |
| 1946 | 3312 | 2872 | 2785 | 3777 | 10061 | 12484 | 10627 | 5652 | 3807 | 4671 | 7351 | 7287 | 6224 |
| 1947 | 5075 | 3990 | 2950 | 2425 | 7635 | 8500 | 9845 | 5180 | 4950 | 4035 | 3390 | 3720 | 5141 |
| 1948 | 3550 | 2835 | 2165 | 2560 | 8200 | 9315 | 9075 | 7590 | 4565 | 3335 | 3330 | 4700 | 5102 |
| 1949 | 3705 | 3435 | 3515 | 4855 | 10265 | 10430 | 5435 | 4745 | 3610 | 3645 | 4595 | 4940 | 5265 |
| 1950 | 5025 | 4420 | 3875 | 3470 | 8930 | 2290 | 2315 | 2115 | 6984 | 3550 | 6845 | 6655 | 4706 |
| 1951 | 4755 | 3725 | 3065 | 2550 | 4645 | 2970 | 3575 | 4700 | 3980 | 7575 | 7540 | 9440 | 4877 |
| 1952 | 6320 | 4880 | 3773 | 1945 | 985 | 2095 | 2040 | 1540 | 1270 | 1245 | 880 | 3420 | 2533 |
| 1953 | 6125 | 3870 | 3185 | 3220 | 5355 | 9305 | 9305 | 1250 | 1350 | 3215 | 7925 | 5240 | 4945 |
| 1954 | 7490 | 5605 | 4395 | 3890 | 7525 | 2585 | 1270 | 5985 | 5920 | 5940 | 6395 | 7560 | 5380 |
| 1955 | 5102 | 4505 | 3990 | 4086 | 9723 | 10870 | 9762 | 5611 | 4265 | 3795 | 4419 | 4678 | 5901 |
| 1956 | 4328 | 3892 | 3468 | 3263 | 4769 | 14565 | 11344 | 6935 | 4807 | 4411 | 4374 | 4630 | 5899 |
| 1957 | 3804 | 3130 | 2865 | 3242 | 9424 | 9950 | 2645 | 6617 | 4423 | 4218 | 5489 | 4542 | 5029 |
| 1958 | 3887 | 3828 | 3548 | 3817 | 8897 | 11370 | 8237 | 5876 | 5356 | 7203 | 8677 | 6865 | 6463 |
| 1959 | 5597 | 4951 | 3804 | 3602 | 5142 | 12181 | 12796 | 9148 | 6694 | 6143 | 5226 | 4774 | 6672 |
| 1960 | 4057 | 3960 | 3288 | 3218 | 5895 | 9877 | 7722 | 4866 | 3507 | 2722 | 3503 | 3894 | 4709 |
| 1961 | 3844 | 3697 | 3419 | 3493 | 9411 | 13165 | 7825 | 4887 | 3510 | 4010 | 4720 | 4090 | 5506 |
| 1962 | 3960 | 4040 | 3450 | 3210 | 4790 | 10250 | 8650 | 7780 | 7960 | 5910 | 4570 | 3960 | 5711 |
| 1963 | 3880 | 3590 | 3090 | 3190 | 4340 | 8310 | 7040 | 9890 | 9090 | 5930 | 4200 | 3710 | 5520 |
| 1964 | 3580 | 3400 | 3100 | 3430 | 11160 | 12780 | 7370 | 12120 | 10620 | 12670 | 9350 | 6630 | 8014 |

I-12. A gated control structure, placed at the outlet of Lake Superior by the United States and Canada, regulates the discharge from and the levels of Lake Superior. The control structure is operated by the International Lake Superior Board of Control under the supervision of the International Joint Commission (I. J. C.). [See Finding II-37]

3. *St. Marys River*

I-13. The St. Marys River, the outlet of Lake Superior, flows in a general southeasterly direction through several channels over a distance of about 70 miles to Lake Huron. More than 90 per cent of the 22-feet drop from Lake Superior level to Lake Huron level occurs in the mile-long rapids at St. Marys Falls at Sault Ste. Marie. In addition to channels dredged to a minimum of 27 feet in depth at LWD throughout the length of the river, four parallel locks on the United States side and a single lock in Canada permit ships to bypass the rapids. Hydroelectric power stations on both sides of the St. Marys River utilize the drop from above to below the rapids to produce power.

4. *Lake Michigan*

I-14. Lake Michigan has an average water surface elevation of about 580 feet above mean tide New York and a water surface area of about 22,400 square miles. Lake Michigan is connected with Lake Huron by the broad and deep Straits of Mackinac. Temporarily, there may be appreciable currents in either direction through the straits because of winds or differentials in barometric pressures over the surfaces of the two lakes, but, on the average, there is a movement of water from Lake Michigan to Lake Huron, which the evidence indicates is somewhere between 40,000 and 55,000 cfs. The two lakes stand at virtually the same level; they are treated as one lake in hydrologic considerations.

I-15. Water from Lake Michigan and its drainage basin is diverted at Chicago, Illinois, into the valley of the

Des Plaines River, a tributary of the Illinois River, and a part of the Mississippi River basin. In the order of 1,700 cfs is pumped from Lake Michigan by the City of Chicago and by other cities in the Sanitary District for domestic and industrial purposes and after use this water is discharged into the waterways in the Chicago area and flows into the Mississippi River basin. In addition, surface runoff that in a state of nature would flow into Lake Michigan and water diverted directly from Lake Michigan, a total amount in the order of 1,500 cfs, is caused to flow through the waterways in the Chicago area into the Mississippi River basin. By these means the water supplied to all of the Great Lakes, except Lake Superior, is reduced in the order of 3,200 cfs.

I-16. Lake Michigan is divided by a submarine ridge into two basins, a northern basin and a southern basin. The ridge lies at an average depth of approximately 232 feet below the water's surface. The deepest portion of the ridge is between 325 and 336 feet below the water's surface, and the shallowest mid-lake portion is approximately 195 feet below the water's surface.

I-17. The bottom topography of Lake Michigan is shown on two maps, Ill. Ex. 646, drawn with 100-foot contour intervals, and Ill. Ex. 647, drawn with 50-foot contour intervals. These maps are included in the Appendix to this Report.

I-18. The total volume of Lake Michigan is $1.64 \times 10^{14}$ cubic feet (1,116 cubic miles). The volume of Lake Michigan's southern basin is $4.07 \times 10^{13}$ cubic feet (277 cubic miles). The water surface of the southern basin is about 31 percent of the lake's total water surface area. The volume of the southern basin is about 25 percent of the lake's total volume.

I-19. Currents in Lake Michigan are set in motion by physical forces, principally wind stresses acting on the water surface and thermal forces. It is recognized that the

direction and magnitude of the wind and the shape of the lake basin are important factors affecting the direction of current movements in Lake Michigan.

5. *Lake Huron*

I-20. Lake Huron, standing at the same elevation as Lake Michigan, has a water surface area of 23,000 square miles. The outlet from Lakes Michigan-Huron is through the St. Clair River, Lake St. Clair, and the Detroit River into Lake Erie, which is approximately eight feet lower than the level of Lake Huron. From 1860 to 1954 the rate of discharge averaged about 189,000 cfs.

6. *St. Clair River, Lake St. Clair and Detroit River*

I-21. The distance from the outlet of Lake Huron through the St. Clair River, Lake St. Clair, and the Detroit River to Lake Erie is about 84 miles. The slopes of the water surface profiles of the two rivers are relatively uniform; there are no rapids or falls, and no locks required for navigation. The channels have been dredged to a depth of at least 27 feet at LWD.

7. *Lake Erie*

I-22. Lake Erie has an average water surface elevation of about 572 feet above mean tide New York and a water surface area of 9,900 square miles. The natural outlet for the discharge from Lake Erie is the Niagara River which flows into Lake Ontario some 326 feet lower than the level of Lake Erie. Water from Lake Erie also reaches Lake Ontario by way of the Welland Canal and the tailrace of De Cew Falls hydroelectric power plant, located about three miles west of the Welland Canal. The De Cew Falls plant draws its water from the Welland Canal. Water from the Welland Canal also reaches the Niagara River via the Welland River and the power canal of the Sir Adam Beck No. 1 hydroelectric power station. From 1860 to 1954 the total rate of discharge into Lake Ontario from Lake Erie

averaged about 205,000 cfs, about 7,000 cfs of which flows through the Welland Canal at present. Water from the Niagara River above the falls also reaches Lake Ontario by way of the New York State Barge Canal. There are also diversions of Lake Erie water around Niagara Falls caused by withdrawals for domestic and industrial use at the cities of Niagara Falls, New York; Lockport, New York; Niagara Falls, Ontario; St. Catharines, Ontario, and Thorold, Ontario. The diversions for Lockport and Niagara Falls, New York, amount to 102 cfs.

I-23. Marine traffic between Lakes Ontario and Erie passes through the Welland Canal, which has been deepened to 27 feet. Barge traffic passes between Lakes Erie and Ontario via the New York State Barge Canal.

8. *Niagara River*

I-24. The Niagara River flows in a general northerly direction from the east end of Lake Erie, descending about 10½ feet in a distance of about 22 miles to the rapids above Niagara Falls. Here the river drops about 50 feet in a short reach above the falls and then plunges over the crest for a drop of 172 feet. From the foot of the falls, an additional descent of about 93 feet occurs in the eight miles of rapids to Lewiston, and thence about one-half foot in the deep, quiet 6½ miles reach of the lower river to Lake Ontario.

I-25. Hydroelectric power stations on both sides of the Niagara River utilize the drop between the upper and lower reaches of the river to generate electricity. The plants take water from the Niagara River above Niagara Falls and return it below the falls.

9. *Lake Ontario*

I-26. Lake Ontario has an average water surface elevation of about 246 feet above mean tide New York and a water surface area of about 7,500 square miles. Discharge from Lake Ontario flows into the Atlantic Ocean by way of

the St. Lawrence River. From 1860 to 1954 the average rate of discharge of Lake Ontario was about 241,000 cfs.

10. *St. Lawrence River*

I-27. The St. Lawrence River is the natural outlet for the entire drainage basin of the Great Lakes. From the outlet of Lake Ontario at Cape Vincent, New York, to Father Point, Quebec, which marks its transition into the Gulf of St. Lawrence, the river falls 246 feet in a distance of 533 miles. From Lake Ontario downstream 64 miles to Ogdensburg, New York, the river is generally wide and deep. Only about one foot of fall occurs in this reach. The major portion of the fall of the St. Lawrence, some 225 feet, occurs in the next 120 miles extending from Ogdensburg to Montreal, Quebec. Most of the remaining 20 feet of fall occurs in the 160-miles reach between Montreal and the City of Quebec. The 120-miles reach between Ogdensburg, New York, and Montreal, Quebec, is divided geographically into two sections, the International Rapids section, between Ogdensburg and Cornwall, Ontario, where the river enters wholly into Canada; and the Canadian section between Cornwall and Montreal. In the International Rapids section, the St. Lawrence hydroelectric power project, utilizing a head of about 81 feet, has been constructed jointly by agencies of the United States and Canada. In the Canadian section, Canadian agencies own and operate two hydroelectric generating plants, Beauharnois and Cedars. Various Canadian plans for the construction of hydroelectric power generators at Lachine Rapids, further downstream, have been proposed but have not gone beyond the planning stage.

I-28. Until the St. Lawrence Seaway was opened in 1959, the reach of the St. Lawrence River between Ogdensburg and Montreal was navigable via a series of canals and locks that had a controlling depth of 14 feet. The Seaway, consisting of a series of locks, dikes and channels provides depths of at least 27 feet. From the Atlantic to Montreal, the project depth of dredged channels in the St. Lawrence is 35 feet.

## II. International Agreements and Related Documents

### A. Niagara River and Falls

II-1. There have been a number of agreements among Great Britain, Canada and the United States regarding the use and diversion of the waters in and around Niagara Falls. The Boundary Waters Treaty was executed by Great Britain and the United States in 1909, and is still in full force and effect except for paragraphs 3, 4 and 5 of Article V. The Treaty, identified as U. S. Ex. 5C, is included in the Appendix to this Report.

II-2. Of the 20,000 cfs referred to in the third paragraph of Article V of the 1909 Treaty which the United States might authorize and permit diverted above the falls for power purposes, the Federal Power Commission on March 2, 1921 issued a license to the Niagara Falls Power Company to utilize 19,500 cfs of the United States share of these treaty waters. The Hydraulic Race Company was subsequently licensed to utilize 275 cfs at its Lockport plant, and, at the same time, the Niagara Falls Power Company license was amended to permit it to use the remaining 225 cfs. In 1928, the Lockport development was substantially abandoned and the 275 cfs used there transferred on a revocable basis to Niagara Falls Power Company. From 1928 to 1956, the entire 20,000 cfs was actually used at the Schoellkopf plant.

II-3. Chandler P. Anderson, specially retained by the Secretary of State, the Honorable Elihu Root, in connection with the negotiation of the 1909 Treaty, wrote George Gibbons, a member of the International Waterways Commission representing Canada and the principal Canadian draftsman of the 1909 Treaty, forwarding a draft of the Treaty, dated December 3, 1908, and pointing out that in that draft all reference to the Chicago Drainage Canal and diversions to it had been omitted. In reply thereto, Mr. Gibbons wrote Mr. Anderson on December 10, 1908, as follows:

"Yours received this morning with the draft re Niagara. We seem now to have got everything in fair shape except Article 2. You must see that this is not in satisfactory shape. Yielding to Mr. Root's suggestion, we have left out the provision dealing with Chicago. As the matter stands now, under Article 2 unlimited diversion is authorized at Chicago and in Minnesota.

"It happens in the working out of matters that the new Article 4, dealing with obstructions, will work to the advantage of your people, I think, in every case. I have no objection to it because I think it is right on principle, but I think that the other principle adopted by our Commission was right also,—that diversion should not be permitted having an injurious effect upon interests in the other country.

"I am quite content, however, to waive this very important point for the sake of the general treaty, and because I feel that, as a whole, Mr. Root is dealing with the matter fairly and in a broad spirit, but it is impossible to let this Article 2 go without some restriction.

"I do not want to interfere with the sovereign right of each nation to deal with its own, but Article 2 as it now stands would justify any diversion, no matter how injurious to the public interests, in boundary waters or in the other country.

"I think it would be wise to get this matter into shape before seeing Sir Wilfred, and therefore am postponing my visit to Ottawa until I hear from you again. I propose when there to try and get the Milk River matter into shape also. It did seem that the provision which we drew when in Washington ought to be added in Article 2. If that is not acceptable, how would this do:

" 'Nothing in this Article is intended to authorize diversions in one country which will seriously interfere with public rights of navigation in boundary

waters or in waters at a lower level than the boundary in rivers flowing across the boundary; and while each of the High Contracting Parties reserves its sovereign right of dealing with such diversions, each recognizes that it is desirable that such right should not be unnecessarily exercised to the injury of public interests in such boundary waters or in waters at a lower level than the boundary in rivers flowing across the boundary.' "

In reply, Mr. Anderson wrote Mr. Gibbons on December 14, 1908 as follows:

"Replying to your letter of the 10th instant, it seems to me that the reservation which we thought should be made in regard to the effect of Article II of the treaty now under consideration would be fully covered by the following provision to be added as a separate paragraph at the end of that Article:

" 'It is understood, however, that neither of the High Contracting Parties intends by the foregoing provision to surrender any right, which it may have, to object to any interference with or diversions of waters on the other side of the boundary the effect of which would be productive of material injury to the navigation interests on its own side of the boundary.'

"This has the advantage of requiring no explanation."

On December 16, 1908, Mr. Gibbons replied to Mr. Anderson:

"Your provision in Article 2 seems to meet the case."

In a memorandum prepared by Mr. Anderson for the Foreign Relations Committee of the United States Senate, Mr. Anderson said with reference to the finally approved draft of the Treaty:

"*Lake Michigan.*—The waters of Lake Michigan do not come within the definition of boundary waters

as defined in the preliminary article of the Treaty and it will be noted that in Article I of the Treaty, the waters of this lake are not included among the boundary waters of the Great Lake system but are covered by a special provision in the second paragraph of that article. The question has arisen as to the effect upon Lake Michigan of the provisions of Article II which deals with tributary waters or rather with all waters which in their natural flow would flow across the boundary or into boundary waters, and the objection is made that if the provisions of this Article apply to Lake Michigan, the right to recover damages for injuries resulting on the other side of the line on account of the diversion of tributary waters might interfere with the diversion of the waters of Lake Michigan for the purposes of the Chicago Canal."

Secretary Root, appearing before the Senate Committee on Foreign Relations on January 20, 1909, testified with regard to Article II as follows:

"* * * The treaty starts with defining the boundary waters as the waters from main shore to main shore of the lakes and rivers and connecting waterways, or the portions thereof along which the international boundary between the United States and the Dominion of Canada passes, including all bays, arms, and inlets thereof, but not including tributary waters which in their natural channels would flow into such lakes, rivers, and waterways or waters flowing from such lakes, rivers, and waterways.

* * * *

"* * * The great bulk of the water goes on the Canadian side, and the Waterways Commission that was appointed some time ago to deal with the question of the lake levels reports, I think, that 36,000 feet can be taken out on the Canadian side and 18,500 on the American side, without injury to the Falls. I thought it wise to follow the report of the Commission and I

put in 1500 feet in addition to get round numbers, so our limit is higher than we want but their limit could not be cut down below what it is because there are three companies on the Canadian side who have the right and works there. * * *

"Then there is this further fact why we could not object to this 36,000 provision on the Canadian side. We are now taking 10,000 cubic feet a second out of Lake Michigan at Chicago, and I refused to permit them to say anything in the treaty about it.

* * * *

"The definition of boundary waters was carefully drawn in order to exclude Lake Michigan. * * *

"The last paragraph of Article II reserves our right to object to any interference with or diversions of waters on the other side of the boundary, the effect of which would be productive of material injury to the navigation interests on its own side of the boundary.

"* * * In the third place [referring to the reasons for allowing the United States to divert but 20,000 cfs, while Canada was allowed 36,000 cfs] they consented to leave out of this treaty and reference to the drainage canal, and we are now taking 10,000 cubic feet per second for the drainage canal which really comes out of this lake system."

II-4. In 1925, the Supreme Court handed down a decision in the case of *Sanitary District of Chicago v. United States*, 266 U. S. 405, a bill in equity brought by the United States to enjoin the Sanitary District of Chicago from diverting water from Lake Michigan in excess of 250,000 cubic feet per minute [4,167 cfs]. The Court granted the injunction, saying with regard to the 1909 Treaty as follows:

"[The United States] has a standing in this suit not only to remove obstruction to interstate and for-

eign commerce, the main ground, which we will deal with last, but also to carry out treaty obligations to a foreign power bordering upon some of the Lakes concerned * * *. With regard to the second ground, the Treaty of January 11, 1909, with Great Britain, expressly provides against uses 'affecting the natural level or flow of boundary waters' without the authority of the United States or the Dominion of Canada within their respective jurisdictions and the approval of the International Joint Commission agreed upon therein." [266 U. S. 425-426].

II-5. A Special International Niagara Board was formed in 1926 to determine how the scenic beauty of Niagara Falls and Rapids could best be maintained, and by what means and to what extent the impairment thereof by erosion or otherwise could be overcome and consistent with the preservation of the scenic beauty of the falls and river, to determine what quantity of water additional to that permitted to be diverted by the Boundary Waters Treaty might be diverted temporarily or permanently. The Board recommended early construction of an initial phase of remedial works and outlined further measures to be considered for preservation of the beauty of the falls which might also permit additional diversions for power purposes.

II-6. On October 14 and 31 and November 7, 1940 the Governments of the United States and Canada exchanged a series of notes which provided that in the interest of Canada's war effort, and contingent upon the Province of Ontario agreeing to provide immediately for diversions into the Great Lakes system of waters from the Albany River Basin which normally flow into Hudson Bay, the United States would interpose no objection, pending the conclusion of a final agreement between the two countries, to the immediate utilization for power at Niagara Falls by the Province of Ontario of additional waters equivalent in quantity to the diversions into the Great Lakes. For the purposes of these notes, this quantity was considered to be 5,000 cfs. These notes, identified as U. S.

Ex. 5E, are included in the Appendix to this Report. These diversions actually took place at Long Lake and Ogoki [See Findings I-10 and I-11].

II-7. Temporary additional diversions over those provided for in the 1909 Treaty were authorized for emergency power purposes by exchanges of notes between Canada and the United States in 1940, 1941 and 1948. The Niagara River Water Diversion Treaty of 1950 provided that the diversion authorized by the 1940 notes referred to in Finding II-6 should continue to be governed by the provisions of those notes. The notes of May 20, October 27 and November 27, 1941 provided for an additional diversion from the Niagara River for the duration of the emergency and subject to reconsideration on October 1, 1942 of 12,500 cfs on the United States side and 9,000 cfs on the Canadian side. On December 23, 1948 a further note allowed an additional diversion of 6,500 cfs by Canada for power purposes. Of this total amount 2,500 cfs in terms of daily aggregate were to be taken only during the non-navigation season. The latter Agreement was, by its terms, to be operative provisionally as of December 23, 1948, and was to enter into force definitively when approved by the United States Senate. The terms of the Agreement provided that if it were rejected by the United States Senate, the Agreement was to terminate thereupon, and the diversions provided therein were to be discontinued. The diversions were to terminate not later than April 15, 1951, were to be reviewed periodically and were to be used only through the existing hydroelectric facilities.

II-8. The initial phase of the remedial works recommended by the Special International Niagara Board, consisting of a submerged weir in the Niagara River about one mile above the Horseshoe Falls, was constructed during the period 1942 to 1947. The weir substantially compensated for the lowering effect of the power diversions on the Chippawa-Grass Island pool and increased the flow over the American Falls. It did not improve the conditions on the flanks of the Horseshoe Falls, where, due to erosion of

the soft limestone of the rocks, the flow had become concentrated in the central portion.

Under the diversions for power and other purposes existing from 1948 to 1953, the submerged weir in the Niagara River had the effect of raising the level of the Chippawa-Grass Island pool about one foot and of raising the level of Lake Erie somewhere between one-tenth and two-tenths of a foot. This submerged weir was drowned out by the control structure constructed between 1953 and 1957, referred to in Finding II-11.

II-9. The Niagara River Water Diversion Treaty of 1950 terminated the provisions of the 1909 Treaty which dealt with the right of the United States to authorize and permit diversion of 20,000 cfs of the flow of the Niagara River and the right of Canada to authorize or permit the diversion of 36,000 cfs, and the provisions embodied in the notes exchanged on May 20, 1941, October 27, 1941, November 27, 1941 and December 23, 1948, regarding temporary diversions of water of the Niagara River for power purposes. The Treaty, identified as U. S. Ex. 5B, is included in the Appendix to this Report.

II-10. The Senate, on August 9, 1950, advised and consented to the ratification of the 1950 Niagara River Water Diversion Treaty with the following reservation:

> "The United States on its part expressly reserves the right to provide by Act of Congress for redevelopment, for the public use and benefit, of the United States' share of the waters of the Niagara River made available by the provisions of the Treaty, and no project for redevelopment of the United States' share of such waters shall be undertaken until it be specifically authorized by Act of Congress". [1 U.S.T. 694, 699].

This reservation was accepted by Canada and was included in the protocol of exchange of ratifications.

II-11. A number of bills were introduced in Congress providing for federal, state or private development of this additional flow for power purposes. None of the bills

achieved passage in both Houses of Congress until 1957, when the Act of August 21, 1957, 71 Stat. 401, P. L. 85-159, was enacted. This act directed the Federal Power Commission to issue to the Power Authority of the State of New York a license for a project to utilize all water allocated to the United States under the 1950 Treaty. The act required that the Power Authority pay to the United States, and include in its net investment in the project, the United States' share of the cost of construction of the remedial works in the Niagara River which were constructed pursuant to the 1950 Treaty. [See Finding X-301] The portion of these works containing the first 13 gates was constructed pursuant to the I.J.C.'s order by The Hydro-Electric Power Commission of Ontario, under the supervision of the International Niagara Board of Control. Parts of the undertaking, including channel excavation, were done by the Corps of Engineers. The design details of the entire works were reviewed for the United States Section of the Board by the Corps of Engineers.

As originally constructed, the remedial works comprised 13 gates, extending approximately 1,550 feet into the river from the Canadian shore. Five additional gates were subsequently constructed. The entire structure now extends approximately 2,150 feet from the Canadian shore, the river being about 4,000 feet wide at this point. The International Joint Commission, in a report entitled the "Preservation and Enhancement of Niagara Falls", dated May 5, 1953, stated the objectives and purposes of the remedial works, as follows:

> "OBJECTIVES.
>
> "In conducting the studies for this report, it was considered imperative that the remedial works be designed to improve the distribution of flow along the crest of the Horseshoe Falls, maintain the present satisfactory conditions at the American Falls, and control the levels of the Chippawa-Grass Island Pool. The maintenance of the present relationship between river

flow and Pool level is considered essential. Such regulation would preserve the existing conditions and appearance of the Niagara River upstream from the Pool and would ensure that Lake Erie levels and corresponding outflows would remain unaffected, thus protecting interests upstream which otherwise might be affected adversely by a general lowering or rapid variation in the Pool level. In addition, adequate flow down the American Rapids and over the Falls would be assured. Full advantage could be taken of the additional water available for power diversions in the night hours of the tourist season as well as at all other times."

Therefore, it was considered that the remedial works should ensure:

"(a) A dependable flow of water over the American Falls and in the vicinity of Three Sisters Islands, approximating the satisfactory flow under existing conditions;

"(b) A dependable adequate flow over both flanks of the Horseshoe Falls sufficient to provide an unbroken crest line;

"(c) Maintenance of the present relationship between total river flow and the level of the Chippawa-Grass Island Pool; and,

"(d) Ability to meet promptly the changes in permissible power diversions while assuring flows of either 50,000 or 100,000 cubic feet per second over the Falls."

II-12. The remedial works which consisted of excavations in river bed areas on both flanks of Horseshoe Falls, land fills at ends of the flanks, and the 13-gate control structure in the Niagara River referred to in Finding II-11 were commenced in 1953 and completed in 1957.

II-13. Diversions of water from the Chippawa-Grass Island pool, if not compensated for, have the effect of lowering the levels of Lake Erie.

II-14. It was thought by the Corps of Engineers at the time of the preparation of Senate Document No. 28, 85th Cong. (L. S. Ex. 19H) that the control structure with 13 gates could not only maintain the levels of the Chippawa-Grass Island pool and Lake Erie with the diversions authorized under the 1950 Treaty, but also that the structure could be operated to compensate for any effect on Lake Erie levels that would result from 1,000 cfs additional diversion at Chicago.

II-15. Prior to February 1960, information was acquired by the Corps of Engineers that indicated that the control structure could not accomplish all of the purposes for which it was designed and at the same time be operated to compensate for lowering of Lake Erie levels that would result from an increased diversion of 1,000 cfs at Chicago.

II-16. Work on construction of five additional gates to the control structure was commenced in 1961 and has since been completed. The constricting effect on the channel of the Niagara River which is provided by the remedial works has been increased by the addition.

II-17. The Joint Board of Engineers on the St. Lawrence Waterway, appointed by the Governments of Canada and the United States, in its report dated November 26, 1926, par. 244, found that no regulating, compensating or other type of works could be constructed which would recover on the St. Lawrence River the power lost by diversion of water from the Great Lakes to another watershed.

II-18. On the Niagara River, the following authorities exercise regulatory control:

The *International Joint Commission* exercises general supervisory authority under the 1909 Boundary Waters Treaty.

The *International Niagara Board of Control* established by the I.J.C. Directive of August 19, 1953 specifies the levels that should prevail in the Chippawa-Grass Island pool for particular Niagara River discharges, the point

where levels are to be measured, and the allowable average daily and average monthly variations from the specified levels. It also causes records to be kept of the Chippawa-Grass Island pool levels on an hourly basis and makes reports to the I.J.C. of daily levels as they occur and of the variations of actual levels from the specified levels.

The *International Niagara Committee*, under the authority of the 1950 Treaty, was established to ascertain and determine the amounts of water available for the purpose of the Treaty, to record the same, and to record the amounts of water used for power diversions. The Committee receives hourly flow data, including those over Niagara Falls and all of the power stations, including the DeCew Falls station. It makes reports to the Governments of the United States and Canada of the average daily, and average monthly Niagara River flows and diversions, and flows over Niagara Falls. These reports also state, for each day, the minimum hourly flows over Niagara Falls, to indicate compliance with treaty requirements or any lack thereof.

II-19. Prior to October 1957 flow in the Niagara River was measured by one or more gages at Buffalo, New York. The flow above Niagara Falls is presently computed by the International Niagara Committee as the sum of the withdrawals of the Sir Adam Beck plants Nos. 1 and 2 of the Hydro-Electric Power Commission of Ontario, the withdrawals by the Power Authority, plus the discharge from the Maid-of-the-Mist pool below Niagara Falls. The Ashland Avenue gage at Niagara Falls, New York, is the gage at the lower end of the Maid-of-the-Mist pool presently used for this purpose.

## B. St. Lawrence River

### 1. *Treaties, Seaway and Hydroelectric Projects*

II-20. The Boundary Waters Treaty of 1909 affirms, in Article I, the rights of the inhabitants of both countries to free and open navigation of the boundary waters, in-

cluding the St. Lawrence River. It also provides for the right of free navigation in Lake Michigan.

II-21. In 1931 the United States negotiated a treaty with Canada providing for a joint seaway project and for power development in each country. The treaty was signed in 1932 but the Senate refused ratification in 1934.

The treaty would have required that the diversion at Chicago be reduced by December 31, 1938, to the quantity permitted as of that date by the decree of the Supreme Court of the United States of April 21, 1930; that any increase thereafter in such diversion proposed by the United States to meet an emergency and objected to by Canada would be submitted for final decision to an arbitral tribunal; and that no other diversion to any other watershed should be made except by authorization of the International Joint Commission.

In 1941 the two Governments signed an executive agreement providing, among other things, for construction of a power seaway project in the International Rapids Section of the St. Lawrence River. The agreement was specifically subject to approval by Congress and such approval was never obtained.

II-22. The United States and Canada, on January 11, 1952, indicated willingness by an exchange of notes to submit applications to the I.J.C. for approval of a power seaway project to be constructed jointly by entities to be designated by the two countries. The two Governments on June 30, 1952, submitted their identical applications covering works needed for power alone as well as those needed for both power and navigation. The applications indicated that the canals and locks would be built by Canada on the Canadian side, but did not preclude their construction on the United States side in the event that the 1941 agreement was approved by Congress.

II-23. On October 29, 1952, the I.J.C. issued an order granting the joint application of the United States and Canada for the construction of certain works for develop-

ment of power in the International Rapids section of the St. Lawrence River. The order also approved plans for the building of canals and locks on the Canadian side but did not preclude their being built on the United States side. It provided that the Canadian part of the power phase, including works common to navigation and power, be built by The Hydro-Electric Power Commission of Ontario and the United States part by an entity to be designated by the United States.

The order also established an International St. Lawrence River Board of Control which, after completion of of the works, was to ensure that the provisions of the order relating to water levels as well as the regulation of the discharge of water from Lake Ontario and the flow of water through the International Rapids section were complied with. It consists of four members from the United States, including representatives of the Corps of Engineers and the Federal Power Commission, and four members from Canada, including representatives of the Department of Northern Affairs and Natural Resources, and the Department of Transport.

The construction, maintenance and operation of these works were approved subject to the following conditions among others:

(a) All interests on either side of the International Boundary which are injured by reason of the construction, maintenance and operation of the works shall be given suitable and adequate protection and indemnity in accordance with the laws in Canada or the Constitution and laws in the United States respectively and in accordance with the requirements of Article VIII of the Treaty.

(b) The works shall be so planned, located, constructed, maintained and operated as not to conflict with or restrain uses of the waters of the St. Lawrence River for purposes given preference over uses of water for power purposes by the Treaty, namely, uses for

domestic and sanitary purposes and uses for navigation, including the service of canals for the purposes of navigation, and shall be so planned, located, constructed, maintained and operated as to give effect to the provisions of the Order.

(c) The works shall be constructed, maintained and operated in such manner as to safeguard the rights and lawful interests of others engaged or to be engaged in the development of power in the St. Lawrence River below the International Rapids Section.

(d) The works shall be so designed, constructed, maintained and operated as to safeguard so far as possible the rights of all interests affected by the levels of the St. Lawrence River upstream from the Iroquois regulatory structure and by the levels of Lake Ontario and the lower Niagara River; and any change in levels resulting from the works which injuriously affects such rights shall be subject to the requirements of paragraph (a) relating to protection and indemnification.

(e) The hydro-electric plants approved by this Order shall not be subjected to operating rules and procedures more rigorous than are necessary to comply with the provisions of the foregoing paragraphs (b), (c) and (d).

(f) Before the Hydro-Electric Power Commission of Ontario commences the construction of any part of the works, it shall submit to the Government of Canada, and before the entity designated by the Government of the United States commences the construction of any part of the works, it shall submit to the Government of the United States, for approval in writing, detailed plans and specifications of that part of the works located in their respective countries and details of the program of construction thereof or such details of such plans and specifications or programs of construction relating thereto as the respective Gov-

ernments may require. If after any plan, specification or program has been so approved, The Hydro-Electric Power Commission of Ontario or the entity designated by the Government of the United States wishes to make any change therein, it shall, before adopting such change, submit the changed plan, specification or program for approval in a like manner.

I.J.C. Commissioner Roger McWhorter dissented from the order, principally on the ground that under its terms the power entities were to pay for the entire cost of works, including channel excavation, which were common to both power and navigation. These works were estimated in 1950 to cost over $200,000,000. Of this total, he estimated that power would be loaded with more than $100,000,000 of costs which navigation rightfully should bear. In fact, the power entities spent over $300,000,000 for works common to both power and navigation.

II-24. On November 4, 1952, Canada advised the United States that it considered the 1941 agreement as having been superseded, and that it intended to proceed with construction of the seaway works all on its side, for which it had passed the necessary enabling legislation.

II-25. The St. Lawrence Seaway Authority of Canada was created by the Canadian Government as its agency to construct, maintain and operate the works necessary for the Canadian part of the Seaway.

II-26. Section 28 of the Canadian statute creating the St. Lawrence Seaway Authority of Canada provides that nothing therein contained affects the operation of "The International Boundary Waters Treaty Act," Chapter 28, of the Statutes of 1911 (1-2 George V) confirming and sanctioning the Boundary Waters Treaty between the United States and Great Britain on behalf of Canada signed at Washington, January 11, 1909.

II-27. Subsequently, on July 15, 1953, the Federal Power Commission issued a license to the Power Authority

of the State of New York for the construction, maintenance and operation of the St. Lawrence Project with the requirement that it comply with all applicable provisions of the October 29, 1952 order of the I.J.C.

The President of the United States on November 4, 1953, by Executive Order No. 10500, designated the Power Authority as the United States entity for the construction of the American part of the power phase of the project.

II-28. The Wiley-Dondero Act, of May 13, 1954, 68 Stat. 92, P. L. 358, established the St. Lawrence Seaway Development Corporation. It provides that the United States part of the Seaway phase of the St. Lawrence Project be constructed, operated and maintained by the St. Lawrence Seaway Development Corporation. The act also provided that such navigation works should not be built until the St. Lawrence Seaway Development Corporation received assurance satisfactory to it that the State of New York, or an entity duly designated by it, or other licensee of the Federal Power Commission, in conjunction with an appropriate agency in Canada, would build the dams and power works approved by the I.J.C.'s order of October 29, 1952 or any modification thereof. The Power Authority gave such assurances to the St. Lawrence Seaway Development Corporation on September 21, 1954. Executive Order No. 10534, issued by the President June 9, 1954, placed the corporation under the direction and supervision of the Secretary of Defense. The Wiley-Dondero Act further required that prior to the construction of any navigational works, the St. Lawrence Seaway Development Corporation obtain assurances that the St. Lawrence Seaway Authority would build the navigational facilities in Canada.

II-29. The United States and Canada, by an exchange of notes in August 1954, agreed that the St. Lawrence Seaway Development Corporation should build on the United States side the canal, locks and other facilities necessary to carry shipping past the two main dams of the project and that it should do considerable channel work.

Canada built on its side a canal and one lock around the Iroquois dam, which, under I.J.C. order, was to be built 25 miles upstream from the other dams.

2. *Regulation of Lake Ontario*

II-30. In 1955, the United States and Canada approved a recommendation of the International Joint Commission that the level of Lake Ontario be held within the range of 244.0 feet (navigation season) and 248.0 feet as nearly as may be. They also approved the Commission's "proposed criteria for a method of regulation of outflows and levels of Lake Ontario applicable to the works in the International Rapids Section of the St. Lawrence River". The criteria are as follows:

> "(a) The regulated outflow from Lake Ontario from 1 April to 15 December shall be such as not to reduce the minimum level of Montreal Harbour below that which would have occurred in the past with the supplies to Lake Ontario since 1860 adjusted to a condition assuming a continuous diversion out of the Great Lakes Basin of 3,100 cubic feet per second at Chicago and a continuous diversion into the Great Lakes Basin of 5,000 cubic feet per second from the Albany River Basin (hereinafter called the "Supplies of the past as adjusted").
>
> "(b) The regulated winter outflows from Lake Ontario from 15 December to 31 March shall be as large as feasible and shall be maintained so that the difficulties of winter power operation are minimized.
>
> "(c) The regulated outflow from Lake Ontario during the annual spring break-up in Montreal Harbour and in the river downstream shall not be greater than would have occurred assuming supplies of the past as adjusted.
>
> "(d) The regulated outflow from Lake Ontario during the annual flood discharge from the Ottawa

River shall not be greater than would have occurred assuming supplies of the past as adjusted.

"(e) Consistent with other requirements, the minimum regulated monthly outflow from Lake Ontario shall be such as to secure the maximum dependable flow for power.

"(f) Consistent with other requirements, the maximum regulated outflow from Lake Ontario shall be maintained as low as possible to reduce channel excavations to a minimum.

"(g) Consistent with other requirements, the levels of Lake Ontario shall be regulated for the benefit of property owners on the shores of Lake Ontario in the United States and Canada so as to reduce the extremes of stage which have been experienced.

"(h) The regulated monthly mean level of Lake Ontario shall not exceed elevation 248.0 * with the supplies of the past as adjusted.

"(i) Under regulation, the frequency of occurrences of monthly mean elevations of approximately 247.0 * and higher on Lake Ontario shall be less than would have occurred in the past with the supplies of the past as adjusted and with present channel conditions** in the Galops Rapids [sic] Section of the St. Lawrence River.

"(j) The regulated level of Lake Ontario on 1 April shall not be lower than elevation 244.0. The regulated monthly mean level of the lake from 1 April to 30 November shall be maintained at or above elevation 244.0 *.

"(k) In the event of supplies in excess of the supplies of the past as adjusted, the works in the International Rapids Section shall be operated to provide

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* U.S.L.S. 1935 Datum

** "Present channel conditions" refers to conditions as of March 1955.

all possible relief to the riparian owners upstream and downstream. In the event of supplies less than the supplies of the past as adjusted, the works in the International Rapids Section shall be operated to provide all possible relief to navigation and power interests."

The Supplementary Order of Approval also stated that:

"The project works shall be operated in such a manner as to provide no less protection for navigation and riparian interests downstream than would have occurred under pre-project conditions and with supplies of the past as adjusted, as defined in criterion (a) herein."

II-31. In the October 29, 1952 Order of Approval, Method of Regulation No. 5 was specified by the I.J.C. for regulating discharge of water from Lake Ontario and the flow through the International Rapids section.

In 1955, the I.J.C. recommended to the two Governments the adoption of the 11 criteria quoted in Finding II-30 and Proposed Plan of Regulation 12-A-9. This Plan of Regulation was recommended solely for the purpose of calculating critical profiles and designing channel excavations so that the entities involved could proceed with the design and excavation of the channels. The two Governments approved the criteria and approved Plan of Regulation 12-A-9, the latter being solely for the purposes recommended.

On July 2, 1956, the I.J.C. issued a Supplemental Order of Approval to its 1952 Order, substituting Plan of Regulation 12-A-9 for Method of Regulation No. 5 as the basis for calculating critical profile and designing channel excavations, and providing that Lake Ontario be held between levels 244.0 (navigation season) and 248.0.

II-32. Regulation Plan 1958-A was the first plan put into actual operation for the regulation of the levels and outflows of Lake Ontario. It was put into operation on the

20th of April, 1960. Events during 1960 resulted in a re-examination of the manner in which Plan 1958-A met the low flow requirements of downstream navigation interests in particular in Montreal Harbor. In January 1961, the Board directed its working committee to review Plan 1958-A and to prepare a qualitative report authorizing possible methods of ameliorating undesirable low flow conditions in Montreal Harbor. Following receipt of this report, the Board instructed the Working Committee to proceed with a detailed study of Plan 1958-A, with the objective of revising the plan, within the framework of the Orders of Approval, so as to reduce the frequency of flows below the low water datum flow for Montreal Harbor during the navigation season, at least to the number which would have occurred with supplies of the past as adjusted.

A revision of Plan 1958-A, designed to accomplish this objective, called Plan of Regulation 1958-C, dated 5 October 1961, is the result of the Board's studies. Plan 1958-A was discontinued in January 1962 at which time Plan 1958-C was put into effect.

Plan 1958-C essentially duplicates the frequency of flows below 230,000 cfs through Montreal Harbor that would take place under recorded adjusted flow conditions, i.e., historic flows adjusted for a 5,000 cfs Long Lake-Ogoki inflow and a 3,100 cfs Chicago diversion, and with no artificial regulation. Sufficient water was obtained to reduce the frequency of low fall flows at Montreal Harbor through reduction in the extreme minimum flows from 190,000 cfs to 188,000 cfs and through seasonal adjustment to the rule curve flows. The minimum prescribed monthly rates of flow are such that outflows during a year under 1958-C may total 26,000 cfs months less than under Plan 1958-A.

On October 5, 1963, a revision of Plan 1958-C, designated Plan 1958-D, went into effect. Plan 1958-D is a refinement of Plan 1958-C which provides for some slight improvement in levels in Montreal Harbor by reducing slightly the frequency of low flows in Montreal Harbor during the navigation season. During the non-navigation

season the frequency of low flows in Montreal Harbor is slightly increased.

II-33. The plans for the regulation of Lake Ontario were developed on the basis of historic adjusted flows for the period June 1860 to December 1954. The adjustment made in the recorded flows assumed an annual average diversion into Lake Superior of 5,000 cfs from the Long Lake-Ogoki project and an annual average diversion from Lake Michigan of 3,100 cfs during the entire period of record.

II-34. The plans of regulation consider that the navigation season on the St. Lawrence River extends, on the average, from April 1 to December 15.

II-35. The International St. Lawrence River Board of Control specifies discharges from Lake Ontario on an average weekly basis. In the past, hourly variations of 20,000 cfs greater or less than the weekly average were permitted, and at times variations up to 30,000 cfs were permitted. Since the closing of proofs, an hourly variation of 30,000 cfs greater or less than the weekly average has been permitted during the navigation season. In each instance it has been required that the daily average of each day during the week be equal to the specified weekly average. During the non-navigation season an hourly variation of 30,000 cfs greater or less than the weekly average is permitted, and a daily variation from the weekly average is also permitted as long as the specified weekly average is maintained. All of these variations from the discharge specified for the weekly average are on an experimental basis.

II-36. The International St. Lawrence River Board of Control (see Finding II-23) today supervises the activities of the following committees in carrying out its mandate under the I.J.C.'s 1952 and 1956 orders:

The *Working Committee*, consisting of eight members, four from each country. The Canadian

members include representatives of the Department of Northern Affairs and Natural Resources, the Department of Transport, the Hydro-Electric Power Commission of Ontario, and The Hydro-Electric Power Commission of Quebec. The United States members include representatives of the U.S. Lake Survey, the Corps of Engineers, the Federal Power Commission and the Power Authority of the State of New York.

The *Operation Advisory Group*, consisting of representatives of The Hydro-Electric Power Commission of Ontario, The Hydro-Electric Power Commission of Quebec, the Power Authority of the State of New York and the Federal navigation agencies of the United States and Canada. This group meets weekly and reports to the Board of Control as to the day-to-day conditions on the St. Lawrence River.

*Regulation Representatives*, the agency which calculates the flow which the Power Authority of the State of New York and Ontario-Hydro are advised, in consultation, to utilize in the St. Lawrence project in order to conform with the criteria and other requirements of the International Joint Commission's Order of Approval of October 29, 1952, as amended by its supplementary Order of July 2, 1956. Each week they consult with and advise the power entities as to the flow provided for by the Plan of Regulation for Lake Ontario.

C. Lake Superior and St. Marys River

II-37. In 1914, the Michigan Northern Power Company and the Algoma Steel Corporation (Ltd.) of Canada each applied to the I.J.C. for permission to obstruct, divert and use the waters of the St. Marys River at Sault Ste. Marie for the generation of hydroelectric power. The I.J.C. authorized the use of water for power purposes conditioned on the construction of remedial works to prevent lowering of the levels of Lake Superior.

By its orders, the I.J.C. also created the International

Lake Superior Board of Control. The officer of the Corps of Engineers charged with the improvement of the Falls of the St. Marys River on the United States side, and an officer appointed by the Canadian government constitute the official Board. The Board determines the amount of water available for power purposes and directly controls the operation of all compensating works, power canals, head gates and bypasses. The Board is further empowered to make and enforce rules in order to maintain as nearly as may be the levels of Lake Superior between 602.1 feet and 603.6 feet, and to regulate the lake in accordance with the other provisions of the Orders. The Orders, L. S. Ex. 313 and 313-A, are included in the Appendix to this Report.

D. Diplomatic Correspondence

II-38. The Government of Canada has stated its opposition to any further unilateral diversions from the Great Lakes basin on several occasions. Five Canadian aides-memoire and notes dated January 6, 1958, February 20, 1959, April 9, 1959, November 2, 1961 (U.S. Ex. 5A), and June 10, 1964 (U.S.Ex. 5F), regarding such diversions are included in the Appendix to this Report. Earlier notes dated April 22, 1921, February 24, 1925 and September 15, 1925, which express Canadian opposition to any increase in the Chicago diversion are also included in the Appendix.

## III. Water Levels

A. Variations in Levels in General

III-1. The mean water levels of the Great Lakes vary from year to year and from month to month. These variations in mean levels correspond to changes in the volume of water in the lakes and result from both natural phenomena and man-made causes. Local temporary variations in water levels also occur; these are related to winds and atmospheric pressure over the lakes.

III-2. The level of each of the Great Lakes depends upon the balance between the quantities of water being

received by the lake and the quantities of water being removed from the lake. If these quantities are exactly the same, the lake level will be in a state of equilibrium, neither rising nor falling. If the quantities being received are larger than the quantities being removed, the volume of water in the lake will increase by the amount of the difference and the lake level will rise. Conversely, if the quantities being received are smaller than the quantities being removed, the volume of water in the lake will decrease by the amount of difference and the lake level will fall. Water is naturally supplied to each of the lakes by rain and snowfall on the lake's surface, by flow into the lake from the adjacent land area of its drainage basin and, to all of the lakes except Lake Superior, by discharge into the lake from the lake above through the connecting river (considering Michigan-Huron to be one lake). Water is withdrawn from each lake by evaporation from the lake surface and by outflow through the natural outlet river of the lake. Water may be either supplied to or removed from the lake through man-made diversions. When the lake level is above average, the depth of water at the lake's outlet is greater than average and hence the capacity of the outlet river to discharge water is also greater than average. Conversely, when the lake level is below average, the depth at the outlet river is less than average and hence the capacity of the outlet river is less than average. For any level of a lake, there is a corresponding definite rate of discharge which is determined by the discharge capacity of the outlet river at that particular level. As the total water entering the lake (minus evaporation from the surface) changes, the lake level and the natural outflow adjust continually, tending to restore the balance between the water entering and the water leaving the lake.

III-3. Dredging in an outlet river increases the cross-sectional area of the channel, and will increase the capacity of the outlet to discharge lake outflows if the dredging is in a reach of the river that controls lake outflows. After the dredging in a control reach of an outflow river, equilibrium

between inflow and outflow will be attained at a lower level of the lake than would have been the case prior to dredging. Works such as sills and dikes can be built to constrict the cross-sectional area of the outflow channels, and thereby decrease the discharge capacity of the channels; thus requiring a higher level of the lake to achieve equilibrium between inflow and outflow.

Regulatory works, including the necessary channel enlargements and gated control structures, can be built in the outflow channels and so operated as to either increase or decrease the discharge from a lake with respect to that which would occur in the unregulated state, thus obtaining a measure of discretionary control on the lake's levels.

III-4. High water levels are experienced in some years and low water levels are experienced in other years, and these variations depend primarily upon such hydrologic processes as precipitation, runoff and evaporation. On the lakes which are regulated artificially, changes in outflows can be made which affect lake levels so that the variations between such high and low levels resulting from hydrologic processes are reduced.

III-5. During a year, the lake levels ordinarily follow a rather definite seasonal pattern related to the occurrence of hydrologic phenomena, with the low for the year taking place in the winter months and the high occurring in the summer. The seasonal variation between winter low and summer high usually ranges between one and two feet.

III-6. The Great Lakes are essentially non-tidal. Their surfaces are subject to appreciable temporary disturbances in addition to the seasonal and long-range variations in levels mentioned above. At any point on the lakes, daily and hourly fluctuations in levels, varying from a few inches to several feet according to the lake and place involved, may occur. These fluctuations, irregular in amount and duration, can be produced either by a gradient in barometric pressure over the surface of a lake, or by winds of sufficient duration and velocity to drive the surface water against the shore

opposite to the direction from which the wind blows in greater volume than that carried by subsurface currents back to the shore from which the wind blows. Thus the level on one shore is raised, and the level on the other shore is lowered.

III-7. Waves, generated by the wind, also disturb the surfaces of the lakes. During severe storms, waves in deep water areas may reach heights of greater than 20 feet from crest to trough. Such deepwater waves are greatly reduced in dimension during their progress towards shore, since passage over the more shoal inshore areas causes the waves to break and re-form with lesser heights.

III-8. The water level gages maintained by the United States Lake Survey and the low water datum elevation at each gage are as follows:

| GAGE | LWD ELEVATION (USLS 1935 Datum) |
|---|---|
| Lake Superior: | |
| Two Harbors, Minn. | 601.6 |
| Duluth, Minn. | 601.6 |
| Ontonagon, Mich. | 601.6 |
| Marquette, Mich. | 601.6 |
| Iroquois Point, Mich. | 601.6 |
| St. Marys River: | |
| Sault Ste. Marie, Mich. | |
| Above locks | 601.1 |
| Below locks | 579.4 |
| Lake Michigan: | |
| Sturgeon Bay Canal, Wis. | 578.5 |
| Green Bay, Wis. | 578.5 |
| Milwaukee, Wis. | 578.5 |
| Calumet Harbor, Ill. | 578.5 |
| Holland, Mich. | 578.5 |
| Ludington, Mich. | 578.5 |

| GAGE | LWD ELEVATION (USLS 1935 Datum) |
|---|---|
| Lake Huron: | |
| Detour, Mich. | 578.5 |
| Mackinac City, Mich. | 578.5 |
| Harrisville, Mich. | 578.5 |
| Essexville, Mich. | 578.5 |
| Harbor Beach, Mich. | 578.5 |
| Lakeport, Mich. | 578.5 |
| St. Clair River: | |
| Fort Gratiot, Pt. Huron, Mich. | 578.2 |
| Dunn Paper, Pt. Huron, Mich. | 578.0 |
| Mouth Black River, Pt. Huron, Mich. | 577.5 |
| Dry Dock, Pt. Huron, Mich. | 577.1 |
| Marysville, Mich. | 576.9 |
| St. Clair, Mich. | 575.8 |
| Algonac, Mich. | 574.6 |
| Lake St. Clair: | |
| Grosse Pointe Yacht Club, Grosse Pte. Shores, Mich. | 573.5 |
| Detroit River: | |
| Windmill Point, Detroit, Mich. | 573.3 |
| Ft. Wayne, Det., Mich. | 572.6 |
| Wyandotte, Mich. | 572.2 |
| Gibraltar, Mich. | 570.8 |
| Lake Erie | |
| Fermi, near Monroe, Mich. | 570.5 |
| Monroe, Mich. | 570.5 |
| Toledo, Ohio | 570.5 |
| Marblehead, Ohio | 570.5 |
| Cleveland, Ohio | 570.5 |
| Erie, Pa. | 570.5 |
| Barcelona, N. Y. | 570.5 |
| Buffalo, N. Y. | 570.5 |

| GAGE | LWD ELEVATION (USLS 1935 Datum) |
|---|---|
| Niagara River: | |
| Black Rock Canal, Buffalo, N. Y. | 565.5 |
| Niagara Intake, Niagara Falls, N. Y. | 562.4 |
| American Falls, Niagara Falls, N. Y. | ——— |
| Ashland Avenue, Niagara Falls, N. Y. | ——— |
| Lake Ontario: | |
| Fort Niagara, Youngstown, N. Y. | 244.0 |
| Rochester, N. Y. | 244.0 |
| Oswego, N. Y. | 244.0 |
| St. Lawrence River: | |
| Cape Vincent, N. Y. | 244.0 |
| Alexandria Bay, N. Y. | 243.6 |
| Ogdensburg, N. Y. | ——— |

III-9. Low water datum in the upper portion of Vidal Shoals in the upper St. Marys River is 601.2.

III-10. The daily mean water levels recorded by the U.S. Lake Survey at its Point Iroquois, Michigan and its Cleveland, Ohio gages for the years 1950 to 1961, inclusive, are shown on Ill. Exs. 854 and 855, respectively.

## B. Variations on Individual Lakes

### 1. *Lake Superior*

III-11. Lake Superior, since 1860, has ranged between a high monthly average elevation of 604.05 in August 1876 and a low monthly average elevation of 599.98 in April 1926. Thus the range of observed monthly average elevations is 4.07 feet. Usually the lake is at its seasonal low in March and reaches its seasonal high in September. The average seasonal rise is about 1.2 feet. The maximum

temporary rise on Lake Superior was 2.8 feet at Marquette, Michigan. A temporary rise of this magnitude may be expected once in 44 years, with rises of lesser magnitude occurring more frequently.

III-12. Outflow from Lake Superior has been controlled since 1922 by works which permit regulation of elevation and outflow of Lake Superior and allow the reduction of flow over the rapids of the St. Marys River. By reducing the flow over the rapids, the works serve several functions, among them that of compensating for flows diverted around the rapids for the generation of power. At the present time the United States collects a rental of $100,000 per year for the use of surplus water in the St. Marys River for power purposes. At no other place on the Great Lakes has the United States made any charge for the use of water, except in connection with the license fees charged by the Federal Power Commission for administrative purposes. The International Joint Commission has ordered that the levels of Lake Superior should be held, as nearly as may be, between elevations 602.1 and 603.6. Since 1922, when regulation was commenced, the highest average elevation, occurring in August 1950, was 603.63, and the lowest monthly elevation, occurring in April 1926, was 599.98. Thus, the range in monthly average levels under regulation has been 3.65 feet.

The current regulation plan for Lake Superior levels and outflows approved by the International Joint Commission was devised in 1949 and amended in 1955. The principal purpose of the 1955 modification was to decrease the frequency of occurrence of low outflows from Lake Superior in the range where it is necessary to curtail the amount of water used for power generation. To meet the requirements of the orders of the International Joint Commission, when the elevation in the St. Marys River below the locks exceeds 584.5, discharge from Lake Superior is reduced even though this may cause the monthly mean levels of the lake to go above 603.6. However, if the monthly mean elevation of the lake were above 603.6 and were above the

monthly mean level that would have occurred in the state of nature, water would be discharged from the lake even though such discharge would cause the elevation below the locks to exceed 584.5, in order that the monthly mean elevation of Lake Superior above 603.6 might be reduced to a point not in excess of the maximum monthly mean actually experienced in a year of recorded high water.

III-13. The Long Lake and Ogoki projects during the period 1945 through 1964 have diverted an average of about 5,390 cfs from the Hudson Bay drainage basin into Lake Superior. These diversions, if assumed to be at a constant rate of 5,000 cfs, would have raised Lake Superior levels on the order of one-quarter of a foot had the lake not been regulated. Due to regulation, however, the levels of the lake have not been materially affected by this diversion.

2. *Lakes Michigan and Huron*

III-14. Lakes Michigan and Huron, between 1860 and July 1965, have ranged between a high monthly average elevation of 583.68, in June 1886, and a low monthly average elevation of 577.09, in March 1964. Thus, the range of observed monthly average elevations is 6.59 feet. During 1952, a recent highwater year, the highest monthly average elevation was 582.69 in August. These lakes are usually at their seasonal low in February and reach their seasonal high in July. The average seasonal rise from low to high is about 1.1 feet. The maximum temporary rise observed on Lake Michigan has been 2.8 feet at Calumet Harbor, Illinois, located near the southern end of the lake. A rise of this magnitude may occur on the order of once in 30 years. The maximum temporary rise observed on Lake Huron, 2.5 feet, was observed at Fort Gratiot, Michigan, at the head of the St. Clair River. A temporary rise of this magnitude on Lake Huron can be expected about once in ten years.

III-15. Dredging of navigation channels has increased the natural discharge capacity of the St. Clair River and, accordingly, has had the effect of lowering the levels of

Lakes Michigan and Huron. During the period 1933 to 1937, downbound channels in the St. Clair River were dredged from a project depth of about 21 feet at LWD* to a project depth of about 25 feet. This dredging lowered the levels of Lakes Michigan and Huron 0.15 foot. During the period 1958 to 1962, channels of the St. Clair River were deepened from a minimum depth of about 25 feet to a minimum depth of 27 feet. The 1958 to 1962 dredging resulted in an additional lowering in the levels of Lakes Michigan and Huron estimated to be 0.11 foot. The net effect of the two dredging projects in the St. Clair River has been to lower the levels of Lakes Michigan and Huron about 0.26 foot.

III-16. During the period 1938 through January 1965, the diversion from Lake Michigan at Chicago ranged from a low of 3,076 cfs in 1939 to a high of 3,288 cfs in 1962, disregarding the years in which larger diversions were permitted by special permission of the Supreme Court or the War Department. No payment is made by the State of Illinois or any of its political subdivisions for the diverted water to any federal or state agency. The diversion from Lake Michigan at Chicago, if assumed to be at a constant rate of 3,100 cfs, has lowered the levels of Lakes Michigan and Huron by about 0.23 foot, or 2.76 inches. When the diversion at Chicago is more or less than the assumed value of 3,100 cfs, the water levels are raised or lowered accordingly. Because the relationship between Lakes Michigan-Huron levels and outflow is not a straight line, the lowering effect on these lakes of any diversion at Chicago is greater when lake levels are low than when lake levels are high. Thus, when Lakes Michigan-Huron levels are high, in the order of 583 feet, a 1,000 cfs decrease in diversion at Chicago raises lake levels by about 0.07 foot. When Lakes Michigan-Huron levels are at medium stages, in the order of 580 feet, a 1,000 cfs decrease in diversion at Chicago raises lake levels by about 0.075 foot. When Lakes Michi-

* Hereinafter all dredged depths will be referred to in relation to LWD, unless otherwise specifically noted.

gan-Huron levels are at low stages, in the order of 578 feet, a 1,000 cfs decrease in diversion will raise Lakes Michigan-Huron levels by about 0.08 foot. Conversely, a 1,000 cfs increase in diversion would cause corresponding decreases in Lakes Michigan-Huron levels.

The diversion of water from the Hudson Bay drainage basin into Lake Superior via the Long Lake and Ogoki projects, if assumed to be at a constant rate of 5,000 cfs, has increased the inflow and hence the levels of Lakes Michigan-Huron by about 0.37 foot.

The net effect of a total diversion of 3,100 cfs at Chicago and a diversion of 5,000 cfs into Lake Superior is to raise the level of Lakes Michigan and Huron by about 0.14 foot.

3. *Lake Erie*

111-17. Lake Erie, during the period 1860 through July 1965, ranged between a high monthly average elevation of 574.70 in May 1952 and a low monthly average elevation of 569.43 in February 1936. Thus the range of observed monthly average elevation is 5.27 feet. The lake is usually at its seasonal low in February and reaches its seasonal high in June. The average seasonal rise is about 1.6 feet. The maximum temporary rise, 8.4 feet, was observed at Buffalo, New York, at the east end of the lake. Records indicate that such a rise may be expected to occur at Buffalo about once in 50 years. Large temporary rises also occur on the west end of Lake Erie. The maximum temporary rise, observed at Toledo, Ohio, at the west end of the lake, was 4.5 feet. Records indicate that such a rise may be expected to occur about once in ten years.

III-18. Water is drawn from the eastern end of Lake Erie for navigation and municipal purposes, in addition to that diverted around Niagara Falls for power generation. Water for municipal purposes for the City of Buffalo is withdrawn from Lake Erie. Buffalo's waste water is returned to the Niagara River above the falls. Water for the cities of Niagara Falls, Ontario; Niagara Falls, New York;

and Lockport, New York, is taken out of the Niagara River above the falls. Waste water from the cities of Niagara Falls, New York, and Niagara Falls, Ontario, is returned to the Niagara River below the falls. Lockport, New York, returns its waste water to Lake Ontario. Two Canadian cities, St. Catharines and Thorold, Ontario, take domestic water from the Welland Canal. The water from all of these cities remains in the Great Lakes basin and is returned to either the Niagara River or Lake Ontario.

The Black Rock Canal, at Buffalo, New York, allows shipping destined for the New York State Barge Canal and for other points on the Niagara River above the falls to bypass the rapidly flowing water at the head of the river. The amounts withdrawn from Lake Erie are returned to the river above the falls. The amount of water withdrawn from Lake Erie through the Black Rock Canal has nearly the same effect, on a cfs for cfs basis, on the levels of Lake Erie as does the natural discharge of Lake Erie through the Niagara River. However, withdrawals from Lake Erie through the Black Rock Canal have only a negligible effect on the levels of Lake Erie.

About 750 cfs is diverted from the Niagara River at Tonawanda, New York, above the falls, for the New York State Barge Canal. This water ultimately reaches Lake Ontario. The diversion has only a negligible effect on the levels of Lake Erie. [See Finding X-325]

III-19. The cities of Lockport, New York and St. Catharines and Thorold, Ontario are located within the Lake Ontario drainage basin, and not in the Lake Erie drainage basin.

III-20. The remedial works referred to in Finding II-11 compensate for the effect that power diversions from the Niagara River would otherwise have on Lake Erie levels.

III-21. The diversion of water from the Hudson Bay drainage basin into Lake Superior and the diversion of water out of Lake Michigan affect the outflows of Lakes

Michigan and Huron through the St. Clair River, Lake St. Clair and the Detroit River and therefore affect the supplies and levels of Lake Erie. The Long Lake-Ogoki diversion into Lake Superior, if assumed to be at an average rate of 5,000 cfs, raises Lake Erie levels by about 0.23 foot. The Chicago diversion, if assumed to be an average of 3,100 cfs, lowers the level of Lake Erie by about 0.14 foot. Thus, the net effect of these two changes from a state of nature is to raise the level of Lake Erie by about 0.09 foot. The diversion of water from Lake Erie to Lake Ontario through the Welland Canal, which includes water used in the De Cew Falls power plant, has averaged 7,000 cfs since 1950 and has the effect of lowering the levels of Lake Erie by about 0.32 foot. Lake Erie levels would be raised about 0.05 foot for each 1,000 cfs decrease in diversion at Chicago. This increment of 0.05 foot per 1,000 cfs applies at all stages.

4. *Lake Ontario*

III-22. Between 1860 and April 1960, when regulation of Lake Ontario commenced, its elevations ranged between a high monthly average elevation of 249.29 in June 1952 and a low monthly average elevation of 242.68 in November 1934. Between April 1960 and July 1965 the range of levels has been from a high monthly average of 247.23 in June 1960 to a low monthly average of 242.98 in January 1965. Thus, the range of observed monthly average elevations since 1860 has been 6.61 feet. Lake Ontario usually is at its seasonal low in January and reaches its seasonal high in June. The average rise from low to high is about 1.8 feet. The maximum temporary rise on Lake Ontario, 2.9 feet, was observed at Tibbetts Point, New York, at the eastern end of the lake. Observations at Tibbetts Point indicate a rise of such magnitude may occur about once in 16 years.

III-23. Since the completion of the St. Lawrence Seaway and power project, the levels of Lake Ontario have been maintained in accordance with regulation plans promulgated by the International Joint Commission. All Regula-

tory Plans so far promulgated by the International Joint Commission, including Plan 1958-C, attempt to keep levels at or above 244.0 during the navigation season.

III-24. A satisfactory plan for the regulation of Lake Ontario reflects a balancing of every interest involved, including riparian interests, navigation and power. When Lake Ontario is controlled in accordance with a plan of regulation based on existing diversions a reduction or increase of 1,000 cfs or more in the existing diversions upstream of Lake Ontario will change inflows into Lake Ontario so that all criteria cannot satisfactorily be met under such a plan of regulation and a new plan of regulation, based on the changed diversion conditions, would have to be developed.

III-25. A diversion of 3,100 cfs from Lake Michigan and its drainage basin would have the effect of lowering the levels of Lake Ontario, if it were not regulated, by about 0.15 foot. The Long Lake-Ogoki diversion into Lake Superior, if assumed to be at a constant rate of 5,000 cfs, would have the effect of raising the levels of Lake Ontario, if it were not regulated, by about 0.24 foot. The net effect of these two changes from a state of nature would be to raise the level of Lake Ontario by about 0.09 foot, if the levels of that lake were not affected by regulation.

C. Effect of Diversions on Lake Levels

III-26. As indicated in the foregoing Findings the levels of all of the lakes, except Lake Superior, are affected by diversions from Lake Michigan at Chicago; the levels of all of the lakes are affected by diversions from the Hudson Bay drainage basin into Lake Superior via the Long Lake and Ogoki projects; and the levels of Lakes Erie and Ontario are affected in some degree by diversions from Lake Erie to Lake Ontario via the Welland Canal. A tabulation showing the approximate effects on levels of these changes from natural conditions to the nearest hundredth of a foot follows:

APPROXIMATE EFFECTS ON LEVELS (IN FEET)

| | Lowering Effect of Chicago Diversion (at 3100 cfs) | Raising Effect of Long Lake-Ogoki (at 5000 cfs) | Lowering Effect of Welland Canal (at 7000 cfs) | Raising or Lowering Effect of a Permanent 1000 cfs change in diversion at Chicago* | |
|---|---|---|---|---|---|
| | | | | Low and Med. Stages | High Stages |
| Superior ..... (unregulated) | ... | 0.25 | ... | ... | ... |
| Michigan-Huron | 0.23 | 0.37 | ... | 0.08 | 0.07 |
| Erie ..... | 0.14 | 0.23 | 0.32 | 0.05 | 0.05 |
| Ontario ..... (unregulated) | 0.15 | 0.24 | ... | 0.05 | 0.04 |
| Montreal Harbor (assuming Ontario unregulated) | 0.14 | 0.23 | ... | 0.05 | 0.04 |

At a Lake Michigan elevation of 577.35, a 1,000 cfs permanent change in diversion at Chicago would result in a change in the elevation of Lakes Michigan-Huron of 0.079 foot. At an elevation of 580.0, such a change in diversion would result in a change in elevation of 0.075 foot. At an elevation of 581.0, such a change in diversion would change the elevation by 0.073 foot. At elevation 582.0, such a change in diversion would result in a change in elevation of 0.072 foot. At elevation 583.0, such a change in diversion would result in a change in elevation of 0.07 foot. At the historical mean elevation of Lake Michigan, 580.58, a permanent change of 1,000 cfs in diversion at Chicago would result in a change in elevation of 0.074.

III-27. A permanent decrease or increase in diversion at Chicago of 1,000 cfs will increase or reduce the discharge from Lakes Michigan-Huron, Erie, and Ontario by 1,000 cfs. The rate of change in the discharge from these lakes would be more rapid in the years immediately following such a change in diversion than in later years, as shown in the following table:

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* To ascertain the approximate raising or lowering effects of a 2,000, 3,000, 4,000 or 5,000 cfs permanent change in diversion at Chicago, the effects of a 1,000 cfs change should be multiplied by 2, 3, 4 or 5 respectively.

CHANGE IN DISCHARGE FROM LAKES
2, 4, 8, AND 15 YEARS AFTER PERMANENT
1,000 CFS CHANGE IN DIVERSION AT CHICAGO

| Years After Change | AMOUNT OF CHANGE IN DISCHARGE | | | | | |
|---|---|---|---|---|---|---|
| | Lakes Michigan–Huron | | Lake Erie | | Lake Ontario | |
| | cfs | % of total change | cfs | % of total change | cfs | % of total change |
| 2 | 485 | 48.5 | 405 | 40.5 | 335 | 33.5 |
| 4 | 735 | 73.5 | 695 | 69.5 | 655 | 65.5 |
| 8 | 930 | 93.0 | 920 | 92.0 | 910 | 91.0 |
| 15 | 998 | 99.8 | 998 | 99.8 | 998 | 99.8 |

III-28. A permanent increase (or reduction) in discharge from Lake Ontario of 1,000 cfs would raise (or lower) the levels of Lake St. Louis approximately 0.03 foot and would raise (or lower) the levels of Montreal Harbor approximately 0.05 foot.

III-29. The effect of an increase in diversion of 1,000 cfs at Chicago on outflows that would exist without regulation from Lakes Michigan-Huron, Lake Erie and Lake Ontario are represented by Plates 5, 7, 8, 9, 10, 11, and 12 of Senate Document 28, (L.S.Ex.19H), dated January 1957. The curves on these Plates also can be used by appropriate proration, to determine the effect of other magnitudes of increases or decreases in diversion, up to at least 5,000 cfs.

III-30. Apart from that part taken for normal consumptive uses, all of the water withdrawn from the Great Lakes or their connecting channels for municipal purposes, navigation or other purposes, is returned to the Great Lakes or its drainage basin, except for the water diverted at Chicago.

III-31. Damage suffered by installations and properties situated on the United States shoreline of the Great Lakes during the period from the spring of 1951 to the spring of 1952 resulting from high water levels was estimated by the Corps of Engineers to be $61,000,000.

III-32. The Corps of Engineers has since the high lake levels of 1951-1952 studied the effects of present and increased diversions at Chicago on shore damage when the lakes are at high stages. The Corps stated that evaluation of the effects on shore property of small lowering of lake levels involves analysis of the frequency of occurrence and duration of various mean lake stages within the range of variations of the lake levels, temporary rises at various points on the lakes, and wave action, as well as with the correlation of these hydrologic and meteorological phenomena with shore property damage. The first element in the analysis is the still water level (monthly mean level) which results from both seasonal and long term climatic conditions over the Great Lakes basin. Superimposed on the still water level at specific locations during the period of a damaging event to shore property is the second element, which is the temporary rise in lake level at the locality being considered, resulting from winds and variations in barometric pressure over the lake surface. The third element comprises wind-generated waves on the surface of the lake which attack the shore and improvements thereon. Correlation of potential damage to shore property with all or any combination of these three elements necessarily includes consideration of probable future shoreline development, past experiences in shore property damages, and the change in damage which might occur when only one of the three elements, still water level, is changed.

A method of providing protection to shore property other than a change in the regimen of mean lake stages is the construction of local flood protection or beach erosion control works. Where such alternative works are justified, a lowering of the higher lake levels would permit a reduction in design height of protective works and result in a saving in cost. The Corps concluded that an ultimate reduction in lake levels up to one inch resulting from a permanent increased Chicago diversion of 1,000 cfs, while permitting a theoretical reduction of the same amount in height of justified local protective works, would in actual

design of such works be of only slight significance. In reaches of the Great Lakes shoreline where protective works are not justified, the determination of the reduction in damage was not considered by the Corps to be feasible when only one of the elements, still water or mean lake level, was reduced by a maximum of one inch. The Corps concluded that the lowering of lake levels from either a 3-years, or a permanent increase of 1,000 cfs in the Chicago diversion, while tending to be beneficial, particularly during high lake stages, would be too small to permit a monetary evaluation of the effects on shore property.

In a report entitled "Variations in Great Lakes Levels", the Corps stated that no appreciable relief from the damage caused by high water and wave action can be brought about by changes in existing diversions or changes in operation of the regulating works at St. Marys Falls at Sault Ste. Marie. The effect on lake levels of such measures would be negligible in view of the fact that the maximum lowering possible is in the order of a few inches, whereas a lowering of feet is required to afford relief.

D. Regulatory and Compensating Works

III-33. The regulatory works at the outlets of Lakes Superior and Ontario may be operated to produce the same effects as sills, in that they can raise lake levels above those that would occur in nature. These regulatory works, with associated channel improvements, also are capable of being operable, subject to the orders of the International Joint Commission or its subsidiary control boards, to increase the outflow capacity of the lake so that discharge from it may be greater, or to decrease its outflow capacity so that discharge from it may be less, for limited periods of time and with due regard to resulting effect upon lake levels, than the discharge which would have prevailed with the same water levels and the lake in an unregulated state.

III-34. It is possible to compensate completely for the effect on Lakes Michigan-Huron and Erie levels resulting from diversions at Chicago by the construction of either

compensating or regulatory works in the outflow channels of Lakes Michigan–Huron and Erie. Regulatory works, with associated channel improvements, would also be capable of being operable, subject to the orders of the International Joint Commission or other international authority having jurisdiction, to increase the outflow capacity of the lake so that discharge from it might be greater, or to decrease its outflow capacity so that discharge from it might be less, for limited periods of time and with due regard to resulting effect upon lake levels, than the discharge which would have prevailed with the same water levels and the lake in an unregulated state. The Division Engineer of the North Central Division of the United States Army Corps of Engineers has made public a report dated September 1, 1965 of a study of plans for the regulation of the levels of the Great Lakes prepared for the International Joint Commission. The study was made under the authority of a resolution adopted by the Committee on Public Works of the House of Representatives of the United States on June 26, 1952.

III-35. The Corps of Engineers is planning the construction of submerged weirs, or sills, in the St. Clair River to compensate for the net lowering effect on the levels of Lakes Michigan-Huron caused by the two dredging projects described in Finding III-15 by which the connecting channels were deepened. The Corps' studies are directed to raising the levels of Lakes Michigan-Huron by 0.26 foot, the net amount which it is estimated levels have been lowered by the two deepening projects. The Corps' program does not contemplate the use of sills to compensate for the lowering due to the diversion at Chicago. In 1932, the Waterways Experiment Station of the Corps of Engineers at Vicksburg, Mississippi, conducted model tests on the installation of sills to determine the number, design and location of sills which, when installed, would have the effect of raising the levels of Lakes Michigan-Huron by 0.54 foot. These proposed sills were never constructed. In 1954, when the Corps of Engineers recommended the deepening of the connecting

channels to a minimum depth of 27 feet, it again proposed the construction of sills in the St. Clair River and in the Detroit River. The Corps estimated the cost, in 1954, of works in the St. Clair River to compensate for the lowering caused by both channel deepening projects to be $10,600,-000. It is the viewpoint of the Corps that new model tests must be constructed to determine the placement, design, velocity and backwater effects of such sills. The Corps in 1963 was contemplating the construction of four submerged weirs in the St. Clair River at an estimated cost of $6,535,000. This estimated cost included the expense of model and engineering tests as well as the actual cost of construction. In 1965 the Corps estimated the cost of works to compensate the level of Lakes Michigan-Huron for the dredging which has taken place in the St. Clair River at $5,600,000. The Corps has studied several designs of sill construction including dumped rock fill, placement of precast concrete slabs, submergence of floating cribs and steel sheet pile placement. It is not known at this time what the Corps' ultimate recommended design will be.

With respect to navigation depths in the St. Clair River, the Corps specifies that the minimum depth over the sills must be 32 feet and would not permit adding to or raising of the sills which would in any way reduce the 32 feet clearance over the sills. The Corps specifies with respect to current velocities that the cross-sectional area remaining for water passage over the sills shall not be less than 40,000 square feet at low water datum. At times of maximum flow, this requirement prevents mean sectional velocities over the sills in excess of approximately 5 feet per second. This requirement also eliminates the possibility of placing a sill in the narrowest reach of the St. Clair River at Port Huron. The probability of siltation upstream of the sills is being considered as a matter important to their continuing effectiveness. The available model data indicates that sills with vertical upstream and downstream faces have a greater backwater effect than those with flat side slopes; i.e., the amount that levels upstream of the sills are raised

would be lessened if the bed of the river upstream of the sills becomes filled with siltation material up to the crest level of the sills. In order to reduce annual maintenance charges for dredging, the siltation rate should be held to a minimum. The model data provided by the Corps' 1932 tests indicate that the slopes of the upstream and downstream faces of the sills have a material influence on the amount of backwater rise that the sills would cause; the tests indicated that the steeper these slopes are, the greater the rise.

III-36. To compensate the levels of Lakes Michigan-Huron for a 1,000 cfs diversion at Chicago or elsewhere on that lake, submerged sills could be constructed in the St. Clair River at a total cost estimated in 1963 of approximately $875,000, or an annual estimated cost of $31,800, including amortization, interest and maintenance. The depth of such sills, and the resulting cross-sectional areas of flow and velocities could more than meet the most stringent specifications of the Corps of Engineers.

III-37. To compensate the levels of Lake Erie for a 1,000 cfs diversion at Chicago or elsewhere on Lakes Michigan-Huron submerged sills could be constructed in the Niagara River at a total cost estimated in 1963 of approximately $225,000, or an annual estimated cost of $29,400, including interest, amortization and maintenance. Such sills would reduce water velocities upstream from their location but leave downstream velocities unaffected. Such sills could form the basis of ice jams in the winter and spring which would reduce temporarily the flow of the Niagara River.

III-38. The benefits from the construction of any sill or sills are on levels only; that is, studies by the Corps may indicate that levels of Lakes Michigan-Huron can be raised by the construction of sills in their outflow channels to the levels that prevailed prior to dredging in those channels. However, sills do not compensate for loss of flow. The diversion at Chicago reduces the outflow from Lakes Michigan-Huron by the amount of that diversion; i.e., if the

Chicago diversion averages 3,200 cfs, then the outflow of Lakes Michigan-Huron is reduced by 3,200 cfs. No sill can replace any part of this flow anywhere downstream.

III-39. Hydrographs of the Great Lakes and Lake St. Clair, L. S. Exhibits 19G and 19G Supplementary, showing levels of the lakes from 1860 through December 1959 and from 1860 through July 1965, respectively, are included in the Appendix to this Report.

## IV. Chicago Diversion

### A. The Metropolitan Sanitary District of Greater Chicago

IV-1. The Metropolitan Sanitary District of Greater Chicago (referred to hereinafter as the "Sanitary District"), formerly called the Sanitary District of Chicago, is a body corporate and politic, a municipal instrumentality and political subdivision of the State of Illinois. (Ill. Rev. Stats. Chap. 42, as amended.)

IV-2. Since its formation in 1889, the Sanitary District has expanded both in population and in area served. When originally formed, the Sanitary District embraced an area of 185 square miles. By about 1930, the District embodied an area of approximately 438 square miles and a population of approximately 3,900,000 persons. As of August 1, 1965, the Sanitary District provided sewage treatment to an area of about 853 square miles encompassing about 90 percent of Cook County, Illinois, including the City of Chicago, which has an area of about 224 square miles, and 105 suburban communities. The population of the District in 1959 was estimated at 4,775,000 people. The District also treats industrial wastes equivalent to the sanitary waste load of more than 3,000,000 people. According to the federal census for the year 1960, the population of the City of Chicago was 3,550,404 and the population of Cook County was 5,129,725. A map of the Sanitary District,

L. S. Ex. 500, showing the territorial annexations from 1889 to 1958 is included in the Appendix to this Report.

IV-3. Prior to 1954 the Sanitary District financed all construction projects through the sale of bonds which were retired from the proceeds of tax levies. Such bonds in the principal amount of $40,092,000 were outstanding as of July 1, 1965. In the 1930's certain grants were received from the Federal Government which amounted to approximately $16,000,000. Since 1954 the Sanitary District has financed construction projects by means of annual tax levies.

IV-4. From 1890, when the Sanitary District was organized, through 1962 the total construction expenditures of the District, exclusive of interest on construction bonds, administrative, legal and clerical expenses, were $525,900,495.17. Of this total $83,398,095.85 was spent for channels and rivers, $192,278,677.76 for treatment works, $212,210,364.80 for sewer systems, $22,315,555.53 for pumping stations, $1,322,428.61 for flood control, $3,578,980.01 for roads and highways, $3,584,258.73 for administration buildings, and $7,203,134.08 for hydroelectric systems. Not reflected in these figures is the cost of pumping stations, sewers and other facilities constructed by the City of Chicago and turned over to the Sanitary District without remuneration.

IV-5. The Sanitary District spent, exclusive of interest on construction bonds, administrative, legal and clerical expenses, $17,854,053.00 on construction projects in 1963. Of this total, $19,603.00 was spent for channels and rivers, $6,660,617.00 for treatment works, $7,375,610.00 for sewer systems, $595,836.00 for pumping stations, $2,916,337.00 for flood control, and $286,050.00 for administration buildings.

IV-6. In 1964 the Sanitary District spent, exclusive of interest on construction bonds, administrative, legal and clerical expenses, $22,921,749.00 on construction projects. Of this total $138,278.00 was spent for rivers and channels,

$8,992,808.00 for treatment works, $12,017,108.00 for sewer systems, $1,671,575.00 for pumping stations, $77,-142.00 for flood control, and $24,838.00 for administration buildings.

IV-7. The total construction expenditures of the Sanitary District for the period 1890 through 1964 were, exclusive of interest on construction bonds, administrative, legal and clerical expenses, $566,676,297.37. Such total construction expenditures are historical cost figures. The Sanitary District does not maintain a depreciation reserve, and the total value of capital equipment now in service is not in the record.

IV-8. During the period 1890 through 1964 the Sanitary District paid $162,246,000 interest on construction bonds issued to finance construction work. This figure does not reflect interest that may be earned by the Sanitary District on bond revenues before such revenues are used for construction purposes.

IV-9. The Sanitary District is authorized to levy taxes at rates which will produce an amount not to exceed $30,-000,000 to be used for construction purposes for the years 1961 through 1965. This limit must also be reduced by the amount of any surplus for construction purposes at the beginning of the year for which the levy is made.

The tax levies do not go into collection until more than a year after they are made. Thus, no collections on the 1961 tax levy were received by the Sanitary District until the last half of 1962. Similarly, no moneys will be received on the 1965 levy until late in 1966. To finance current operations each year the District sells tax anticipation warrants up to a limit of 75 percent of its tax levy. During the period 1961-1965, the Sanitary District levied taxes for construction purposes of $112,000,000. The levies through 1964 are all now in process of collection. The 1965 levy is expected to go into collection in May 1966.

IV-10. The Sanitary District has formulated a long range construction program extending through the year

2010, and has a financed construction program calling for an expenditure of approximately $95,500,000 for construction purposes during the period 1962 through 1965.

IV-11. Between 1962 and the year 2000, assuming the Sanitary District continues to treat the same percentage of total sewage to the same degree of treatment as it has to the date of the end of these hearings, it will have to provide new sewers, additions to existing sewers, new pumping stations, additions to existing pumping stations and new treatment facilities. The cost of these additions to the Sanitary District on the basis of 1962 construction costs was estimated to be as follows:

| ITEM | ESTIMATED COST |
|---|---|
| Sewers | $273,312,000 |
| Pumping Stations | |
| On Sewers | 22,123,000 |
| At Sewage Treatment Plants | 4,826,000 |
| Sewage Treatment Facilities | 63,886,000 |
| Sludge Disposal Facilities | 51,506,000 |
| Waterways | 128,677,000 |
| Replacements | 76,000,000 |
| Unforeseen Developments and Omissions | 93,050,000 |
| Total | $713,380,000 |

To the extent that the additions made to the Sanitary District's physical plant during the period 1962-1964 constitute a portion of such construction, the amount yet to be expended by the year 2000 has accordingly been reduced.

IV-12. If the Sanitary District were to enlarge its facilities between 1962 and 2000 to the extent necessary to enable it to treat two times dry weather flow in the year 2000 the cost would be $148,908,000, as compared with a cost of $120,218,000 which would be incurred if the facilities were expanded to treat 1.5 times dry weather flow.

IV-13. These costs are based on cost experience which prevailed in December 1962. Construction costs will trend upward in the next 38 years. A witness for the defendants testified that if construction costs increase in the next 38 years at the same rate as was experienced in the period 1930-1955, costs will be twice those currently experienced. The witness also testified that it is difficult to expect such a large increase in construction costs. However, he believed that the Sanitary District should prudently provide for an increase of costs in planning facilities for sewage disposal on the basis of the present method.

IV-14. The total sewage treated by the Sanitary District during the period 1952-1964, the percentage of biochemical oxygen demand (hereafter expressed as BOD) removal, total suspended solids in sewage, and percentage of suspended solids removed by treatment are as follows:

| Year | Sewage Treated Million Gallons Per Day | % BOD Removal | Suspended Solids Tons Per Day Raw Sewage | % Suspended Solids Removal |
|---|---|---|---|---|
| 1952 | 1113 | 93.6 | 786.3 | 91.1 |
| 1953 | 1104 | 89.6 | 741.5 | 84.7 |
| 1954 | 1171 | 88.1 | 781.2 | 82.9 |
| 1955 | 1183 | 86.1 | 876.4 | 82.4 |
| 1956 | 1150 | 85.8 | 937.5 | 88.2 |
| 1957(1) | 1231 | 85.6 | 862.0 | 80.6 |
| 1958 | 1103 | 90.6 | 835.7 | 87.5 |
| 1959 | 1247 | 90.8 | 936.3 | 86.7 |
| 1960 | 1241 | 90.5 | 923.4 | 86.0 |
| 1961(2) | 1261 | 87.8 | 909.3 | 81.4 |
| 1962 | 1238 | 89.9 | 1012.0 | 86.2 |
| 1963 | 1182 | 90.6 | 904.0 | 89.4 |
| 1964 | 1253 | not-available | 913.0 | 88.7 |

NOTES:

(1) Low removal due to construction interferences and to experimentation with modified activated sludge in Battery C of West-Southwest plant.

(2) Low removal due to necessity for extra aeration of solids, because of limitation on sludge disposal facilities, now being corrected.

IV-15. The daily efficiency of large activated sludge-type sewage treatment plants varies from the annual average efficiency to a greater degree than average monthly efficiencies.

IV-16. The reasons for the variations in the efficiency of sewage treatment plants are not all known. However, some of the causes are the variable characteristics of the sewage, the weather, unusual discharges of industrial wastes, and difficulties in keeping all parts of the sewage treatment plant in operation at high efficiency at all times.

## B. Rivers and Canals

IV-17. The locations of the rivers and canals and some important features of the sewerage system of the Sanitary District are shown on Ill. Ex. 719, which is included in the Appendix to this Report.

IV-18. The divide separating the Great Lakes-St. Lawrence River drainage basin from the Mississippi River drainage basin passes through the Sanitary District generally about ten miles to the west of the Lake Michigan shoreline at Chicago. When the Sanitary and Ship Canal was constructed, the divide was about ten feet above the level of Lake Michigan at LWD.

IV-19. On the western side of the divide is the Des Plaines River, which rises in southeastern Wisconsin and flows in a southerly direction, parallel to and about 12 miles west of the lake shore; at a point near Summit, Illinois, it turns southwestward and after a distance of about 40 miles, it joins the Kankakee River to form the Illinois River. From this point, the Illinois flows southwestward about 273 miles, and empties into the Mississippi River at Grafton, Illinois.

IV-20. Between Lake Michigan and the divide lie the Chicago River and its two branches, the North Branch which flows in a southerly direction, and the South Branch, which before the Sanitary and Ship Canal was constructed, flowed northerly. About 1.6 miles from the controlling works situ-

ated off the mouth of the Chicago River, these two branches unite to form the main channel of the Chicago River which, before the Sanitary and Ship Canal was constructed, flowed into Lake Michigan.

IV-21. The flow of the Chicago River was reversed in the year 1900, so that it now flows landward, away from Lake Michigan, into the Sanitary and Ship Canal. This canal begins at the West Fork of the South Branch of the Chicago River, at a point about six miles from Lake Michigan measured along the Chicago River. Flowing southwestward, away from Lake Michigan, the Sanitary and Ship Canal pierces through the divide which separates the Great Lakes-St. Lawrence River drainage basin from the Mississippi River drainage basin, and enters the valley of the Des Plaines River. The canal parallels the Des Plaines and ultimately joins that river near Lockport, Illinois, about 31 miles downstream from the junction of the South Branch and the Sanitary and Ship Canal.

IV-22. A canal known as the North Shore Channel connects the North Branch of the Chicago River with Lake Michigan at Wilmette, Illinois, a suburb north of Chicago. This channel flows southerly about 8.1 miles where it joins with the North Branch of the Chicago River. Diversions from Lake Michigan and its drainage basin through the North Shore Channel flow into the Sanitary and Ship Canal by way of the North and South branches of the Chicago River.

IV-23. At the Wilmette intake of the North Shore Channel, there is a sluice gate installed in what was once a lock, and a pumping station designed to permit lake water to be pumped into the channel, but at the same time prevent water in the channel at high channel and low lake levels from flowing back into the lake.

IV-24. At the mouth of the Chicago River, there are sluice gates and a lock which permit lake water to enter, and normally prevent river water from flowing into the lake.

IV-25. Since completion of the control works severe storms in October 1954, July 1957, and September 1961 produced enough runoff to require that the gates in the locks at the mouth of the Chicago River be opened for several hours to permit the water in the canal to flow into Lake Michigan. Since completion of the North Shore Channel, there were three occasions when severe storms required that the Wilmette Sluice Gate be opened for several hours to permit the North Shore Channel to flow into Lake Michigan. Two of these occasions were in September 1961; the third was on July 2, 1962. The gates were opened and the flow was permitted to enter the lake, because the hydraulic capacity or gradient of the canals was insufficient to carry all of the storm runoff away from the lake.

IV-26. The Little Calumet River and Grand Calumet River rise in the State of Indiana. Part of the flow of the Little Calumet River enters Lake Michigan in Indiana through Burns Ditch, and a part flows in a westerly direction into the State of Illinois. Part of the flow of the Grand Calumet River enters Lake Michigan through the Indiana Harbor Canal at Indiana Harbor, Indiana, and a part flows in a westerly direction into the State of Illinois. After entering the State of Illinois, the Little Calumet River curves to the north and east and unites with the Grand Calumet River to form the Calumet River which connects with Lake Michigan at Calumet Harbor, Illinois.

IV-27. From its junction with the Little Calumet River near Blue Island, Illinois, the Calumet-Sag Channel runs westerly into the valley of the Des Plaines River and joins with the Sanitary and Ship Canal near Sag Junction, Illinois about 16 miles west of the beginning at the Little Calumet.

IV-28. A lock, known as the Blue Island Controlling Works, is located in the Calumet-Sag Channel about 250 feet west of the junction of the Little Calumet River and the Calumet-Sag Channel. Gates in the lock are operated to try to control the flow into or out of the Calumet-Sag Channel.

IV-29. The flow into the Calumet-Sag Channel of water diverted through channels of the Calumet River system, from Lake Michigan and its drainage basin including runoff from that portion of the Calumet River watershed which is situated generally eastward of the Blue Island Lock, is regulated by operation of the lock gates. The gates normally open sufficiently to draw into the Calumet-Sag Channel the desired amount of water. They are completely opened during periods of heavy rainfall when it is desired to minimize, insofar as possible, runoff flows into the lake, and they are closed as far as possible, but not completely, whenever the water level in the Calumet-Sag Channel becomes higher than the level in the Little Calumet River at its junction with the Calumet-Sag Channel.

The parts of the flow of the Grand Calumet and the Little Calumet Rivers entering the State of Illinois, and the flow of the Calumet River are sometimes into the Calumet-Sag Channel and sometimes toward Lake Michigan. A reasonable estimate of the amount of water diverted from Lake Michigan and its drainage basin through the Calumet-Sag Channel during the years 1956-1960 is 200 cfs. A new lock, known as the O'Brien Lock, has been constructed in the Calumet River lakeward of the junction of the Little Calumet River and the Calumet-Sag Channel, downstream of the junction of the Little Calumet River and Grand Calumet River with the Calumet River and just landward of Lake Calumet. The O'Brien Lock was placed in operation on July 1, 1965. With the O'Brien Lock in operation, a larger portion of the runoff from the watershed of the Calumet River system eastward of the O'Brien Lock will be diverted to the Calumet-Sag Channel. A reasonable estimate of the amount of water so diverted from Lake Michigan is 400 cfs.

IV-30. The Illinois and Michigan Canal was completed in 1848. Water was diverted from the drainage basin of Lake Michigan through this canal. The Sanitary and Ship Canal was first opened to the passage of water from the

canal into the Des Plaines River in 1900. Upon completion of the Sanitary and Ship Canal in 1910, including a navigation lock at Lockport, Illinois, that portion of the Illinois and Michigan Canal between the Chicago River and the Des Plaines River at Joliet, Illinois, was abandoned and the diversion of water through the Illinois and Michigan Canal ceased. The present Illinois waterway, including the Sanitary and Ship Canal and the Calumet-Sag Channel and the canalized channels of the Des Plaines and Illinois Rivers, constitutes a federally maintained waterway extending from the Lake Michigan ports of Chicago and Calumet Harbor to the Mississippi River at Grafton, Illinois, with a least project depth of nine feet.

The Chicago River from Lake Michigan to the junction of the North and South Branches of the river has a channel bottom width of about 250 feet and has a project depth of 21 feet, with the lake at LWD, and with the river, landward of the lock, at normal pool level—0.6 foot below the LWD level of Lake Michigan. The South Branch of the Chicago River, from its junction with the North Branch to the Sanitary and Ship Canal, has a channel bottom width of about 200 feet and the channel depth, when constructed, was 21 feet below the hydraulic grade line that then existed, with the Lake Michigan level at Chicago City Datum (hereinafter CCD) which is 579.88 feet above mean tide New York. The Sanitary and Ship Canal had an original depth of between 21 and 24 feet. Its bottom width is between 160 and 200 feet.

The North Shore Channel from its junction with Lake Michigan at Wilmette to its junction with the North Branch of the Chicago River is about ten feet deep when the water surface elevation is at CCD. Its bottom width is about 30 feet.

For a distance of 1.6 miles downstream from its junction with the North Shore Channel, the North Branch is about ten feet deep when the water surface elevation is at CCD, and has a bottom width of about 30 feet. Continuing southward on the North Branch for 3.5 miles, the bottom

width varies from about 80 to 100 feet and the depth is about 13 feet, when the water surface elevation is at CCD. For the remaining distance to the junction of the North Branch with the Chicago River, the bottom width varies from about 90 to 110 feet and the project depth is 21 feet with the Chicago River at normal pool level.

The Calumet River from Calumet Harbor, where it joins with Lake Michigan, to a point about 1½ miles northerly of the junction of the Little and Grand Calumet Rivers has a project depth of 21 feet and a channel bottom width of about 200 feet. Continuing southerly from this point on the Calumet River to the junction of the Little and Grand Calumet Rivers and continuing westerly from the junction, on the Little Calumet River to the Calumet-Sag Channel, the project depth is nine feet and the bottom width is about 300 feet. The Calumet-Sag Channel was originally constructed with a channel bottom width of from 36 to 60 feet, in which channel the present minimum depth is about 13 feet. The existing federal project for widening the Calumet-Sag Channel provides for a bottom width of 225 feet. The project depth for this widening is nine feet. Work on the project to widen the Calumet-Sag Channel commenced in 1955 and is still in progress. The increased width has been provided except at fixed bridges and in a reach of the channel in the vicinity of Blue Island, Illinois.

IV-31. The lock at the mouth of the Chicago River permits marine traffic to enter and leave the canal system, and normally prevents canal water from discharging into the lake. The amount of water diverted into the Sanitary and Ship Canal by operation of this lock depends on the number of lockages which varies substantially with the season. The amount of lockage water required also depends on the relative water levels of Lake Michigan and the Chicago River and Sanitary and Ship Canal at the time of each lockage. In the period 1955-1960, the maximum annual requirement of the lock at the mouth of the Chicago River was equivalent to a continuous flow of 45 cfs and

the minimum annual requirement was equivalent to the continuous flow of 14 cfs. No data are available as to the lockage requirements of the O'Brien Lock, but it is expected that the requirements of this lock will not exceed 60 cfs.

Combining the lockage requirements for the Chicago River Lock and the O'Brien Lock and allowing 20 cfs for leakage gives a total estimated lockage requirement in the upper locks of 130 cfs. Lockage requirements at Lockport are in the order of 300 to 450 cfs throughout the year. The average lockage requirement at Lockport for the year 1964 was 369 cfs. Water from all sources in the canal, including effluent, water admitted directly from the lake, lockage water from the upper locks, and a portion of the runoff, is available for lockages and the generation of power at Lockport.

### C. Sources of Water Diverted

IV-32. Water diverted from Lake Michigan enters the Sanitary District's canals from three separate sources. Water is diverted directly from Lake Michigan into the canals through the locks and control works at the mouth of the Chicago River and at Wilmette, and through the Calumet River and the Little Calumet River to its junction with the Calumet-Sag Channel. Part of the runoff from the drainage basins of the Chicago River and Calumet River systems, which before the canals were constructed flowed into Lake Michigan, now flows directly into the canals or their tributaries or is diverted into the canals or their tributaries through the sewers, interceptors and treatment plant systems in the Sanitary District. Water withdrawn from Lake Michigan through the intake cribs of the Bureau of Water of the City of Chicago, for domestic, industrial and other purposes, is discharged into the Sanitary District's canals after use in the form of sewage effluent and spillage from the interceptors. Water from cities in the Sanitary District not served with water by the City of Chicago, some of which is taken from Lake Michi-

gan and its drainage basin, is similarly discharged after use into the Sanitary District's canals.

IV-33. The 1930 decree of the Supreme Court of the United States [281 U.S. 696-697] enjoined "the defendants, the State of Illinois and the Sanitary District of Chicago . . . from diverting any of the waters of the Great Lakes-St. Lawrence system or watershed through the Chicago Drainage Canal and its auxiliary channels or otherwise in excess of the annual average of 1,500 cubic feet per second in addition to domestic pumpage."

IV-34. The amount of water from Lake Michigan diverted directly into the canals during the years 1950 through 1964 is estimated to be an annual average of 1,018 cfs. Disregarding the years 1956 and 1957 when the allowable total diversion was increased pursuant to an order of the Supreme Court of the United States [352 U.S. 945 (1956)], the amount diverted directly into the canals during the years 1950 through 1964 is estimated to be an annual average of 945 cfs. The foregoing figures are arrived at by deducting from the figures of 1,568 cfs and 1,495 cfs, respectively, appearing in column (a) of the table contained in Finding IV-37, the figure of 550 cfs given in Finding IV-35 as the average amount of diverted runoff for the years 1950 through 1959.

IV-35. The amount of runoff diverted from the drainage basins of the Chicago and Calumet River systems for the period 1950 through 1959, inclusive, is estimated to be an average of about 550 cfs annually.

IV-36. Domestic pumpage accounted for at Lockport amounted to an annual average of 1,734 cfs for the years 1950 through 1964. Water diverted by the City of Chicago for domestic, industrial and other purposes for the period 1950 through 1964 amounted to an annual average of 1,569 cfs. In addition to the water reported as domestic pumpage for the City of Chicago by the Department of Water and Sewers of the City of Chicago, the Chicago Park

District uses about 4 cfs of water diverted from Lake Michigan annually.

IV-37. The Sanitary District, under the supervision and direction of the District Engineer, Chicago District, Corps of Engineers, United States Army, determines the total of the amount of water diverted directly into the canals from the lake plus the amount of runoff diverted from the drainage area which under natural conditions would flow into Lake Michigan. This determination, partly a measurement and partly an estimate, is made by deducting from the total flow at Lockport the domestic pumpage from Lake Michigan by the City of Chicago; the domestic pumpage from Lake Michigan by municipalities not served by the City of Chicago, but discharging sewage into the Sanitary District drainage area; the domestic pumpage reaching the canals from wells; the pumpage by the Chicago Park District; and the inflow from the Des Plaines watershed which is not a part of the Great Lakes-St. Lawrence River system or watershed. The remainder is water diverted directly from Lake Michigan and its drainage basin exclusive of domestic pumpage.

The total amount of water diverted from Lake Michigan on an annual average basis for the years 1930 through 1964, showing separately the amounts of water diverted directly from the lake and as runoff, the amount of domestic pumpage diverted by all cities in the Sanitary District including the City of Chicago, and the amounts of domestic pumpage diverted solely by the City of Chicago, are tabulated in the following table:

| Year | (a) Water taken directly through canals from Lake Michigan plus runoff from Lake Michigan watershed (cfs) | (b) Domestic Pumpage reaching canals from all cities in Sanitary District including City of Chicago (cfs) | (c) Domestic Pumpage by City of Chicago and suburbs served by City of Chicago (cfs) | (d) Total Diversion [(a) + (b)] (cfs) |
|---|---|---|---|---|
| 1930 | 6660 | 1700 | 1639 | 8360 |
| 1931 | 6500 | 1680 | 1599 | 8180 |
| 1932 | 6450 | 1650 | 1562 | 8100 |
| 1933 | 6270 | 1690 | 1605 | 7960 |
| 1934 | 6433 | 1692 | 1605 | 8125 |
| 1935 | 6484 | 1602 | 1527 | 8086 |
| 1936 | 4862 | 1712 | 1636 | 6574 |
| 1937 | 4989 | 1665 | 1585 | 6654 |
| 1938 | 4999 | 1604 | 1514 | 6603 |
| 1939 | 1499 | 1577 | 1492 | 3076 |
| 1940* | 1681 | 1589 | 1491 | 3270 |
| 1941 | 1496 | 1610 | 1512 | 3106 |
| 1942** | 1528 | 1575 | 1479 | 3103 |
| 1943 | 1500 | 1605 | 1509 | 3105 |
| 1944** | 1531 | 1606 | 1512 | 3137 |
| 1945 | 1498 | 1587 | 1491 | 3085 |
| 1946 | 1495 | 1600 | 1504 | 3095 |
| 1947 | 1500 | 1616 | 1516 | 3116 |
| 1948 | 1500 | 1640 | 1503 | 3140 |
| 1949 | 1493 | 1641 | 1504 | 3134 |
| 1950 | 1499 | 1607 | 1471 | 3106 |
| 1951 | 1490 | 1616 | 1481 | 3106 |
| 1952 | 1497 | 1633 | 1497 | 3130 |
| 1953 | 1499 | 1692 | 1557 | 3191 |
| 1954 | 1497 | 1708 | 1573 | 3205 |
| 1955 | 1500 | 1739 | 1604 | 3239 |
| 1956* | 1699 | 1805 | 1596 | 3504 |
| 1957* | 2387 | 1784 | 1581 | 4171 |
| 1958 | 1498 | 1760 | 1557 | 3258 |
| 1959 | 1487 | 1803 | 1599 | 3290 |
| 1960 | 1497 | 1774 | 1590 | 3271 |
| 1961 | 1493 | 1745 | 1577 | 3238 |
| 1962 | 1496 | 1792 | 1625 | 3288 |
| 1963 | 1489 | 1783 | 1614 | 3272 |
| 1964 | 1491 | 1771 | 1617 | 3262 |

* Increase over 1,500 cfs authorized by Supreme Court.

** Increase over 1,500 cfs authorized by the War Department.

| | | | | |
|---|---|---|---|---|
| Averages 1930-1964 | 2682 | 1676 | 1552 | 4358 |
| Averages 1950-1964 | 1568 | 1734 | 1569 | 3302 |
| Averages 1950-1964 not including 1956 and 1957 | 1495 | 1725 | 1566 | 3220 |

The differences between the amounts shown in columns (b) and (c) are attributable to the inclusion in column (b) of the following amounts in addition to the amounts in column (c):

Domestic pumpage drawn from Lake Michigan by a number of Illinois suburbs on the lake north of Chicago and by certain Indiana municipalities which drains into the Sanitary District drainage area and the production from several municipal and other wells located within and without the Lake Michigan drainage basin. For example, in 1957, 213.97 cfs (adjusted downward and reported as 203 cfs) of domestic pumpage reached the canal from sources other than the domestic pumpage drawn from the lake by the City of Chicago. Of this amount, 42.37 cfs was drawn from the lake by the Illinois northshore suburbs, 63.84 cfs was drawn from the lake by four Indiana municipalities, and 107.76 cfs was drawn from municipal and private wells within and without the Lake Michigan drainage area in Illinois. The pumpage reaching the canals from the Indiana municipalities is estimated to have been about 37 cfs in 1962, the decrease being caused by the lower lake level at the time. Other data subsequent to 1957 is not of record.

In addition to water from the Lake Michigan drainage basin, the canals upstream of Lockport receive water from the Des Plaines River drainage basin. In the years 1950 through 1964, an average of 239 cfs reached the canals, above Lockport, from the Des Plaines watershed. The inflow from the Des Plaines watershed has varied on an annual average basis from 81 to 462 cfs.

D. THE WATER WORKS SYSTEM

IV-38. Domestic pumpage withdrawn from Lake Michigan by the City of Chicago was about 0.5 million gallons per day (hereafter expressed as MGD),* or less than one cfs in 1854, and 1,046 MGD, or 1,617 cfs, in 1964. Of the 1,617 cfs of domestic pumpage diverted by the City of Chicago in 1964, about 1,409 cfs were used by the City of Chicago and about 208 cfs were sold to suburban communities served by the City of Chicago.

IV-39. The water system is operated by the Bureau of Water, Department of Water and Sewers of the City of Chicago, a corporate municipal instrumentality and political subdivision of the State of Illinois.

IV-40. The water system of the City of Chicago consists generally of water intake cribs in Lake Michigan, tunnels to bring the water from the cribs into the treatment works, the South District Filtration Plant, the Central District Filtration Plant, which was completed and has been in operation since October 1964, a number of pumping stations and ground reservoirs, and a system of tunnels and mains through which the water is distributed to all parts of the city, a number of suburbs and industrial plants which are supplied with water from the Chicago water system. A map, in evidence as page 17 of Ill. Ex. 618, showing the location of the principal features and the areas supplied by the water system is included in the Appendix to this Report.

IV-41. Water from Lake Michigan enters the water works system through structures, known as cribs, located offshore in the lake. The Wilson Avenue Crib is located 2.1 miles offshore in a water depth of 33.5 feet below CCD. The William E. Dever Crib is located 2.65 miles offshore in a water depth of 34 feet below CCD. The Edward F. Dunne Crib is located two miles offshore in a water depth of 32 feet below CCD. Two other cribs, the Carter H. Harrison

* 1 MGD equals 1.547 cfs.

Crib and the 68th Street Crib, presently located in the lake, are no longer in use. The Four Mile Crib is now used only as a temporary source of supply for the Chicago Park District. The Central District Filtration Plant is supplied with raw water from the Wilson Avenue and Dever Cribs and from a shore intake. The South District Filtration Plant is supplied with raw water from the Dunne Crib and at certain times of the year, with a supplemental supply from a shore intake. The shore intake is in a water depth of 24 feet below CCD.

IV-42. Water enters the cribs through intake ports in the crib walls, the center points of the ports being at depths of about 25 feet below CCD. The center points of the intake ports at the Wilson Avenue Crib are 26.5 feet below CCD. The center points of the intake ports at the Dunne Crib are 22.0 feet below CCD. The center points of the intake ports at the Dever Crib are between 28.5 and 31.5 feet below CCD.

IV-43. From the cribs, the water flows shoreward through concrete-lined tunnels drilled through rock, 50 to 190 feet below the lake level into the South District Filtration Plant for treatment and into the Central District Filtration Plant for complete treatment and filtration before distribution in the North and Central Districts. The entire tunnel system comprises a total length of about 75 miles of tunnels ranging in diameter from six to 20 feet.

IV-44. Water distributed in the southern third of the area served is given complete treatment and filtration at the South District Filtration Plant. At present, water distributed in the northern two-thirds of the area served receives chlorination and fluoridation only. The Central District Filtration Plant provides complete treatment and filtration for water distributed in the northern two-thirds of the area served.

IV-45. The South District Filtration Plant provides coagulation, settling, filtration and chlorination to the water received from the lake. A schematic diagram show-

ing the flow of water through the South District Filtration Plant is given in Ill. Ex. 619, Figure 5.

IV-46. The raw water is elevated 20 or 25 feet by eight electrically powered pumps from the intake basin into the raw water conduit, where the flow is divided into three equal parts and discharged into three mixing basins. From the raw water conduit, the water flows through the plant and the balance of the treatment process by gravity.

IV-47. Chemicals are measured, added and gently mixed with the water in the mixing basins. The chemicals are chlorine, aluminum sulfate (commonly called alum), ferrous sulfate, lime, activated carbon, hydrofluosilicic acid, and sometimes sodium silicate treated with sulfuric acid.

IV-48. The function of the chlorine is to destroy bacteria in the raw water and, under some conditions, to partially oxidize pollutants which cause undesirable tastes and odors in the water.

IV-49. The alum (or aluminum sulfate) and the ferrous sulfate are coagulants. Their function is to produce coagulation by which much of the suspended particles, such as mud, bacteria, algae, other microscopic organisms, and other impurities are brought together. The coagulants bring the finely suspended solids in the raw water together into masses of particles that become large enough and heavy enough to settle to the bottom of the settling basins.

IV-50. Sodium silicate treated with sulfuric acid is used under certain conditions to secure more satisfactory flocculation and coagulation. Lime is used to raise the alkalinity, or pH, of the finished water to the desired level. Activated carbon is used to remove undesirable tastes and odors.

IV-51. After the chemicals are mixed, the water flows slowly through three settling basins. Each basin is 480 feet long by 140 feet wide and two stories high. The water is retained in the basins for three to five hours. Seventy to

90 percent of the coagulated material and impurities are removed by settling.

IV-52. The masses of particles not removed by settling are removed by filtration. Eighty filters are used to filter the water. Each filter is composed of a sand bed, 54 feet by 25.7 feet, supported by gravel in a reinforced concrete tank. Cast iron pipes, spaced 12 inches apart, containing holes at six-inch intervals, are placed at the bottom of each filter. The pipes are covered with 21½ inches of gravel, ranging in effective size from 3½ inches at the bottom to ½ inch at the top. On the top of this is 25 inches of sand, about 0.65 millimeter in effective size.

IV-53. In filtration, the water flows from the top of the settling basins into the conduits leading to the top of the filters, passes downward through the sand and gravel, collects in the underdrain pipes, and then flows through a filter rate controller into the filtered water reservoir underneath.

IV-54. The production of each filter is from two to eight million gallons of filtered water daily, depending on requirements.

IV-55. The filtration of water eventually results in the accumulation on the filters of chemically coagulated matter, algae and other microorganisms, and other suspended solids. This accumulation gradually reduces the rate of filtration per unit of filter area to a point at which the filter must be washed by reversing the flow of water to force it up and through the gravel and sand. Under normal conditions, filters are washed on the average of once daily; at the South District Filtration Plant, four to ten million gallons of filtered finished water are required daily to wash the 80 filters. Each filter is provided with troughs and a gutter, which carry the wash water away for discharge into the lake after undergoing settling treatment.

IV-56. The chlorinating system is so arranged that in case the residual, or concentration, of chlorine in the

water under treatment should drop below the desired level at any point in the treatment plant, additional chlorine can be added to it. Chlorine can be added in the mixing basins, in the filtered water conduit, or in the outlets of the finished water reservoirs. As water is withdrawn from the finished water reservoir a small amount of chlorine and ammonia is added. The ammonia combines with the free chlorine to form chloramines which have a lasting bactericidal effect without imparting a noticeable chlorine taste to the water. The Chicago Bureau of Water has been successful in producing a bacteria-free finished water at Chicago by providing only chlorination of the drinking water distributed in the northern two-thirds of the city and by providing coagulation, filtration, and chlorination of the water distributed through the South Filtration Plant.

IV-57. The South District Filtration Plant has a rated capacity of 320 MGD, or 495 cfs. The settling basin capacity of the plant is presently being increased by two-thirds. The filter capacity is being increased by one-half.

IV-58. The new Central District Filtration Plant functions much the same as the South District Filtration Plant. The Central District Filtration Plant is the world's largest filtration plant, having a nominal capacity of 960 MGD, or 1,480 cfs, and a maximum design capacity of 1,700 MGD, or 2,600 cfs.

IV-59. From the filtration plants the water is distributed to the consumers via underground mains. In 1960, the City of Chicago water system had 4,140 miles of water mains, ranging in diameter from four to 54 inches. The average diameter of mains in Chicago's system is 10.2 inches.

IV-60. The City of Chicago also sells water to 61 suburban communities, all of which are located within the Sanitary District. (See map appearing on page 17 of Ill. Ex. 618, which is included in the Appendix to this Report.) In 1964, 134.5 MGD or 208 cfs, were sold by the City of Chicago

to the suburban communities. The amount of water sold to the suburbs since 1930 is indicated on the following table:

| Year | WATER SOLD TO SUBURBAN COMMUNITIES MGD | cfs |
|---|---|---|
| 1930 | 39.6 | 61.3 |
| 1935 | 37.9 | 58.6 |
| 1940 | 45.9 | 71.1 |
| 1945 | 63.6 | 98.4 |
| 1950 | 70.2 | 108.5 |
| 1955 | 106.4 | 164.8 |
| 1960 | 122.9 | 190.0 |

IV-61. It is not possible to determine the actual amount of underground leakage from the Chicago water main system, but it is agreed that the best estimate from the data available is 45,000 gallons per day per mile of pipeline. Based on 4,107 miles of pipeline in service in 1957, the leakage amounts to about 185 MGD, or about 285 cfs, for the entire City of Chicago system.

IV-62. As of December 1964, there were 508,270 customer service connections in Chicago of which 160,354 were metered. As of that date water meters had not been installed at 68.5 percent of the customer service connections in Chicago. The percentage of unmetered customer services since 1920 is indicated by the following table:

| Year | Number of Services | Number of Services Metered | Percentage of Services Unmetered |
|---|---|---|---|
| 1920 | 313,392 | 29,921 | 90.5 |
| 1930 | 422,066 | 85,845 | 79.7 |
| 1935 | 413,189 | 111,773 | 73.0 |
| 1940 | 414,434 | 115,174 | 72.2 |
| 1945 | 420,397 | 115,016 | 72.7 |
| 1950 | 438,765 | 121,834 | 72.2 |
| 1955 | 474,414 | 132,436 | 72.1 |
| 1960 | 500,436 | 151,836 | 69.7 |

In 1930, 33.4 percent of the water sold in the City of Chicago, was metered, and in 1964, 48.4 percent of the

water sold in the City of Chicago was metered, including in both cases metered water to free services. In 1964, total metered pumpage, including water delivered to the suburbs, was 55.3 percent of total pumpage.

IV-63. Based on population statistics and water production records, the average per person water usage in the City of Chicago was 258 gallons per capita per day in 1957, and 256 gallons per capita per day in 1964.

IV-64. The Chicago system of pumping stations operated in conjunction with the tunnel system has an installed capacity of 3,030 MGD. In 1964, the average daily pumpage was 1,046 million gallons, the maximum day pumpage was 1,530 million gallons, and the maximum hour pumpage was at a rate of 1,888 MGD. Pumping station capacity in excess of expected peak demand is required to meet emergency requirements arising from fire fighting, power failure at pumping stations, and regular shut down of pumps for repair.

IV-65. The capacity of the filtered water reservoirs at the South District Filtration Plant is 47,000,000 gallons, not including the capacity of a 30,000,000 gallons reservoir at the Western Avenue Pumping Station used in conjunction therewith. Daily demand for water at the South District may be as much as 575 MGD, and the peak hourly demand may reach a rate of 632 MGD.

IV-66. The capital improvement program for the five-year period 1962-1966 for the Chicago Department of Water and Sewers calls for a total expenditure of $85,731,000 which includes $32,400,000 for completion of the Central District Filtration Plant, $36,398,000 for water main construction, and $16,933,000 for improvements to the South District Filtration Plant, to tunnels and shafts, and to pumping stations. This program of capital expenditures was approved by the Chicago City Council on September 21, 1962.

IV-67. Chicago's maximum day pumpage in 1930 was 1,251 million gallons and in 1964 was 1,530 million gallons.

Its maximum hourly rate of pumpage in 1930 was 1,444 MGD and in 1964 was 1,888 MGD. In 1930, Chicago's average daily pumpage was 1,059 MGD, and in 1964 was 1,046 MGD.

IV-68. The existing requirements for water meters in the City of Chicago, as set out in the relevant city ordinance, require meters for all premises (1) where the gross charges under assessed rates are $35 annually or more; (2) on service pipes supplying four or more one-story stores; (3) on service pipes which serve buildings located remotely from the city water main; and (4) on service pipes supplying premises located outside of the corporate limits of the city. The ordinance further states that meters shall not be required in single family and two-flat dwellings unless they contain machines or devices which tend to the excessive use of water. The ordinance further provides that meters may be installed on any service pipe when leaks, waste, or unauthorized or excessive use of water are found.

IV-69. The Chicago city ordinance governing the use of water meters also requires that all meters shall be furnished and installed by and at the expense of the city, except in new buildings where the owner's plumbing contractor shall install the meters.

IV-70. Practically every residential building containing three or more flats or apartments has an annual water bill at assessed rates in excess of $35. As of July 1965, the program for metering residential buildings of three flats or larger in size was completed, except for premises recently converted from two flat size. The metering of these additional premises has been completed and hereafter meters will be installed in all newly built or newly converted three-flat buildings or larger as construction or conversion is completed.

IV-71. Universal metering of private dwellings in Chicago, over and above three-flat and larger residential units for which metering is presently planned or completed,

would require installation of meters in 332,689 single family and two-flat dwellings.

E. THE SEWERAGE SYSTEM

IV-72. Sewage from the homes, commercial establishments and industries and the runoff from storms within the Sanitary District are picked up by lateral and main sewers built and maintained by the individual municipalities served, such as the City of Chicago.

IV-73. The lateral and main sewers discharge into interceptors, built and maintained by the Sanitary District. The interceptors carry a mixture of sanitary sewage and storm runoff to the Sanitary District's treatment plants. See Ill. Ex. 719, which is included in the Appendix to this Report.

IV-74. The lateral and main sewers serving the City of Chicago and about one-half of the suburban communities served by the Sanitary District are combined sewers.

It is estimated that in 1965 approximately 83 percent of the population served by the Sanitary District was served by combined sewers. The other 17 percent was served by sanitary sewers.

IV-75. Combined sewers receive storm runoff, infiltration and sanitary and industrial waste. The sanitary and industrial waste and the storm runoff are inextricably mixed in combined sewers. Sanitary sewers receive sanitary and industrial waste, but do not intentionally admit storm runoff, although occasionally some runoff does infiltrate or otherwise enter such sewer through improper connections and other causes.

IV-76. During intense storms, the volume of runoff reaching the combined sewers within the Sanitary District may be 30 to 50 times the volume of the peak dry weather flow. The dry weather flow is the flow attributable to sanitary and industrial wastes unaffected by rainfall. Some of the storm runoff collects in streets and gutters and enters

the combined sewers through curb inlets or catch basins. Some of the runoff also collects in depressions and ultimately seeps into the ground or evaporates.

IV-77. The intercepting sewers, or interceptors, generally parallel open watercourses, such as the canals, rivers and lakes. The interceptors pass below the lower ends of the municipally owned sewers and collect their flow for the purpose of transporting it to the Sanitary District's treatment plants.

IV-78. The connections between the municipally owned combined sewers and the interceptors are provided with alternate outlets which permit part of the flow from the municipally owned sewers to run into the nearest stream or canal, no part of the flow being permitted to run into Lake Michigan. The alternate outlets are necessary to prevent flooding during storms, since the interceptors are sized to take the dry-weather sanitary sewage and a portion of the combined storm and sanitary flow during periods of storm. The interceptors are generally designed to have a capacity of between 2 and 3½ times the projected dry-weather flow that will occur some 40 or 50 years in the future. The spillage from the municipally owned sewers normally flows into the adjacent water courses by gravity. The inside top of the interceptors is generally below the surface elevation of adjacent water courses, so that there can be no gravity flow from the interceptors to such water courses. However, at certain locations some of the flow in the interceptors is, at times, pumped into the adjacent water courses.

IV-79. Since the storm flow may be as much as thirty to fifty times the peak dry weather flow, when the interceptors are sized to take 2 to 3½ times the dry weather flow as much as 90 to 95 percent of the combined flow of untreated sewage and runoff reaching the interceptors during or shortly after storms may be spilled (or pumped) into the nearest watercourse.

IV-80. At a number of the connections between the municipally owned combined sewers and the interceptors, the quantity of flow entering the interceptors and the quantity of flow discharged into the nearest open stream or canal are controlled at structures known as diversion chambers.

IV-81. There are approximately 360 diversion chambers in the Sanitary District.

IV-82. In most cases, the controlling devices in diversion chambers are adjusted so that flows from the municipally owned sewers up to a pre-determined quantity, generally 1½ or 2 times the average dry weather flow, pass through the openings into the interceptors below. Thus, when the flow is small, as during dry weather, the entire flow of the municipal sewers passes through the openings into the interceptors. When the flow is large, as during a storm, the water level builds up in the municipally owned sewers, the openings into the interceptors being too small to permit all the flow to pass through. When the level builds up enough, some of the flow from some of the municipally owned sewers escapes into the nearby waterways. (L.S. Ex. 502 is a schematic diagram of a typical diversion chamber.)

IV-83. When the interceptor is not full, the quantity of flow reaching an interceptor and the quantity of flow overflowing into the canal are dependent upon the size of the opening into the interceptor; upon the depth, or head, of flow in the municipally owned sewer; and upon the type of diversion chamber, the gate setting, the relative elevation of the stream or canal surface in relation to the water elevation in the sewer, the presence or absence of flood gates, and other factors. The size of the opening depends on the setting of the sluice gate in the diversion chamber. The head depends on the position and height of the weir placed on the downstream side of the opening into the interceptor. When the interceptor is full, the quantity of

flow entering the interceptor depends upon the relative elevation or pressure of the flow in the sewer and in the interceptor. On at least one occasion, the mechanism in a diversion chamber has malfunctioned and permitted untreated sewage to pass into the canal system during dry periods.

IV-84. The quantity of flow intercepted at most diversion chamber points is controlled by fixed gate settings which can be adjusted from time to time. In some diversion chambers, the sluice gates are motor operated by remote control or automatic devices.

IV-85. Some flow not passing into the interceptors usually flows by gravity, but in some cases is pumped, into the canals or streams.

IV-86. The Sanitary District's interceptor system includes about 270 miles of intercepting sewers, varying in size from 18 inches in diameter to 24 feet in height to 20 feet in width. The interceptor system is shown on Ill. Ex. 719, which is included in the Appendix to this Report.

IV-87. Nine pumping stations are located throughout the interceptor system. The pumps are necessary to force the flow through the system, due to the extremely flat terrain in the Sanitary District. Some of the pumps also pump excess combined sewage out of the sewers into the canals during storms in order to prevent sewage from flooding houses, basements and other facilities. The Racine Avenue Pumping Station and the Calumet Storm Pumping Station discharge some of the flow coming to them into the canals during storms for short periods. The Racine Avenue Pumping Station, after a storm, may also pump back into the interceptor from the South Fork.

IV-88. At each of the Sanitary District's major treatment plants large pumps lift the sewage from the deep interceptors to a point where it can flow by gravity

through the treatment works and discharge as effluent into the canal or its tributaries.

IV-89. As of August 1, 1965 the Sanitary District had three major sewage treatment plants and eight small independent sewage treatment plants. The eight small plants operated by the District in 1965 treat only 0.3 percent of the total sewage flow of the Sanitary District. The three major treatment plants of the District are:

(1) The North Side Treatment Works, which prior to the installation of the fourth battery of tanks in 1962, had a design rated capacity of 250 MGD average flow and 385 MGD design maximum flow.

(2) The Calumet Treatment Works with a design rated capacity of 136 MGD average flow and 210 MGD design maximum flow.

(3) The Stickney Treatment Works, consisting of the West Side and Southwest Treatment Works, which are operated as one unit and together have a design rated capacity of 900 MGD average flow and 1,200 MGD design maximum flow. The locations of the treatment plants as of 1962 are shown on Ill. Ex. 719, which is included in the Appendix to this Report.

IV-90. The quantities of combined sewage entering the plants for complete treatment cannot be greater than the hydraulic capacities of the plants, which are 385 MGD for the North Side Treatment Works, 210 MGD for the Calumet Treatment Works, and 1,200 MGD for the Stickney Treatment Works. The Sanitary District seldom allows the amount of sewage pumped into the plants to reach these hydraulic capacities. Sewage not pumped into the plants for treatment is discharged into the canals through overflows at the pumping stations or at the diversion chambers.

IV-91. The sewage treatment employed at the North Side Plant, the Calumet Plant and the Southwest division

of the Stickney Plant is known as the activated sludge process. As used in these plants, the activated sludge process consists of three steps:

(1) Heavy solid material is first removed from the sewage by means of screens, grit chambers, and primary or preliminary settling tanks. The solid material so removed from the sewage is disposed of.

(2) The clarified effluent from the primary or preliminary tanks is then subjected to vigorous aeration and mixing in the presence of previously formed activated sludge. The sludge is composed of organic material, inoculated with aerobic bacteria that have the faculty of breaking complex organic material down into simple stable compounds. The aeration process takes place in the aeration tanks, and is the most essential part in reducing the biochemical oxygen demand of the sewage.

(3) The aerated and biologically treated effluent from the aeration tanks passes to final settling tanks where the activated sludge settles out. If the aerated effluent went directly to the canal without final settling it would carry in it large masses of flocculent activated sludge that might settle out and form sludge banks in the canal. The final tanks are necessary therefore to provide a clear effluent, low in suspended solids, and to reclaim part of the activated sludge for return to the aeration tanks to inoculate the clarified effluent from the primary or preliminary tanks as it enters the aeration tanks in order that the process may be continuous. The activated sludge organisms must be fed the proper amount of food, that is, organic material, and air, under conditions suitable for growth.

The process of decomposing organic material by the activated sludge process is essentially the same as the natural processes that would take place in a receiving stream containing adequate oxygen, except that, by concentrating food, organisms and oxygen in

aeration tanks under continuous mixing the treatment plants are able to accomplish in a few hours what would take many days in the receiving stream. The process does not normally produce noxious odors.

IV-92. The principal elements of the Sanitary District's major works which carry out the activated sludge process consist essentially of the following:

(1) Raw sewage pumping stations ahead of each plant.

(2) Screens, grit chambers, and primary or preliminary settling tanks for the removal of debris, coarse floating solids, and the readily settleable solids.

(3) Aeration tanks for oxidation of the incoming sewage by aerobic bacteria contained in previously formed activated sludge; compressors for supplying the air, air piping and diffusers for distributing the air in the tanks.

(4) Final settling tanks for the removal of activated sludge from the aerated sewage prior to final discharge of the effluent into the receiving waterway or canal.

(5) Facilities for disposing of the screenings, scum and sludge removed from the sewage in the preliminary and final settling tanks.

IV-93. The West Side Treatment Works are operated in conjunction with the Southwest Treatment Works, the two treatment facilities being sometimes referred to collectively as the Stickney Plant, or as the West-Southwest Sewage Treatment Works. At the West Side Plant, sewage is given preliminary treatment by the Imhoff process. In the Imhoff process, settleable and suspended solids from the liquid part of the incoming sewage are separated, the solids (or sludge) are digested, and the liquid (or effluent) is discharged. Almost all of the effluent is sent to the

Southwest Plant for treatment by the activated sludge process; some of the West Side effluent is discharged directly into the Sanitary Canal on infrequent occasions during periods of extremely heavy rainfall. The Imhoff tanks digest the sludge anaerobically and reduce the organic matter 40 to 50 percent in a period of one to six months.

IV-94. After treatment, the effluent from the treatment plants is discharged into the waterways. Effluent from the Stickney Plant is discharged into the Sanitary and Ship Canal, effluent from the North Side Plant is discharged into the North Shore Channel, and effluent from the Calumet Plant is discharged into the Calumet-Sag Channel.

F. Projected Population Growth and Anticipated Diversion.

IV-95. In the opinion of Dr. Philip M. Hauser, a qualified demographer, the human population of the area served by the Sanitary District will not approach 15 to 20 million people by the year 1978, nor will the human population of the area equal that amount by the year 2000. There is no evidence suggesting that the population of the area will reach that amount at any time thereafter.

IV-96. The 1960 population of the City of Chicago was 3,550,404. In Dr. Hauser's opinion, it is not likely to exceed 4,000,000 by the year 2000.

IV-97. In Dr. Hauser's opinion, between 1960 and 2000 the population of Cook County, including the City of Chicago, will increase from 5,129,725 to approximately 6,622,000 persons.

IV-98. The amount of water diverted from Lake Michigan at Chicago for domestic pumpage is not likely to double by the year 1975, or by the year 2000, or at any time in the foreseeable future.

IV-99. The most reliable information and opinion available indicate that the human population of the Northeastern Illinois Metropolitan Area * will increase between 1960 and 2000 by approximately 3,330,000 to a total of approximately 9,500,000. If, after utilizing all local ground and surface water supplies in the area exclusive of Lake Michigan, which are estimated to amount to about 250 MGD, or 390 cfs, the additional water requirements of this increased population were to be withdrawn from Lake Michigan, the additional amount to be withdrawn has been estimated as approximately 350 MGD, or 540 cfs. If no additional local ground and surface water supplies are utilized the additional withdrawal from Lake Michigan might be as much as 600 MGD or 930 cfs.

G. Efforts to Secure Additional Diversion Legislation

IV-100. Application by Illinois for increased diversions was made during World War II to President Roosevelt who referred it to the War Production Board and the Federal Power Commission. The Chairmen of these agencies reported unfavorably on the request to the President as follows:

"August 6, 1943

"Report to the President

"Re: Chicago Water Supply Problem

"In accordance with your request of June 29, we have jointly explored the proposal made by the City of Chicago that wartime emergency powers be used to grant additional diversion of Lake Michigan waters to safeguard the City's water supply.

"Full consideration has been given to the City's understandable desire to provide for such diversion through the Calumet-Sag Canal so as to assure an extra margin of

* As used in this finding the term Northeastern Illinois Metropolitan Area describes the geographic area included within the eleven study areas shown on Ill. Ex. 654, which is included in the Appendix to this Report.

safety and allay public anxiety during any critical periods of abnormal pollution of the water supply which may occur prior to completion of the new water treatment facilities now under construction.

"After detailed exploration of the City's proposal, and after a lengthy meeting on July 20 with Mayor Kelly and his staff, we have come to the conclusion that *exercise of the emergency wartime powers in this instance is not necessary or desirable*, because:

"1. Construction of additional water treatment facilities for Chicago is provided for by priorities already granted by the War Production Board. These facilities, which should be completed by 1944, are calculated to give ample protection to the City for the duration of the war.

"2. Pending completion of these additional facilities, there is every reason for confidence that Chicago's present chlorination facilities, which have been strengthened since last summer, will be adequate for the critical period this year, assuming that efficient operation is maintained. Existing facilities coped successfully with heavy pollution during the last two summers. Pollution so far this year, as reflected in Chicago's records, has been less serious than for a number of years, including the past two years.

"3. If additional diversions become necessary to counteract pollution, they will only be needed in limited amounts and for short periods until the presently authorized works are in operation. The City of Chicago can now make such additional diversions, relying on reductions later to keep within the annual limitation.

"4. The Supreme Court, which fixed the annual limit, retains jurisdiction to modify the decree governing diversion of Lake Michigan water by the Chicago Sanitary District. If the limited additional diversions which may become necessary should leave an insufficient balance of diversion for the remainder of the year, the City's application for an additional amount should be addressed to the Court.

"Owing to the widespread anxiety reported among the citizens of Chicago as to the safety of their water supply, due both to the publicity given the matter in the Chicago press and the distinct taste of chlorine in the water resulting from the heavy dosages now used, it would appear highly desirable to make the facts known to the City at the earliest possible time. The essential points are summarized below:

"NATURE OF THE PROBLEM

"Chicago's water problem relates primarily to water supply for the south district, comprising about one-third of the City. Water for this section is obtained from Lake Michigan through the Dunne and 68th Street crib intakes, and is subject to varying degrees of pollution caused by discharges into the lake some miles south of the cribs. This is a condition of many years' standing which the City states has been aggravated lately by increased industrial activity.

"Representatives of Chicago say that the bacterial content of the water for the south district is higher than the limit suggested in the U. S. Public Health Service Manual for the production of safe water by chlorination. However, War Production Board sanitary engineers (including Dr. Abel Wolman, who participated in the preparation of the USPHS Manual) point out that the manual contains the express qualification that the limit which it suggests is applicable to 'Water Requiring Simple Chlorination, or its Equivalent,' whereas, in Chicago's south district, double and super-chlorination are employed. Under these conditions, the bacterial content of the water supply does not seem to justify apprehension.

"In connection with the current anxiety over the safety of the City's water supply, wide publicity has been given to a report prepared for the Surgeon General on the pollution problem at the request of the Chicago Board of Health by L. M. Fisher, Senior Sanitary Engineer, U. S. Public Health Service, District No. 3. This report was filed over a year and a half ago. Steps already taken by the Federal

Government to aid the construction of improved water treatment facilities by the City have given full recognition to the conditions which the report discussed. This construction is taking place under a long term program of improved water treatment facilities adopted by the City in 1938 and designed to provide permanent relief. The program ultimately calls for a new treatment system involving coagulation, sedimentation, chlorination and filtration.

"ACTION TAKEN BY THE WAR PRODUCTION BOARD

"Although faced with continuing war shortages in materials and equipment, the War Production Board, nevertheless, has approved priorities for those parts of the new water treatment system essential to safeguard water supply during the war. These priorities provide for coagulation, sedimentation and chlorination facilities.

"In 1942 the War Production Board issued priorities for work on certain tunnels, which must be finished before the coagulation and sedimentation plants now authorized can be used. Those tunnels have been under construction since the early fall of 1942, and should be completed in 1944. It was obviously inadvisable to issue priorities for the plants until the tunnels were well advanced; since to do so would have tied up materials currently needed for urgent war work.

"Once the tunnels were partly constructed, WPB found it possible as of March, 1943, to grant priorities for the coagulation and sedimentation structures. Priorities have also been approved for the equipment to be installed in these structures.

"These arrangements should make it possible to commence operation of the coagulation and sedimentation works by the summer of 1944, provided the City acts with diligence in carrying out the project. The sanitary engineers of the War Production Board are satisfied that, considering all the facts, the coagulation and sedimentation works, when completed, will be adequate to safeguard the

public health of Chicago for the duration. The filtering facilities proposed have value as a long-term improvement, but are not essential for maintaining adequate standards of safety during the war.

"Pending completion of the tunnels and coagulation and sedimentation facilities, there is every reason to believe that Chicago can rely upon its present chlorination system to protect the public health. The degree of pollution so far this year, as reflected in Chicago's records, has generally been much less than in any recent year. Moreover, additional emergency chlorination equipment, first authorized by the War Production Board in 1942 and assigned higher priorities in March, 1943, to assure operation this summer, should give a further margin of safety over last year.

"STEPS OPEN TO CITY IN OBTAINING INCREASED DIVERSION

"The request of the City of Chicago is for the exercise of emergency war powers to permit increased diversion up to the full capacity of the Calumet-Sag Canal on a continuing basis for the duration. This would involve diversion through the Calumet-Sag at the rate of 3,000 cubic feet per second, requiring an increase of about 2,500 cubic feet per second over present diversion.

"The present limitation on diversion is fixed by Supreme Court decree entered in 1930. In that decree, the Court retained jurisdiction to make such modifications as might prove necessary at any time. In view of this fact, counsel for the Federal Power Commission and the War Production Board advise that exercise of emergency war powers for this purpose would not appear appropriate. Such action would imply that the Supreme Court would not, on proper application, take all steps necessary to enable the City of Chicago adequately to safeguard public health.

"The Chicago Sanitary District has in the past, in case of emergency, diverted larger amounts than the per-

missible annual average, relying on reduced diversions at other periods to balance its annual diversion budget. If such additional diversions prove necessary to provide an increased margin of safety in the present instance, this practice can be followed. At most, such additional diversions would only be needed in limited amounts and for short periods of heavy pollution. Chicago's records indicate that the critical period is practically limited to the latter part of the summer.

"To meet the possibility that such additional diversions may result in an insufficient balance in the annual diversion budget for necessary operations during the remainder of the year, the Sanitary District can arrange for immediate application to the Supreme Court for relief. This remedy has always been open to the City and we are advised that the interested states would cooperate to expedite consideration of such application.

"A general lifting of the limit on the diversion, such as Chicago originally requested, does not appear necessary to meet the health problem discussed here. Such action might be considered as a precedent, affecting rights which have been the subject of litigation over a period of many years and involving the States of Illinois, Wisconsin, Minnesota, Ohio, Pennsylvania, Michigan and New York. Vigorous protests against Chicago's proposal have already been filed by the States of New York, Ohio, and Pennsylvania as well as by the Great Lakes Harbors Association, the Great Lakes Carriers Association and others. The effect upon navigation of a continuing increase in diversion such as Chicago urges might well be serious."

"Respectfully submitted,

/s/ DONALD M. NELSON,
*Chairman, War Production Board*

/s/ LELAND OLDS
*Chairman, Federal Power Commission*"

IV-101. In the past 30 years the following bills proposing additional diversions by Illinois or the Sanitary District on either a temporary or permanent basis, have been introduced in Congress by Illinois members. Except for the bills introduced in the 75th Congress, whenever hearings have been held on these bills they have been consistently advocated by the Sanitary District. The Department of State has generally communicated its opposition to or reservations about such bills to the appropriate committees of the Congress. None of these bills has been enacted into law. Other action on them, if any, is indicated below.

(a) 75TH CONGRESS
H.R. 7808
H.R. 8327

These bills proposed a total diversion of 5,000 cfs in addition to domestic pumpage. Hearings were held in the House on H.R. 8327 during January, February, March and April, 1938 before the Committee on Rivers and Harbors. The Secretary of War opposed the diversion.

(b) 76TH CONGRESS
H.R. 7

(c) 77TH CONGRESS
H.R. 1625
H.J. Res. 297

These bills would have authorized the Secretary of War to withdraw 5,000 cfs from Lake Michigan in addition to domestic pumpage.

(d) 78TH CONGRESS
H.J. Res. 148
H.R. 1026
H.R. 3146

Hearings were held by the House Rivers and Harbors Committee on H.J. Res. 148 beginning on September 28, 1943. No action was taken by the Committee on any of these bills.

(e) 81ST CONGRESS
H.R. 7469

This bill would have permitted withdrawal of 3,500 cfs plus domestic pumpage for a 30 days period.

(f) 82ND CONGRESS
H.R. 6098
H.R. 6100
H.R. 8165
H.J. Res. 372

Hearings were held in the House before the Committee on Public Works, May 27, 28, June 4, and 5, 1952. H.R. 8165 was reported to the House June 16, 1952 (H. Rept. 2173). These bills would have authorized a diversion of 3,500 cfs in addition to domestic pumpage. In addition, H.J. Res. 372 would have vested a discretionary right to increase or decrease the diversion above or below 3,500 cfs in the Chief of the Corps of Engineers.

(g) 83RD CONGRESS
H.R. 3192
H.R. 3193
H.R. 3194
H.R. 3195
H.R. 3196
H.R. 3197
H.R. 3208
H.R. 3209
H.R. 3210
H.R. 3211
H.R. 3212
H.R. 3213
H.R. 3214
H.R. 3300

These bills would have authorized an additional diversion of 2,500 cfs. Hearings were held in the House before the Committee on Public Works on H.R. 3300 and related

bills, July 15 and 16, 1953. At these hearings A. O. Stanley, Chairman of the International Joint Commission, testified as follows:

> "Mr. Stanley. At the time this treaty [1909 Boundary Waters Treaty] was negotiated, you will find the statement in the testimony of Elihu Root—in order to avoid that question being raised he permitted the Canadians to take 16,000 more second-feet of water from the Niagara River at Niagara Falls than was given to the United States in that division of water under article V of the treaty. Although the treaty provides as a general thing that the diversion from international streams should be split 50-50 between the two countries there was a sort of gentleman's agreement that in lieu of that 16,000 second feet the question of withdrawal through the Sanitary Canal of Chicago would not be raised.
>
> * * *
>
> "Mr. Machrowicz. One more question. You have no objection to this proposed diversion, do you?
>
> "Mr. Stanley. None in the world. Let me qualify that, Mr. Chairman. In fact, in its present status, it is not for the Commission to object or to approve. We are an international tribunal and these matters are referred to us by the two Governments. But speaking personally—under present conditions when we are troubled by the unusually high waters in Lake Ontario, the diversion of a larger amount of water at Chicago would be beneficial to the lake conditions.
>
> "Mr. Dondero. Thank you very much, Mr. Stanley, for your statement." [Hearings, p. 11]

Later in the same hearings, Mr. Stanley stated:

> "Mr. Chairman, I want to make my statement clear. I said that personally I do not object to withdrawal of 2,500 feet, but I did not mean by that that Congress could authorize withdrawal of it. You can-

not withdraw 1 foot of water from these Great Lakes and their connecting streams without the approval of the International Joint Commission under the terms of the treaty. But if the matter comes before us, as it is in a way under the present reference, why, I am inclined to welcome a larger withdrawal." [Hearings, p. 14]

The Hon. Thruston B. Morton, Assistant Secretary of State, wrote the Hon. George A. Dondero, Chairman, Committee on Public Works, United States House of Representatives, on July 16, 1953, in response to Mr. Dondero's request to receive the views of the State Department on the various bills then pending to authorize the State of Illinois and the Sanitary District to divert additional water from Lake Michigan, as follows:

"Because of the effect this withdrawal of water would have on the level of water in the other Great Lakes, it is believed that the subject matter can appropriately be considered by the International Joint Commission, established in accordance with the Treaty of January 11, 1909. * * *

"The diversion of water at Chicago from Lake Michigan through the Drainage Canal of the Sanitary District has been the subject of considerable controversy. It was settled so far as States of the United States were concerned by decisions of the Supreme Court of the United States in the cases of *Wisconsin v. Illinois* (278 US 367, and 281 US 179). * * *

"When the boundary waters treaty was signed on January 11, 1909, a much larger quantity of water was being diverted out of the Great Lakes-St. Lawrence Basin through the Chicago Dra[i]nage Canal. Consequently, that treaty provided in article V for aggregate daily diversion at the rate of 20,000 cubic feet of water per second in the United States and diversion in Canada of 36,000 cubic feet of water per second. In view of the limitation of diversion pre-

scribed by the Supreme Court previously mentioned, the United States and Canada agreed in the treaty signed on February 27, 1950, concerning uses of the Niagara River to replace the unequal division of water authorized by the provisions of article V of the 1909 treaty with an equal division of Niagara waters for power purposes. A change in the amount of water diverted at Chicago might affect the arrangements set forth in the Niagara treaty.

* * * *

"After a further exchange of notes, on June 25, 1952, a reference under article IX of the 1909 treaty was sent by the United States and Canada to the International Joint Commission. It will be noted that the reference, a copy of which is enclosed, provides in article 2 that the Commission shall study '*any diversion of water into or out of the Great Lakes Basin.*' (Italics added.)

"As a result of this reference, the Commission appointed a Joint International Engineering Board composed of representatives of Canada and of the United States, and studies by this Board are now in progress.

"On June 4, 1953, the Commission held a public hearing at Detroit, Mich., at which testimony by Col. W. P. Trower, division engineer, Great Lakes division, Corps of Engineers, and by Col. John D. Bristor, district engineer, and United States member of the International Lake Superior Board of Control, was presented regarding the effect of these diversions into Lake Superior and out of Lake Michigan. It is anticipated that the Commission will make a full report in due course.

"In the circumstances, it is considered that these bills should not be enacted and that action in regard to this matter should await the receipt of the report and recommendations of the International Joint Com-

mission—United States and Canada on this subject pursuant to the reference of June 25, 1952.

"The Department has been informed by the Bureau of the Budget that there is no objection to the submission of this report."

H.R. 3300 was reported to the House, January 11, 1954 [H. Rept. 1100], and passed the House February 4, 1954. The State Department opposed the bill because of Canadian opposition, expressed in notes Nos. 79 and 169, dated February 1 and March 10, 1954, respectively, from Ambassador Heeney to Secretary of State Dulles. Hearings were held in the Senate before the Committee on Public Works on H.R. 3300, April 20, 1954. The bill was reported to the Senate July 16, 1954 [S. Rept. 1815], and passed the Senate August 20, 1954. It was vetoed September 3, 1954 by President Eisenhower. In his memorandum of disapproval the President said:

"I have withheld my approval of H.R. 3300, 'To authorize the State of Illinoios and the Sanitary District of Chicago, under the direction of the Secretary of the Army, to help control the lake level of Lake Michigan by diverting water from Lake Michigan into the Illinois Waterway.'

"The bill would authorize the State of Illinois and the Sanitary District of Chicago, under the supervision and direction of the Secretary of the Army, to withdraw from Lake Michigan, in addition to all domestic pumpage, a total annual average of 2,500 cubic feet of water per second into the Illinois Waterway for a period of 3 years. This diversion would be 1,000 cubic feet per second more than is presently permitted under a decree of the Supreme Court of the United States dated April 21, 1930. The bill also would direct the Secretary of the Army to study the effect in the improvement in conditions in the Illinois Waterway by reason of the increased diversion, and to report to the Congress as to the results of the study on or before

January 31, 1957, with his recommendations as to continuance of the increased diversion authorized.

"The bill specifies that the diversion would be authorized in order to regulate and promote commerce, to protect, improve, and promote navigation in the Illinois Waterway and Mississippi Valley, to help control the lake level, to afford protection to property and shores along the Great Lakes, and to provide for a navigable Illinois Waterway. No mention is made of possible improvements of sanitary conditions or increase in hydroelectric power generation on the waterway.

"I am unable to approve the bill because (1) existing diversions are adequate for navigation on the Illinois Waterway and Mississippi River, (2) all methods of control of lake levels and protection of property on the Great Lakes should be considered before arbitrarily proceeding with the proposed increased diversion, (3) the diversions are authorized without reference to negotiations with Canada, and (4) the legitimate interests of other States affected by the diversion may be adversely affected. I wish to comment briefly on each of these points.

"I understand that waterborne traffic on the Illinois Waterway has grown in the last 20 years from 200,000 tons to 16 million tons annually. The Corps of Engineers advises, however, that the existing diversions of water are adequate for navigation purposes in the Illinois Waterway and the Mississippi River. Surveys are now underway by the International Joint Commission and the Corps of Engineers to determine the best methods of obtaining improved control of the levels of the Great Lakes and of preventing recurrence of damage along their shores. Reasonable opportunity to complete these surveys should be afforded before legislative action is undertaken.

"The diversion of waters into and out of the Great Lakes has historically been the subject of negotiations with Canada. To proceed unilaterally in the manner

proposed in H.R. 3300 is not wise policy. It would be the kind of action to which we would object if taken by one of our neighbors. The Canadian Government protested the proposed authorization when it was under consideration by the Congress, and has continued its objection to this bill in a note to the Department of State dated August 24, 1954. It seems to me that the additional diversion is not of such national importance as to justify action without regard to the views of Canada.

"Finally, as is clear from the report of the Senate committee, a major purpose of the proposal to divert additional water from Lake Michigan into the Illinois Waterway is to determine whether the increased flow will improve existing adverse sanitation conditions. The waters of Lake Michigan are interstate in character. It would seem to me that a diversion for the purposes of one State alone should be authorized only after general agreement has been reached among all the affected States. Officials of several States adjoining the Great Lakes, other than Illinois, have protested approval of the bill as being contrary to their interests and not in accord with the diversion authorized under the 1930 decree of the Supreme Court. Under all of these circumstances, I have felt that the bill should not be approved." [100 Cong. Rec. 15569]

(h) 84TH CONGRESS
H.R. 314
H.R. 1773
H.R. 1827
H.R. 2014
H.R. 2025
H.R. 3210
H.R. 3211
H.R. 3212
H.R. 3213
H.R. 3214
H.R. 3215

H.R. 3216
H.R. 3217
H.R. 3218
H.R. 3219
H.R. 3220
H.R. 3221
H.R. 3222
H.R. 3223
H.R. 3224
H.R. 3225
S. 1772
S. 2550

These bills would have authorized a diversion of 2,500 cfs for a three-years period, in addition to domestic pumpage. Hearings were held in the House before the Committee on Public Works on June 17 and 22, 1955, on H.R. 3210. H.R. 3210 was reported to the House June 29, 1955 [H. Rept. 1029]. It passed the House July 6, 1955. Hearings were held by a subcommittee of the Senate Committee on Public Works on July 5 and 13, 1956, on H.R. 3210 and S. 2550. H.R. 3210 was reported to the Senate July 14, 1956 [S. Rept. 2578] and passed the Senate July 27, 1956. It was vetoed by President Eisenhower on August 9, 1956. In his memorandum of disapproval the President stated:

> "I have withheld my approval of H.R. 3210, 'To authorize the State of Illinois and the Sanitary District of Chicago, under the direction of the Secretary of the Army, to test, on a three-year basis, the effect of increasing the diversion of water from Lake Michigan into the Illinois Waterway, and for other purposes.'
>
> "This bill is substantially the same in purpose and effect as H.R. 3300 of the 83d Congress from which I also withheld my approval in that it would authorize the State of Illinois and the Sanitary District of Chicago to increase from 1,500 to 2,500 cubic feet per second the diversion of water from Lake Michigan to the Illinois Waterway for a period of 3 years. H.R. 3210

would also direct the Secretary of the Army to make a study with respect to the effect of the diversion and to make recommendations regarding its continuance. While certain conditions and limitations are imposed that were not in the earlier bill these do not deal with the fundamental reasons for my withholding approval of that measure.

"In my memorandum of disapproval of H.R. 3300 I stated, among other things:

> 'I am unable to approve the bill because . . . (2) all methods of control of lake levels and protection of property on the Great Lakes should be considered before arbitrarily proceeding with the proposed increased diversion, (3) the diversions are authorized without reference to negotiations with Canada, and (4) the legitimate interests of other States affected by the diversion may be adversely affected.'

"A comprehensive report by the Corps of Engineers which will include consideration of the best methods of obtaining improved control of the levels of the Great Lakes and of preventing recurrence of damage along the shores is nearing completion. I am asking the Secretary of Defense to expedite completion of this report. This report is in addition to the technical report on the effects of an increased diversion into the Illinois Waterway which has been made by the Joint Lake Ontario Engineering Board to the International Joint Commission. I think it would be unwise to proceed with the diversion in the manner proposed in H.R. 3210 until all relevant information has been obtained, particularly since objections to the proposed diversion have been registered by the Canadian Government in its note dated February 13, 1956, and additional objections filed by legal advisers of the States of Wisconsin, Ohio, and New York.

"Although I am fully aware of the seriousness of some of the problems confronting the Chicago area

and the State of Illinois, the record on H.R. 3210 affords no basis for me to change my position in this matter. Accordingly, under the circumstances, I am convinced that the bill should not be approved.

"I am asking the State Department to engage in discussions with the Canadian Government in an attempt to work out a solution to these problems as soon as all pertinent facts are available." [102 Cong. Rec. 15304]

(i) 85TH CONGRESS

S. 1123
H.R. 2
H.R. 18
H.R. 139
H.R. 180
H.R. 181
H.R. 212
H.R. 338
H.R. 356
H.R. 492
H.R. 570
H.R. 740
H.R. 2135
H.R. 2467
H.R. 2789
H.R. 2791
H.R. 3237
H.R. 6260

These bills would have authorized an increase in the direct diversion of 1,000 cfs for a three-years period, in addition to domestic pumpage. Hearings were held on H.R. 2 and others before the Subcommittee on Rivers and Harbors of the House Public Works Committee on March 26 and 27, 1956. H.R. 2 was reported from the Public Works Committee on April 17, 1957 [H. Rept. 369]. It passed the House May 22, 1957. Hearings were held before the Subcommittee of the Senate Committee on Public Works

on H.R. 2 and S. 1123 on July 28, 29 and August 7, 1958. H.R. 2 was reported to the Senate on August 20, 1958, from the Public Works Committee [S. Rept. 2482].

(j) 86TH CONGRESS

S. 308
H.R. 1
H.R. 206
H.R. 1796
H.R. 1798
H.R. 1799
H.R. 1827
H.R. 1834
H.R. 1869
H.R. 1872
H.R. 1880
H.R. 1936
H.R. 1965
H.R. 2003
H.R. 2162
H.R. 2219
H.R. 2220
H.R. 2762
H.R. 2878
H.R. 3331

These bills provided for an increase in the diversion of 1,000 cfs for a one year period in addition to domestic pumpage. Hearings were held on H.R. 1 before the House Committee on Public Works on February 17, 18 and March 3, 1959. The bill was reported from the Public Works Committee, March 9, 1959 [H. Rept. 191]. H.R. 1 passed the House March 13, 1959. Hearings were held before a Subcommittee of the Senate Committee on Public Works on H.R. 1 and S. 308 on July 13, 14, 27 and August 7, 1959.

William B. Macomber, Jr., Assistant Secretary of the Department of State, transmitted to the Senate Committee the Canadian aide-memoire of February 20, 1959, and Canadian note No. 184 of April 9, 1959 (both of which

are included in the Appendix to this Report) with his letter of May 8, 1959, which reads in part as follows:

> "The Department is not in a position to question strongly held Canadian views that an additional withdrawal of water from the Great Lakes would affect adversely Canadian interests. It is noted also that S. 308 contains no provisions for the compensation of injured parties. The Department believes that enactment of S. 308 would have unfortunate repercussions on our relations with a friendly foreign government and it is therefore unable to support this legislation." [Hearings, p. 161]

The following statement by Woodbury Willoughby, Director of the State Department Office of British Commonwealth and Northern European Affairs was received by the subcommittee during the same hearings:

> "H.R. 1 authorizes the withdrawal of water from the Great Lakes Basin at Chicago and thus must be considered in relation to the rights of Canada as a coriparian in the waters of that basin. The Department, in the interest of maintaining harmonious relations with that country, has traditionally sought its views on proposals of this type.
>
> "This committee has previously been furnished with the texts of the recent communications exchanged with the Canadian Government regarding its views on H.R. 1, and will have noted the protest registered by that Government against implementation of the proposals contained in the bill. I should be glad to submit a copy at this time for insertion in the record.
>
> "The most recent Canadian aide memoire, dated February 20, 1959, expresses the opinion that any authorization for an additional diversion from Lake Michigan at Chicago would be incompatible with the arrangements for the St. Lawrence Seaway and power development, and with the Niagara Treaty of 1950,

and would be prejudicial to navigation and power development which these mutual arrangements were designed to improve and facilitate.

"Neither the Niagara Treaty nor the International Joint Commission Orders relating to the development of power by the United States and Canada in the International Rapids section of the St. Lawrence River, place any specific limitation upon diversions of the type authorized by H.R. 1. Nevertheless, the Department is not in a position to question the Canadian position that an additional withdrawal of water from the Great Lakes Basin such as that under consideration would affect adversely Canadian navigation and power interests in the Great Lakes, their connecting channels and the St. Lawrence River.

"I understand that estimates have been furnished to the Congress by the U.S. Army Corps of Engineers as to the extent of the damage that would be suffered by downstream hydroelectric interests on both sides of the boundary in the event that the present proposal is enacted. It is noted that H.R. 1 provides no means by which injured parties may be compensated.

"In view of the foregoing, the Department believes that enactment of H.R. 1 would adversely affect our relations with a friendly foreign government. Therefore, it is unable to support this legislation." [Hearings, pp. 164-165]

On August 25, 1959, the Senate Committee on Public Works reported H.R. 1 [S. Rept. 808]. On September 2, 1959, the bill was referred to the Senate Foreign Relations Committee.

On February 15, 1960, after discussions were had with the Canadian Government, Mr. Macomber wrote to Chairman Fulbright of the Senate Foreign Relations Committee, as follows:

"DEPARTMENT OF STATE
WASHINGTON

"Dear Mr. Chairman: Feb. 15, 1960

"I refer to your letter to the Acting Secretary of September 3, 1959, and his reply of September 22, 1959, regarding H.R. 1, 'An Act to require a study to be conducted of the effect of increasing the diversion of water from Lake Michigan into the Illinois Waterway for navigation, and for other purposes'. The Acting Secretary stated in his reply to you that the Department's earlier proposal for discussions on the diversion legislation had been accepted by the Canadian Government, and that they were expected to take place in the near future. I am pleased to be able to report now the results of these recently completed discussions, for the assistance of your Committee in its consideration of H.R. 1.

"The consultations were held in Ottawa between a Canadian delegation headed by the Honorable Howard Green, Secretary of State for External Affairs, and a United States delegation headed by the Honorable Richard B. Wigglesworth, Ambassador to Canada. A number of different matters were discussed, all of which were related to the position of the Canadian Government with respect to the pending United States legislation authorizing a temporary increased withdrawal of water from Lake Michigan at Chicago.

"After a general discussion of the treaties and other arrangements between the two countries relating to the regime of the Great Lakes and the St. Lawrence Seaway, the United States delegation proposed exploration of the following specific matters: (a) whether H.R. 1 can be amended in any way, including provision for compensation to injured parties, to make it acceptable to Canada; (b) whether an additional diversion into the Great Lakes Basin from the Albany River Basin or some other source in Canada, to offset

the proposed increased diversion from Lake Michigan, is physically possible and economically feasible; (c) Canadian estimates of any damage which would be incurred by reason of the diversion contemplated by H.R. 1; (d) Canadian views on the desirability of a study of the entire diversion question by the International Joint Commission or by a specially created Great Lakes Joint Commission. (Establishment of the latter body was proposed by Mr. Spaulding Glass, a Chicago attorney, and his proposal was communicated to your Committee by Senator Dirksen in a letter dated September 17, 1959, a copy of which was sent to the Department).

"The presentation which was made by the Canadian delegation of its Government's views on the above matters, as well as on various other aspects of an increased withdrawal of water from the Great Lakes Basin by the United States, can be summarized as follows:

"(1) Canada, with two-thirds of its population and a large percentage of its productive capacity located in the Great Lakes area, attaches great significance to the St. Lawrence Seaway and related developments. The Canadian Government views with the utmost concern any action by the United States which would tend to interfere with maximum use of the Seaway and fullest development of the various facilities related thereto.

"(2) The lowering effect on water levels of a removal of water from the Great Lakes is of particular importance to navigation and riparian use. The adverse effect on these uses can be most readily observed in the lakes, rivers, connecting channels and harbors. Most of the connecting channels are artificial and have been controlled to a minimum acceptable depth for navigation on the assumption that there would be no decrease in the natural supplies of water. The governing depths of many harbors in Canada is less than

the governing depth of the Seaway, and therefore every fraction of an inch change in the water levels requires light loading of vessels precisely to that extent. In view of the construction of vessels for purposes of buoyancy, each inch less of draft may represent as much as 100 tons loss of cargo carrying capacity. (The Canadians referred, at this point, to a Report of the United States Army Corps of Engineers, dated January 18, 1957, Senate Document No. 28, 85th Congress, 1st Session, which stated: 'Actual experience of vessel operations shows clearly that they do take advantage of increments of depth as small as one inch.')

"(3) Another effect of removal of water from the Great Lakes Basin is to decrease the volume available for development of hydro-electric power, thus causing losses to Canadian power plants at Niagara Falls, Barnhart Island (in the International Rapids Section of the St. Lawrence River), Beauharnois and Lachine (both located in that part of the St. Lawrence River which lies wholly in Canada. The estimated loss in energy and capacity to Canadian plants at Niagara Falls and Barnhart Island from an additional diversion of 1,000 cfs for one year would be $359,200. If this diversion were made permanent, the estimated annual loss at these plants would be $561,200. At Beauharnois and Lachine, where the full flow of the St. Lawrence River is being or will be developed by the Hydro-Electric Power Commission of Quebec, there would also be losses suffered by an increased diversion of 1,000 cfs from Lake Michigan. The estimated annual losses, if the diversion were permanent, would be $208,000 to existing power installations in Quebec and an additional $130,000 on projected installations there. (No estimates were given by the Canadians of the estimated dollars losses to the Quebec power plants at Beauharnois and Lachine from a one-year increased diversion.)

"In connection with the large joint power development in the International Rapids Section of the St. Lawrence River, any increase in Great Lakes water withdrawals above the amount upon which the regulation of levels in the St. Lawrence area was predicated will, in Canada's opinion, affect the basis on which that development has been built. It will result in a waste of money to the extent that generation facilities will have been provided which cannot be fully utilized because of a decrease in flows.

"(4) The Canadian Government believes that the effects of an additional withdrawal of water from Lake Michigan on Great Lakes power and navigation interests, on navigation in the Mississippi River System, and on the treatment of sewage are well known already through various reports based on adequate studies of these subjects. Consequently, a temporary experimental diversion does not appear necessary to accomplish the purposes of the study provided for in H.R. 1.

"(5) The Canadian Government has attempted to ascertain whether any more water could be added to the Great Lakes Basin from sources within Canada to offset an increased diversion at Chicago. The Province of Ontario, which has control over these waters, has concluded that to obtain additional water would not be economic; the location of any available source of other water and the intervening topography are such that the cost of pumping and piping an adequate quantity would be out of all proportion to the benefits conferred. Apart from these difficulties, there would be the question of compensation due to Ontario for the loss of this natural resource.

"(6) The Canadian Government feels strongly that no amendment of H.R. 1 would meet its objections thereto. These objections to the proposed unilateral diversion of water at Chicago are fundamental and

no variation in the terms of the bill would suffice so long as its implementation would adversely affect the levels and flows of the Great Lakes as far east as tidewater. In this regard, the Canadian Government feels that its position could not be changed even if the bill were amended to provide for a claims tribunal or some other method of compensating injured parties, since it would not be possible to make restitution for certain losses of an irreparable or intangible character which might be incurred. For example, immeasurable damage to the economic life of entire communities might result from a reduction in the number of ships using their port facilities or carrying their products.

"(7) The Canadian Government does not favor the establishment of a Great Lakes Joint Commission to study the effects of the proposed experimental diversion and to exercise authority over diversions into Lake Superior. Neither does it consider desirable a study of the diversion problem by the International Joint Commission. The Canadian Government does not believe that such a study could solve any of the fundamental problems posed by the pending diversion legislation. In addition, any recommendations by the International Joint Commission the effect of which would be to alter Great Lakes levels and flows to the detriment of Canadian interests would be unacceptable to the Canadian Government.

"(8) Both the United States and Canada have in recent years in many fields of activity endeavored to conserve natural resources to make the best use of them. The withdrawal of additional water from Lake Michigan and the denial of its use to all parties downstream for a distance of 1,500 miles merely to assist in the treatment of sewage waste is not, in Canada's opinion, the best use of this water and is incompatible with the need for conservation and optimum utilization of this great natural resource.

"On the basis of the above-described discussions with the Canadians, there does not appear to us any possibility of a joint arrangement being developed whereby Canadian assent would be given to an increased diversion of water from Lake Michigan such as that contemplated by H.R. 1. In view of that Government's unalterable opposition, as previously stressed by the Prime Minister, to any United States legislation authorizing additional withdrawals of water from the Great Lakes-St. Lawrence System on a unilateral basis, whether temporary or permanent, the Department of State continues to be of the opinion that enactment of H.R. 1 would have a serious adverse effect on United States relations with Canada. Consequently, from the standpoint of this Department's interests, it is recommended that such legislation not be enacted.

"Sincerely yours,

WILLIAM B. MACOMBER, JR.
*Assistant Secretary*

"The Honorable

J. W. FULBRIGHT, *Chairman,*
*Committee on Foreign Relations,*
*United States Senate.*"

## V. Methods Proposed by Plaintiffs for Reducing Chicago Diversion

### A. Steps to Reduce the Quantity of Polluting Organic Waste Discharged into the Canal.

1. *Present Conditions*

V-1. Oxygen-demanding organic wastes are presently discharged into, or reach, the canal as:

a. Untreated sewage and industrial waste which overflow into the canal from the diversion chambers during periods when storm runoff is sufficient to cause the sewers to overflow. These wastes are sometimes referred to herein as spillage.

b. Effluent from the treatment plants.

c. Treated and untreated wastes which are discharged into the canal directly from industrial plants. These wastes are sometimes referred to herein as direct discharges of industrial waste.

Other oxygen-demanding organic matter also finds its way into the canal as stated in Finding VI-16.

V-2. The canal is badly polluted at a number of places between Wilmette and Lockport. There are times and places where the canal is unsightly and gives off noxious odors.

2. *Reduction of Spillage of Untreated Sewage and Industrial Waste*

a. *Effect of Spillage*

V-3. Spilled untreated sewage contains a greater proportion of heavier solids, both organic and inorganic, than does treated effluent. Whereas the solids in the treated effluent tend to stay in suspension and exert a BOD only while the sewage is flowing downstream, the heavier solids present in the spilled untreated sewage tend to settle out and form sludge banks along the bottom of the canal. Decomposition of the organic material in the sludge banks is a cause of oxygen depletion in the canal. Therefore

spillage is significant in terms of oxygen consumption. Spillage of raw sewage also causes floating matter and debris to be discharged into the canal.

V-4. Much spillage has occurred that could have been prevented if the treatment plants had been operated at more nearly maximum capacity for longer periods of time. This spillage causes pollution, produces unnecessary dissolved oxygen depletion, and contributes to the formation of sludge banks.

b. *Expansion of Treatment Plants to Treat Two Times Rated Capacity*

V-5. As a first step that can be taken to reduce the quantity of combined sewage which is presently allowed to spill into the canals during storms, the Sanitary District could expand the treatment plants to treat sewage flows of up to two times the rated capacities of the plants during periods of storm runoff. Although it is impractical to treat all of the combined storm flow which reaches the sewers, the substantial pollution load that spillage imposes on the canal makes it important that the Sanitary District treat as much of the combined sewage and storm flow as possible at the treatment plants.

V-6. The terms, "rated capacity", "dry weather flow", "maximum capacity" and "dilution ratio" are used herein in the following sense:

The "rated capacity" is the rate of sewage flow which a treatment plant is considered capable of treating on a continuous basis with proper disposal of sludge and no loss in efficiency.

The "dry weather flow" is the actual rate at which sewage flows through the plants during periods when no storm runoff enters the sewers. Usually, the dry weather flow is less than the rated capacity of the plants, since a sewage treatment plant is designed and constructed to accommodate a dry weather flow which is anticipated at a future date.

The term "dry weather flow", therefore, is not a precise term, since the dry weather flow increases (or decreases) as a city's population and use of sewers increases (or decreases). On the other hand, the term "rated capacity" is specific, since it relates to the actually existing plant facilities and is unrelated to the variable quantity of sewage flowing through the treatment plant. Normally, sound engineering practice dictates that the rated capacity of a treatment plant should be increased before the rate of the dry weather flow to that plant increases to the rated capacity.

"Maximum capacity" may be either the maximum rate at which sewage can be put through a sewage treatment plant hydraulically, or it may be some lower rate established by the management, such as the maximum rate at which sewage can be treated without seriously interrupting the treatment process. During periods when combined sewage is flowing into a treatment plant at a rate greater than the rated capacity of the plant, and up to the maximum capacity of the plant, one would expect a decrease in plant efficiency.

The term "dilution ratio" or "dilution factor", as used in sewage treatment plant design, is the ratio of the maximum sewage flow actually treated in a sewage treatment plant to the dry weather flow of the plant.

V-7. As a matter of practice, the Sanitary District does not operate its plants at maximum capacities during periods of storm runoff. Instead, much of the combined sewage in the sewers, which would be treated at the plants during periods of storm runoff if the plants were operating at their maximum capacities, is allowed to flow into the canals at the diversion chambers, or is pumped into the canals at the pumping stations, without any treatment whatsoever.

V-8. The improvement and expansion of the treatment plants could be done in a two-phase process. As the first phase, the plants could be expanded and improved as needed

to avoid outages and to insure efficient operation at one and one-half times the rated capacities. As the second phase, the plants could be further improved and expanded to maximum operating capacities of two times the rated capacities. Such improvement and expansion could include elimination of bottlenecks in the interceptor system, regulation of the diversion chambers so that the flows in the interceptors are adjusted to the availability of interceptor and plant capacities, and enlargement of the pumping stations and treatment plants to take the greater flows without interruption.

V-9. The cost, as estimated in 1960, of improving the treatment plants from their present condition to a condition which would make them capable of efficiently treating up to one and one-half times the rated capacities for the loads anticipated in the near future is $30,990,000, including necessary standby equipment.

V-10. To further expand the plants from a condition which would make them capable of efficiently treating one and one-half times the rated capacities to a condition which would make them capable of efficiently treating two times the rated capacities, would cost, as estimated in 1960, approximately, an additional $39,182,000. Treatment of flows, during periods of storm, of up to two times the rated capacities would greatly reduce the spillage of untreated combined sewage during storms, a primary cause of pollution and noxious conditions in the canal, particularly because the spilled sewage contains large amounts of organic and inorganic solids which form sludge banks.

V-11. It is reasonable to require that the plants treat flows during storms at rates of up to two times their rated capacities rather than at rates of up to two times the dry weather flow, because dry weather flow is an imprecise and variable rate, and in fact is usually lower than rated capacity. The need for a high degree of sewage treatment at Chicago requires that the plants be actually operated at their maximum capacities during periods of storm runoff

and such maximum capacities could be increased to two times the rated capacities of the plants.

V-12. Reinforcing the treatment plants to permit treatment of flows of up to one and one-half times the rated capacities would substantially reduce the amounts of BOD presently discharged to the canal. Improving the system to treat combined sewage flows of up to two times the rated capacities would further substantially reduce the amounts of BOD presently discharged to the canal.

c. *Overflow Treatment Plants*

V-13. In addition to enlarging the major treatment works, facilities could be built to provide primary treatment of the combined sewage which cannot be treated at the treatment plants during periods of storm flow. Primary treatment, as contemplated by this proposal, consists of the settlement and removal of solids in the spillage in settling tanks or holding basins. This can be accomplished by building overflow treatment plants at strategic points along the interceptor system. Even with the overflow treatment plants it would not be feasible to treat all of the combined sewage, since during periods of heavy storm, the volume of flow of the combined sewage is much greater than the amount which can be treated. While conditions in the canals at Chicago warrant strong measures to eliminate pollution, five times the dry weather flow is the limit beyond which it would not be feasible to treat combined sewage. This limit assumes that flows equivalent to two times the rated capacities of the three major treatment plants enlarged as described above, would receive activated sludge treatment. The remainder of the combined sewage flow, up to the five times the dry weather flow limit, would receive primary treatment (preliminary settling) in the overflow treatment plants.

V-14. There are at least 15 sites, three on the North Shore Channel, three on the South Branch of the Chicago River, two along the Sanitary and Ship Canal, two on the

Des Plaines River, and five in the Calumet area, that could be used for primary treatment of combined sewage overflows. It is estimated that seven overflow treatment plants in all would be adequate to provide treatment of up to five times dry weather flow.

V-15. The overflow treatment plants would consist of holding basins or settling tanks on high ground adjacent to the interceptors, and a pumping station for lifting the combined sewage from the interceptors into the basins, together with the necessary conduits and equipment for removing sludge and emptying the tanks into the interceptors after the storm has passed. The basins themselves would be about 200 feet wide and 750 feet to 1,080 feet long, depending upon the particular installation. The basins would be equipped with an inlet from the pumping station, an outlet to the nearest canal or waterway, and sludge removal facilities.

V-16. During dry weather and low flow conditions the overflow treatment plants would not operate. The basins would go into operation only when the major treatment works were loaded to capacity and the combined sewage began to back up in the interceptors. At this time the pumps serving the overflow treatment plants would start and would draw down the water level in the interceptors by discharging the excess flow into the overflow treatment basins.

V-17. The overflow treatment plants, by providing primary treatment for a portion of the combined sewage which cannot be treated at the treatment plants during periods of storm runoff, would permit the heavier suspended solids and accompanying BOD in the combined sewage to settle out in the settling basins and be flushed back into the sewer system after the storm for complete treatment at the treatment plants. The overflow plants themselves would remove about 50 percent of the BOD in that portion of the spillage which passed through such plants.

V-18. The total construction cost for the seven suggested overflow treatment plants was estimated in 1960 to be $84,000,000.

V-19. The seven overflow treatment plants, built to supplement the major treatment works, as expanded to treat two times rated capacity, would substantially reduce the BOD discharged to the canal, in addition to the BOD reduction to be achieved by the treatment at the major treatment works of flows up to two times rated capacities.

d. *Discontinuance of Extension of the Combined Sewer System*

V-20. The continued increase in the amounts of sewage spilled in the future could be partially curtailed by discontinuing the expansion of the combined sewer systems into undeveloped areas. Separate sanitary sewers and storm drainage facilities could be constructed in the future instead.

e. *Elimination of Discharges of Untreated Sewage and Industrial Wastes into the Canals during Non-Storm Periods.*

V-21. In addition to the untreated sanitary sewage spilled from the system during storms, discharges of untreated sanitary sewage directly into the canal occur during non-storm periods. Untreated sewage is discharged directly into the canals because of plant outages, interruptions due to repair and new construction, and malfunctioning diversion chambers.

V-22. The annual operating reports of the Sanitary District contain references to temporary bypassing of sewage or incomplete treatment given to sewage because of equipment failure or outage. The plants could be provided with adequate standby equipment so that the bypassing and incomplete treatment could be reduced to a minimum.

3. *Treatment Plant Efficiency and Operation*

V-23. The activated sludge process, used by the Sanitary District, is a satisfactory type of treatment process. The treatment plants, when operating properly, obtain removals of BOD and suspended solids which compare favorably with the best plants in the United States. However, the plants are frequently operated at much less than optimum efficiency. During the period 1952-1963, the annual BOD removal averaged 89.1 percent, ranging from as high as 93.6 percent in 1952 to a low of 85.6 percent in 1957. During the same period, the suspended solids removals averaged 85.6 percent, with a high of 91.1 percent in 1952 and a low of 80.6 percent in 1957. These figures, however, do not reflect discharges of BOD or suspended solids to the canal in a manner other than through the effluent channel. Such other discharges, due to temporary bypassing necessitated by shutdown due to outage or repairs, reduced the overall efficiency of the plants below the figures given above.

4. *Direct Discharges of Industrial Wastes*

V-24. A number of industrial plants located on or near the canals discharge untreated industrial waste directly into the canals. The number of these plants and the amount of waste discharged has not been exactly determined. However, in 1961, the Sanitary District reported that there were 13 unconnected industrial plants discharging waste into the canal. These discharges had a total population equivalent of 19,000 persons. This is equivalent to the pollution that would be contributed by the sewage effluent from an activated sludge treatment plant serving a population of 200,000 persons or more. In 1961 and 1962 the Public Health Service investigated the sources and amounts of industrial wastes discharged directly into the canal. The Public Health Service reported that the known and evaluated sources of industrial wastes discharged directly into the Illinois River system within the boundaries of the Sanitary District have a population equivalent of 147,000 persons.

V-25. The discharges of untreated industrial wastes by industrial plants located along the canal, can be eliminated. In many instances this can be accomplished by connecting the industrial plants in question to the sewerage system. Alternatively, separate waste treatment plants can be built, and the industries can be required to provide adequate treatment.

5. *Chlorination of Treatment Plant Effluents*

V-26. The treatment plant effluents could be chlorinated to reduce the BOD in such effluents.

V-27. Sufficient chlorination would destroy bacteria and viruses in the effluent [but see Findings V-405 and VII-70] as well as reduce the BOD. [See Finding IV-48.]

V-28. Chlorinating facilities and 20 minute chlorine contact tanks at each of the major treatment works would cost, as estimated in 1960, approximately $5,000,000 to install. Effluent chlorination to remove BOD would probably be needed only during the three warm summer months. The operating costs for operating three months a year, including chlorine, labor, and maintenance, as estimated in 1960, would be approximately $250,000.

B. Artificial Aeration of the Canal.

V-101. The direct diversion of water from Lake Michigan reduces the oxygen deficiency in the Sanitary and Ship Canal which would otherwise exist under present conditions. It requires in the order of 2,000 cubic feet of Lake Michigan water to supply 1 lb. of oxygen to the canal in the summer. The average dissolved oxygen content in 1,000 cfs of water diverted from Lake Michigan is approximately 45,000 lbs. per day.

V-102. Methods exist for artificially accelerating the natural process by which a stream absorbs oxygen from the air, but these methods have not heretofore been applied, except experimentally, to a stream of the size of the

Sanitary and Ship Canal. To accomplish such artificial aeration the oxygen must be supplied to the water in such a manner that it will enter into solution. Physically, this may be accomplished by increasing the quantity of water which comes into contact with the air. One possible method is by diffused air reaeration, i.e. forcing air into water in such manner that it passes through the water in small bubbles, presenting in the aggregate a large surface area of contact with the water, and inducing sufficient motion in the water for diffusion. There are also a number of types of mechanical aerators available from various manufacturers, all of which involve the creation of turbulence to increase the air and water interfaces and the entraining of air, together with the moving of relatively large volumes of water in order to diffuse the entrained air throughout the mass of the liquid. Among the various types are those having impellers near the surface of the liquid, submerged impellers with air spargers and partially submerged brush-type aerators.

V-103. The operating efficiency of aeration equipment decreases, all other things being equal, as the relative oxygen saturation of the water in which it operates increases. The more efficient operation of such equipment would be at points where the dissolved oxygen content of the water was below one and one-half parts per million and the less efficient where the dissolved oxygen content was in excess of that amount.

V-104. As early as 1923, the Sanitary District began conducting experiments relative to artificial aeration. In 1923, 1924 and 1925, experiments were conducted in the old navigation lock at Lockport utilizing air diffusion methods to increase the DO concentration of water drawn into the lock from the main channel. Since that time the District has, intermittently, conducted tests in its laboratories and its treatment plants for the purpose of studying oxygen absorption by means of air diffusion. In 1961 the District included in its program of future expenditures

$3,000,000 for further research and experimentation relative to artificial aeration. About $300,000 was spent on an experimental floating mechanical aerator which began tests in the canal commencing July 12, 1962. The aerator was tested at three different sites in the canal during 1962: from July 12th through September 12th in Mason Slip, just east of the Commonwealth Edison Company's Fisk Generating Station on the South Branch of the Chicago River; from September 18th through November 2d in the Chicago River between Chicago Avenue and Erie Streets; and subsequently to November 5th above the locks at Lockport.

V-105. The experimental aerator consisted essentially of two turbine-type pumps, each powered by a 75 horsepower diesel engine, which pumped water over a circular weir or cone. This equipment was mounted between two pontoons which formed a catamaran. The operating principle is that the water from the canal is pumped up through the center of the cone and thrown tangentially and the spray, as it is diffused through the atmosphere, picks up oxygen from the air. Some oxygen also is picked up from the air as the result of the turbulence in the canal caused by the operation of the craft.

V-106. During the experimental test period from July 12 to October 18, 1962 the experimental aeration craft operated in water containing from zero to four ppm DO. Results during this period from sampling points upstream and downstream of the craft indicated an average of 2,950 lbs. per day more DO in the stream at the downstream sampling points than at the upstream sampling points. Since some oxygen was utilized between these sampling points by the BOD in the stream, the DO input of the machine during this period was approximately 5 percent greater than the 2,950 lbs. measurement.

V-107. During the later period of operation from October 29 to November 2, 1962 in which the initial DO remained relatively constant at 1.0 ppm, the sample

downstream of the craft showed 5,500 lbs. per day greater DO than the upstream sample; if 5 percent oxygen utilization between the sampling points from the BOD in the stream is assumed, the DO input of the experimental aeration craft for the period would be approximately 5,775 lbs. per day.

V-108. Based on an assumed transfer rate of 2,950 lbs. per day, the cost of operating sufficient mechanical aeration craft in the canal to supply the oxygen equivalent of 1,000 cfs of lake water, on a nine-months operational basis, was estimated in 1962 by the assistant chief engineer of the Sanitary District to be $767,907 per year; and the equivalent cost for 700 cfs to be $542,052. As a result of the test data obtained from the existing experimental aeration craft, it is reasonable to assume that aeration craft can be built having substantially better than 2,950 lbs. per day DO input at no greater cost than the experimental craft. Thus, actual annual costs for replacing 1,000 or 700 cfs direct diversion by aeration, might well be substantially less than those above indicated.

V-109. The efficiency of a mechanical aerator is proportional to the oxygen deficit of the water in which it is operated. Therefore, an aerator would be more efficient operating in 32°F water containing 1 ppm DO and having an oxygen deficit of 13.62 ppm than it would be operating in 68°F water containing 1 ppm DO and having an oxygen deficit of 8.17 ppm, or in 80°F water containing 1 ppm DO and having an oxygen deficit of 7.17 ppm. [See Findings VI-13 and VI-14]

V-110. It would hardly be possible to maintain existing sanitary conditions in the canal if artificial aeration were substituted for water currently diverted from Lake Michigan. Reducing the existing diversion would reduce the velocity of flow in the canal, which would at times result in increased canal water temperatures, increased silting and sludge bank formation, increased coliform, streptococci and chemical concentrations, increased accumulation

of oil slicks and floating debris, and the probable growth of objectionable aquatic plants and algae. These effects would be less likely to occur if the measures outlined in Findings V-5 to V-28 were also undertaken.

C. Conservation of Domestic Pumpage

V-201. From 1930 to 1960, Chicago's population increased from 3,378,000 to 3,550,000. In the same period, the domestic pumpage for the City of Chicago declined from 1,019,000,000 gallons daily, or 302 gallons per capita per day, to 904,000,000 gallons daily, or 255 gallons per capita per day. During the same period, Chicago achieved a reduction in pumpage of 115,000,000 gallons daily, or 11 percent less while serving a population increased by 172,000 persons, or 5 percent greater, than in 1930. In the same period, the population of suburbs served by Chicago increased from 305,000 to 873,000. In the same period, total pumpage for Chicago and suburbs declined from 1,059,000,000 gallons daily to 1,027,000,000 gallons daily. A water conservation program initiated by the City of Chicago in 1930 not only produced a substantial reduction in its own pumpage, but enabled the City to absorb the increased water demand of the suburbs and still achieve a reduction in total pumpage of 32,000,000 gallons daily.

V-202. Nonetheless, a substantial portion of the domestic pumpage of the City of Chicago is still lost through leakage and waste. The leakage and waste may be considered to be of two broad types:

a. Leakage from distribution mains, and

b. Leakage and waste at customer service pipes and fixtures.

V-203. Leakage from the distribution mains, which is now estimated to be at the rate of 45,000 gallons per mile of main per day, or about 285 cfs for the entire system, is much higher than in many comparable city systems.

The amount of leakage from the water mains in Chicago could reasonably be reduced to about 20,000 gallons per mile of main per day, or about 125 cfs for the entire system. Reducing leakage from the mains from the estimated 45,000 gallons per mile of main per day to 20,000 gallons per mile of main per day would result in a reduction in the domestic pumpage diverted from Lake Michigan of approximately 160 cfs. Leakage from mains can be reduced to 20,000 gallons per mile of main per day if an adequate leak detection and repair program is initiated. Universal metering would provide a statistical verification of the results of such a program.

V-204. Since 1930, the City of Chicago has carried out expanding programs of underground leakage control, inspection and repair of on-premises leakage, and a program of gradual additional metering. In the period 1952-1962, approximately $200,000,000 has been spent on filtration plants, enlargement and modernization of pumping stations and tunnels, and improvement of the water main system. In 1961, the National Board of Fire Underwriters, which rates water systems as to adequacy and reliability, reclassified the City of Chicago water system from Class II to Class I, the highest classification given.

V-205. The City of Chicago's program for locating and repairing leaks in water mains has not been effective in securing a reduction of leakage below 45,000 gallons per mile of main per day. The City has not budgeted the funds or acquired the manpower and up-to-date equipment necessary to reduce the leakage from mains below that amount. Heretofore, the City's leak detection and repair crews inspected the system, on the average, about once in every 15 years. During the 15 years interval a great many leaks develop, particularly where the mains are old.

V-206. The City of Chicago has announced plans to step up its leakage control program. In the past, the City has spent a great deal of time making precise measurements of leakage located and repaired. The City no longer

plans to make such measurements. Therefore a substantial part of the time of the repair crews will be made available to locate and repair leaks. Under a more intensive application of detection methods heretofore employed the entire system of mains would be inspected and repaired about once every 5 years. In 1963 the City acquired 12 electronic sound level devices for use in detecting underground leakage which will permit the main system to be inspected with greater frequency, perhaps once every 3 years. Such a program, if properly executed, could keep main leakage below 20,000 gallons per mile of mains per day. However, leakage from mains could be kept at an even lower amount if the system was checked and repaired annually.

V-207. Universal metering would greatly reduce leakage and waste from customer service pipes and fixtures. There is a relationship between the amount of leakage and waste in a water system and the degree to which the system's customer use is metered. It is recognized that a customer who pays for water on the basis of gallons on a meter will be far more diligent in economizing and in repairing leaky fixtures than one who is paying a flat rate for service. Since a dripping fixture can waste many gallons per day, customer fixture leakage is an important factor in water system consumption where many of the customers are unmetered.

V-208. The per capita use in recent years of about 255 gallons per capita per day is high, even though Chicago is a large industrialized city. Leakage and wasteful uses of water are responsible for a substantial portion of this high per capita use figure. Also, the legitimate per capita use is expected to increase in the Chicago area in the future because of industrial growth and increased residential uses. Legitimate per capita use is expected to increase at the rate of about 0.6 gallons per capita per year. However, the overall per capita use in Chicago, which includes leakage and waste, can decrease in the future, if leakage and waste control measures are effected.

V-209. Many United States cities have rates of per capita water consumption in a range which approximates or exceeds that of Chicago, although the great majority have rates substantially lower than that of Chicago. Other large, highly industrialized cities situated on the Great Lakes, and comparable to Chicago, report water consumption per capita per day as follows: Cleveland, 215; Buffalo, 230; Erie, 252; Detroit, 155; Milwaukee, 178; and Toledo, 141.

V-210. Metered consumption within the City of Chicago amounted to 230 gallons per capita per day for the portion of the population served through meters, as compared with its average per capita consumption by all users, both metered and unmetered, of 255 gallons per capita per day in 1960.

V-211. In 1964, 55.3 percent of Chicago's total water production (i.e., water produced by the City of Chicago for use by the city and the suburbs served by it), or 578,200,000 gallons daily, was metered. The City of Chicago is committed to the metering of all three-flat buildings and larger, and has completed that program. The City is also instituting a program of progressive metering of both public and private premises where waste or extraordinary consumption is found.

V-212. Universal metering reduces customer usage to the extent that it eliminates customer waste and fixture leakage, but it does not produce any permanent reduction in legitimate water consumption.

V-213. In 1960, excessive use of water due to consumer waste and fixture leakage in Chicago amounted to approximately 81,000,000 gallons daily, or 125 cfs. Metering of all services except single-family and two-flat dwellings, plus a strict program of fixture inspection and repair, would save at least one-half of the amount of water presently attributed to excessive usage, that is, not less than 40,500,000 gallons daily, or 62 cfs. A program of universal metering of Chicago's single-family and two-flat

dwellings, plus a strict program of fixture inspection and repair, would save substantially the greater part of the amount attributable to excessive usage.

V-214. Metering of the 332,689 single-family and two-flat dwellings in Chicago which are presently unmetered would result in a net reduction of Chicago pumpage of at least 40,500,000 gallons daily, or not less than 62 cfs.

V-215. The capital cost of universal metering at Chicago has been estimated to be about $15,030,900, assuming a gross cost per setting of $45.18 per meter. Interest and amortization for 30 years would average about $815,000 per year. The estimated annual average costs of this additional metering in Chicago would be:

| | |
|---|---|
| Interest and Amortization | $ 815,000 |
| Meter Operation and Repair | 345,000 |
| Reading, Billing, Collecting and Accounting | 490,000 |
| | $1,650,000 |

V-216. This annual cost would be offset, in part at least, by savings in water treatment costs.

V-217. In addition, a reduction in domestic pumpage would reduce the load on the water treatment plants, and would thereby release plant capacity to meet peak demands and future loads and would benefit the Sanitary District by reducing the volume of flow to the sewage treatment plants.

V-218. In relation to the water treatment and distribution costs of other cities, the cost of water treatment and distribution in Chicago is very low, in fact, it is one of the lowest in the United States.

V-219. In Chicago's system of 4,142 miles of water mains, 1,000 gallons per mile per day equals 4,142,000 gallons daily, or 6.40 cfs. Pumpage wil be reduced, for ex-

ample, by 32 cfs if an additional 5,000 gallons per mile per day can be saved.

D. COMPENSATING DIVERSIONS

V-301. It is physically possible to make diversions into Lake Michigan from water courses presently flowing into the Mississippi River watershed. If such a diversion was made intermittently, and if from year to year the average annual amount of such taking was substantially constant, then the effect on the level and outflow of Lakes Michigan-Huron would not be greatly different than that which would prevail if a diversion into those lakes was made at a constant rate equal to the average annual rate resulting from the intermittent taking.

V-302. Witness George H. Buck has proposed numerous variations of four general schemes of diversion from streams flowing into the Mississippi watershed, one being from a site on the lower Kankakee River, two (designated Scheme A and Scheme B) being from a site on the upper Kankakee River, and one being for a combined diversion from the Fox and Des Plaines Rivers in the State of Illinois. All of these schemes, which are in the area generally indicated on L. S. Ex. 562 and more particularly located on L. S. Exs. 563, 570, 573 and 576, are physically possible. There is no evidence that the waters proposed to be diverted into Lake Michigan are of poorer quality than much of the water which is now flowing naturally into the southern portion of the lake.

V-303. The four general schemes proposed by Buck suggest the diversion of flows in excess of those which have prevailed a certain percentage of the time during past historical periods, consisting of 41 years of recorded flows on the lower Kankakee River, 28 years of adjusted recorded flows on the upper Kankakee River, 43 years of

adjusted recorded flows on the Fox River and 13 years of recorded flows on the Des Plaines River. Thus, for example, where he proposed to take a 60 percent flow, all flows equal in amount to those which had prevailed 60 percent or more of the time during the period of record referred to will be allowed to continue, and only flows in excess of such amount would be diverted.

V-304. All of Buck's proposed compensating diversions would, if carried out, reduce the flows in the rivers below the points at which the diversions were made. For example, if, as Buck proposes, an 80 percent flow were taken from the lower Kankakee River, all flows in excess of 890 cfs and up to the capacity of his works would be diverted to Lake Michigan and the annual average flow in the river below the point of diversion would be reduced.

V-305. Buck's proposed scheme for diverting water from the lower Kankakee River into Lake Michigan would require the construction of inlet control works in the river below its junction with the Iroquois River and just upstream from the City of Kankakee, Illinois, equipped with control gates, a settling lagoon to permit the settlement of some of the solids in the water to be diverted, a pumping station, a concrete-lined tunnel about 44 miles long running in part through the State of Indiana and terminating in an outlet works having a flaring outlet designed to reduce velocity. Such outlet would be located in Lake Michigan off the shore of the State of Indiana at a point east of Indiana Harbor, Indiana.

V-306. Preliminary cost estimates made for the purposes of comparing the alternative projects, determining general feasibility and magnitude of costs, based upon some of the available United States Geological Survey (U.S.G.S.) topographic maps and geologic data, supplemented by an automobile reconnaissance of some of the areas involved, are as follows:

LOWER KANKAKEE

| Maximum Capacity (cfs) | Construction Cost ($) | Percentage of time flows are diverted* | Yield (cfs) | Annual Cost ($) | Cost per million gallons ($) |
|---|---|---|---|---|---|
| 1000 | 102,065,000 | 50 | 440 | 6,267,000 | 60.38 |
| | | 60 | 500 | 6,545,000 | 55.47 |
| | | 70 | 560 | 6,830,000 | 51.70 |
| | | 80 | 620 | 7,050,000 | 48.19 |
| 1500 | 129,700,000 | 50 | 610 | 7,516,000 | 52.23 |
| | | 60 | 710 | 7,783,000 | 46.47 |
| | | 70 | 780 | 8,027,000 | 43.63 |
| | | 80 | 870 | 8,264,000 | 40.27 |
| 2000 | 152,107,000 | 50 | 760 | 8,579,000 | 47.85 |
| | | 60 | 880 | 8,857,000 | 42.66 |
| | | 70 | 960 | 9,124,000 | 40.28 |
| | | 80 | 1080 | 9,345,000 | 36.68 |
| 2500 | 175,836,000 | 50 | 890 | 9,577,000 | 45.60 |
| | | 60 | 1025 | 9,786,000 | 40.47 |
| | | 70 | 1120 | 10,000,000 | 37.85 |
| | | 80 | 1250 | 10,232,000 | 34.70 |
| 3000 | 198,244,000 | 50 | 1010 | 10,268,000 | 43.09 |
| | | 60 | 1155 | 10,477,000 | 38.45 |
| | | 70 | 1260 | 10,703,000 | 36.01 |
| | | 80 | 1400 | 10,865,000 | 32.89 |
| 3500 | 210,814,000 | 50 | 1110 | 11,075,000 | 42.29 |
| | | 60 | 1260 | 11,295,000 | 38.00 |
| | | 70 | 1390 | 11,533,000 | 35.17 |
| | | 80 | 1530 | 11,730,000 | 32.50 |
| 4000 | 235,976,000 | 50 | 1200 | 11,907,000 | 42.06 |
| | | 60 | 1360 | 12,098,000 | 37.70 |
| | | 70 | 1500 | 12,266,000 | 34.66 |
| | | 80 | 1650 | 12,452,000 | 31.99 |

V-307. The upper Kankakee proposed Diversion Scheme A and Scheme B both involve diversions from a site near the mouth of Sandy Hook Ditch near Hebron, Indiana.

V-308. Buck's upper Kankakee Diversion Scheme A would require the construction of an inlet control works consisting of a weir equipped with control gates, outlet works, including a velocity reduction structure, a settling lagoon, and a concrete-lined tunnel about 22 miles long,

* See Finding V-314.

beginning at a point near Hebron, Indiana, and terminating at the Little Calumet River east of its junction with Burns Ditch, Indiana. The entire project would be in the State of Indiana.

V-309. Preliminary cost estimates made for the purposes of comparing the alternative projects, determining general feasibility and magnitude of costs, based upon some of the available U.S.G.S. topographic maps and geologic data, supplemented by an automobile reconnaissance of some of the areas involved, are as follows:

UPPER KANKAKEE—SCHEME A

| Maximum Capacity (cfs) | Construction Cost ($) | Percentage of time flows are diverted* | Yield (cfs) | Annual Cost ($) | Cost per million gallons ($) |
|---|---|---|---|---|---|
| 1000 | 61,278,000 | 60 | 360 | 2,703,000 | 31.80 |
| | | 70 | 425 | 2,703,000 | 26.95 |
| | | 80 | 480 | 2,703,000 | 23.86 |
| 1200 | 67,210,000 | 60 | 400 | 2,962,000 | 31.38 |
| | | 70 | 460 | 2,962,000 | 27.27 |
| | | 80 | 530 | 2,962,000 | 23.68 |
| 1400 | 72,182,000 | 60 | 430 | 3,183,000 | 31.36 |
| | | 70 | 495 | 3,183,000 | 27.25 |
| | | 80 | 570 | 3,183,000 | 23.67 |
| 1600 | 77,754,000 | 60 | 455 | 3,427,000 | 31.91 |
| | | 70 | 525 | 3,427,000 | 27.66 |
| | | 80 | 600 | 3,427,000 | 24.20 |
| 1800 | 80,444,000 | 60 | 475 | 3,549,000 | 31.66 |
| | | 70 | 550 | 3,549,000 | 27.34 |
| | | 80 | 630 | 3,549,000 | 23.87 |
| 2000 | 82,897,000 | 60 | 490 | 3,663,000 | 31.69 |
| | | 70 | 570 | 3,663,000 | 27.23 |
| | | 80 | 655 | 3,663,000 | 23.69 |
| 2200 | 89,069,000 | 60 | 510 | 3,933,000 | 32.67 |
| | | 70 | 590 | 3,933,000 | 28.25 |
| | | 80 | 675 | 3,933,000 | 24.69 |

V-310. Buck's proposed Scheme B for diverting water from the upper Kankakee River into Lake Michigan

* See Finding V-314.

would require the construction of inlet control works consisting of a weir equipped with control gates, a settling lagoon, a pumping station, a concrete-lined tunnel about 15 miles long, outlet works on a natural stream, Salt Creek, a concrete-lined canal about 8½ miles long in the valley of Salt Creek, through which the water would flow to the Little Calumet River. The entire project would be in the State of Indiana.

V-311. Preliminary cost estimates made for the purposes of comparing the alternative projects, determining general feasibility and magnitude of costs, based upon some of the available U.S.G.S. topographic maps and geologic data, supplemented by an automobile reconnaissance of some of the areas involved, are as follows:

UPPER KANKAKEE—SCHEME B

| Maximum Capacity (cfs) | Construction Cost ($) | Percentage of time flows are diverted* | Yield (cfs) | Annual Cost ($) | Cost per million gallons ($) |
|---|---|---|---|---|---|
| 1000 | 40,459,000 | 60 | 360 | 2,689,000 | 31.64 |
| | | 70 | 425 | 2,782,000 | 27.74 |
| | | 80 | 480 | 2,904,000 | 25.65 |
| 1200 | 45,073,000 | 60 | 400 | 2,838,000 | 30.06 |
| | | 70 | 460 | 2,931,000 | 26.99 |
| | | 80 | 530 | 3,029,000 | 24.23 |
| 1400 | 49,740,000 | 60 | 430 | 2,974,000 | 29.30 |
| | | 70 | 495 | 3,073,000 | 26.31 |
| | | 80 | 570 | 3,160,000 | 23.49 |
| 1600 | 52,849,000 | 60 | 455 | 3,141,000 | 29.25 |
| | | 70 | 525 | 3,234,000 | 26.10 |
| | | 80 | 600 | 3,332,000 | 23.55 |
| 1800 | 57,276,000 | 60 | 475 | 3,253,000 | 29.02 |
| | | 70 | 550 | 3,351,000 | 25.82 |
| | | 80 | 630 | 3,433,000 | 23.09 |
| 2000 | 60,624,000 | 60 | 490 | 3,412,000 | 29.52 |
| | | 70 | 570 | 3,505,000 | 26.06 |
| | | 80 | 655 | 3,604,000 | 23.33 |
| 2200 | 65,291,000 | 60 | 510 | 3,547,000 | 29.46 |
| | | 70 | 590 | 3,600,000 | 25.86 |
| | | 80 | 675 | 3,687,000 | 23.15 |

* See Finding V-314.

V-312. Buck's scheme for diverting water from the Fox and Des Plaines Rivers would require the construction of inlet control works on both rivers, settling lagoons near each of the inlet control works, a concrete-lined tunnel about 13 miles long, connecting the settling lagoon at the Fox River site with the control works at the Des Plaines River site, another concrete-lined tunnel about seven miles long, extending from the settling lagoon at the Des Plaines River site to outlet works situated about one-half mile off the shore of Lake Michigan at a point about two miles from Lake Forest, Illinois.

V-313. Preliminary cost estimates made for the purposes of comparing the alternative projects, determining general feasibility and magnitude of costs, based upon some of the available U.S.G.S. topographic maps and geologic data, supplemented by an automobile reconnaissance of some of the areas involved, are as follows:

FOX AND DES PLAINES

| Maximum Capacity (cfs) | Construction Cost ($) | Percentage of time flows are diverted* | Yield (cfs) | Annual Cost ($) | Cost per million gallons ($) |
|---|---|---|---|---|---|
| 1000 | 42,870,000 | 60 | 345 | 1,969,000 | 24.19 |
| | | 70 | 375 | 1,969,000 | 22.25 |
| | | 80 | 410 | 1,969,000 | 20.36 |
| 1200 | 47,418,000 | 60 | 380 | 2,176,000 | 24.29 |
| | | 70 | 415 | 2,176,000 | 22.23 |
| | | 80 | 450 | 2,176,000 | 20.49 |
| 1400 | 50,045,000 | 60 | 410 | 2,299,000 | 23.77 |
| | | 70 | 445 | 2,299,000 | 21.90 |
| | | 80 | 485 | 2,299,000 | 20.10 |
| 1600 | 52,434,000 | 60 | 435 | 2,414,000 | 23.53 |
| | | 70 | 470 | 2,414,000 | 21.77 |
| | | 80 | 515 | 2,414,000 | 19.87 |
| 1800 | 55,781.000 | 60 | 455 | 2,568.000 | 23.93 |
| | | 70 | 495 | 2,568,000 | 21.99 |
| | | 80 | 535 | 2,568,000 | 20.35 |
| 2000 | 58,289,000 | 60 | 475 | 2,687,000 | 23.97 |
| | | 70 | 515 | 2,687,000 | 22.12 |
| | | 80 | 555 | 2,687,000 | 20.53 |

* See Finding V-314.

V-314. In each of the four general diversion schemes advanced by Buck, he has proposed alternate diversion structures of different capacities and the diversion of different amounts of water. In his scheme for diverting flows from the lower Kankakee River into Lake Michigan, he has proposed seven alternate diversion facilities, and diversion of all flows in excess of those which in the past have prevailed 50, 60, 70 or 80 percent of the time. Buck's two diversion schemes for the upper Kankakee River each involve seven alternative diversion facilities. His Fox and Des Plaines Rivers diversion scheme involves six alternative diversion facilities for each river.

V-315. Since the plans contemplate diversions of certain flows, they might have some slight beneficial effect upon flood conditions in the Kankakee, Illinois or Mississippi River basins, to which no monetary value can be attached.

V-316. The Fox River of Wisconsin flows northeastwardly into Lake Winnebago and thence into Lake Michigan at Green Bay. At Portage, Wisconsin, the upper Fox River is about one and one-half miles northeast of the Wisconsin River which flows into the Mississippi River. At that point the normal level of the Fox River is about five feet lower than that of the Wisconsin River and the two are connected by a canal with a lock at its southwestern end constructed about 100 years ago. The Wisconsin River is subject to high water flows in the spring of each year and at high stages the level of that river is as much as 21 feet above the level of the upper Fox River at Portage. For about 150 years a levee has been maintained along the bank of the Wisconsin River at Portage which has contained the flood waters of the river. In a state of nature, however, whenever the river rose to a stage more than about 14 feet above normal, the river overflowed its banks and some of its water found its way into the upper Fox River. Records of the stages of flow in the Wisconsin River kept by the United States Geological Survey indicate that

about 3.9 percent of the time the level of flows in the Wisconsin River exceeds the height of the natural river bank at Portage and that the water which, absent the levee, would overflow the river banks at that point would amount on the average to about 700 cfs throughout the year.

V-317. It is physically possible to divert a substantial amount of water from the Wisconsin River into Lake Michigan by way of the Fox River at Portage, Wisconsin. To accomplish the diversion it would be necessary to construct a suitable canal and controlling works at Portage and to canalize the upper Fox River. Water thus diverted from the Mississippi River system could be returned to the Mississippi River at Grafton, Illinois, by way of the Sanitary and Ship Canal, the Des Plaines River and the Illinois River. Such a diversion would increase the hydroelectric power producing potential of the lower Fox River between Lake Winnebago and Green Bay, but would adversely affect such potential of the Wisconsin River below Portage and of the Mississippi River between Prairie du Chien and Grafton.

V-318. It is physically possible to divert substantial amounts of water from the Hudson Bay watershed in the Dominion of Canada into Lake Superior in the region of Lake Nipigon and into the Georgian Bay of Lake Huron in the region of Lake Nipissing. Diversions from the Hudson Bay watershed into Lake Superior have actually been taking place in western Ontario at Long Lake since 1939 and at Ogoki since 1943, as indicated in Finding I-10.

## E. Effluent Return

### 1. *Feasibility*

V-401. It would be physically possible for part of the domestic pumpage diverted from Lake Michigan to be returned after use to the lake in the form of chlorinated sewage treatment plant effluent. Treatment plant effluent is returned to Lake Michigan at the present time at Mil-

waukee, Kenosha, and Waukegan, among other places. Other large cities on the Great Lakes which do so are Detroit, Toledo, Cleveland, Buffalo, Toronto and Rochester.

2. *Facilities Required*

V-402. The quantity of effluent discharged from the West-Southwest Plant at Stickney would be sufficient to effect any amount of effluent return suggested up to 1,250 cfs. The facilities required to return effluent from the Stickney Plant to Lake Michigan, as proposed by Richard Hazen, a witness for the Lake States, would consist chiefly of a chlorinating and pumping station, a tunnel 14.4 miles long from the Stickney Plant to a discharge point almost 6 miles off shore, a crib and shaft, diffuser pipes at the outer end of the tunnel, and intermediate shafts and appurtenances.

V-403. The effluent to be returned to the lake would first be discharged into the chlorinating and pumping station. After chlorination, the effluent would be pumped into a vertical shaft which would lead into a tunnel approximately 170 feet beneath the surface. The tunnel would terminate some 125 feet below the lake bottom at a point about 5.7 miles off-shore. At this point, the tunnel would discharge upwards through a vertical shaft to diffuser pipes on the lake bottom. An outlet crib and intermediate land shafts might also be useful, but are not essential.

3. *Cost*

V-404. The capital cost of the Hazen project would be approximately $90,000,000. This cost includes a land tunnel 46,000 feet long and a lake tunnel 30,000 feet long. The fixed charges on the investment would be $3,900,000 per annum, based on a 3¼ percent interest rate, and a depreciation rate of 1 percent on $82,400,000 and 2 percent on $7,600,000. The annual operating costs of the project would be approximately $800,000 per year to return 1,000

cfs and approximately $595,000 per year to return 750 cfs. The annual cost assumes an annual average chlorine dosage of 5 parts per million. All these cost estimates were made in 1960.

V-405. Application of chlorine to the sewage effluent sufficient to produce a free chlorine residual for disinfectant purposes might require a dosage of as much as 50 parts per million. If a dosage in this amount were applied, the total annual cost of effluent discharge would be $7,105,000 to discharge 750 cfs, and $7,310,000 to discharge 1,000 cfs. These estimates, which were made in 1960, do not include fixed charges on investment or annual operating costs that would be incurred if further treatment should be found necessary, such as additional chlorination and the removal of nutrient chemicals.

4. *Amounts that Can be Returned at Chicago*

V-406. On the basis of actual navigation requirements of the canals at the present time, it would be possible to return to Lake Michigan more than 1,250 cfs of sewage treatment plant effluent on an average annual basis. If maximum development of navigation on the canals should occur, a return of 750 cfs would still be possible.

5. *Desirability and Effect of Return*

V-407. Hazen suggested several safeguards which could be employed to reduce the danger that the effluent as discharged into Lake Michigan would impair the use of Lake Michigan water for water supply or recreational purposes. First, the activated sludge treatment given to the sewage at the Stickney Plant could be expected to decompose 90 percent or more of the organic material in the sewage. Chlorination of the effluent at the treatment plant is the second safeguard which could be provided. Dilution of the effluent in the lake water, and the distance of the effluent discharge point, or outfall, from the shore and the nearest domestic water intake crib is the third suggested safeguard.

The filtration and chlorination that would be provided at Chicago's water treatment plants would afford an additional safeguard.

V-408. The probable effects of the discharge of a substantial quantity of sewage effluent into Lake Michigan at Chicago are stated in Findings VII-68 and following.

## VI. Water Quality Conditions in the Illinois River System

### A. Great Lakes-Illinois River Basins Project

VI-1. In September 1960 the Great Lakes-Illinois River Basins Project was established as part of the Division of Water Supply and Pollution Control of the United States Public Health Service. Its permanent staff included sanitary and hydraulic engineers, chemists, biologists, bacteriologists, radiochemists, oceanographers and economists. Its laboratory facilities included four laboratories—chemical, bacteriological, biological, and radiochemical, as well as field laboratory facilities. The first undertaking of the Project was the investigation of the water quality of the Illinois River system which had as its objective the determination of the degree and source of pollution of the surface waters of the Illinois River basin.

### B. Sewage and Sewage Decomposition in Streams

VI-2. Untreated sewage ordinarily consists of more than 99.9 percent water and less than 0.1 percent organic and inorganic solids. The solids are present in suspended form and in solution. The organic matter, whether in solution (dissolved) or suspended, decomposes by means of chemical-biological processes into simple, stable compounds. Alkyl Benzene Sulfonate (ABS), an organic compound in synthetic detergents, and certain other organic compounds, do not decompose by such processes as rapidly or as completely as other types of organic material found in sewage.

VI-3. When sewage decomposes in the presence of oxygen, whether in the aeration tanks of an activated sludge unit or in a stream, the process of decomposition is aerobic. If decomposition takes place in the absence of oxygen the decomposition process is anaerobic. Aerobic decomposition is far more desirable in open streams than anaerobic decomposition, because anaerobic decomposition is likely to produce foul and noxious odors, whereas aerobic decomposition does not produce such odors.

VI-4. Some of the organic matter contained in untreated sewage, industrial wastes, or sewage effluent, will oxidize and decompose after being discharged into a river or canal. In the presence of dissolved oxygen (DO) the organic material will decompose aerobically and will not produce noxious odors. The receiving stream therefore should contain enough DO to prevent anaerobic conditions. The amount, or concentration, of oxygen required in a given reach of a receiving stream to prevent anaerobic conditions is dependent, among other things, upon the strength, quantity and nature of the sewage discharged as well as the rate at which the DO is consumed and replaced.

VI-5. Suspended organic matter discharged into the canals or rivers of the Sanitary District may remain in the flowing portion of the stream or may settle out and form sludge banks. Some of the organic matter in the sludge banks, as well as some of the organic matter in the flowing portion of the stream, decomposes, using DO from the waters. Decomposition, when oxygen is present, is essentially oxidation of the organic matter. The decomposing organic matter is said to "exert a demand" on the DO.

VI-6. Sludge banks are most concentrated at points in the waterways where the velocities are lowest, such as at the turning basins and at wide places in the channels, at bends or at the junctions of streams. Sludge may accumulate to thicknesses of several feet. All sludge accumulations do not remain indefinitely at one place. During periods of storm runoff and especially during unusually

heavy floods, stream velocities may get high enough to flush some of the sludge downstream, much of which resettles in wide sections of the channels, where velocities are low. On the other hand, some of the heavier or more compacted sludge may not move at all.

VI-7. Sludge banks cause undesirable conditions in the waterways of the Sanitary District. They are objectionable from the standpoint of navigation. Organic matter deep within the deposited sludge may become cut off from dissolved oxygen available in the stream and decompose anaerobically. The results of this are the production of carbon dioxide, methane, and hydrogen sulfide gas, bubbles of which may be visible as they rise to the surface. Organic matter in the sludge banks which is in contact with dissolved oxygen decomposes aerobically and depletes available oxygen supplies. The sludge adds to the oxygen demand on the waterways, particularly during the warmer months when the rate of oxygen utilization is greatest and the oxygen supply is most limited.

VI-8. The amount of oxygen that a given sample of organic matter consumes during oxidation is measured in terms of the biochemical oxygen demand (BOD). BOD is defined as the quantity of oxygen utilized in the biochemical oxidation of organic matter in a specified time and at a specified temperature. It is not related to the oxygen requirements in chemical combustion, being determined entirely by the availability of the organic material as a biological food and by the amount of oxygen utilized by the microorganisms during oxidation.

VI-9. BOD is a measure of the capacity of organic matter to remove DO from water. Sewage, sewage effluent or any other fluid containing organic matter with a high BOD will require proportionately more DO than sewage, sewage effluent or any other fluid containing organic matter with a low BOD. BOD is measured by incubating diluted samples of waste under standard conditions and measuring the loss in DO. The BOD test may be applied to untreated

sewage, sewage effluent, industrial wastes, sludge, water from Lake Michigan or any other fluid containing organic matter. The generally accepted tests for measuring BOD involve the measurement of dissolved oxygen initially present in a sample and the dissolved oxygen remaining after incubation of the sample in the dark for five days at 20 degrees C. The five days BOD test measures approximately 68% of the amount of oxygen required to stabilize the oxidizable carbonaceous material present. The term "ultimate BOD" is an expression indicating approximately 100% of the amount of oxygen required to stabilize the oxidizable carbonaceous material present. Five days BOD may be converted to ultimate BOD by multiplying the five days BOD value by 1.47; conversely, ultimate BOD may be converted to five days BOD by multiplying the ultimate BOD value by 0.68. Temperature affects the rate at which sewage is oxidized, that is, the rate at which the BOD is exerted. The rate of oxidation generally doubles with each 18 degrees Fahrenheit rise in temperature. Therefore, the temperature of the receiving stream is important in estimating the effect of sewage discharges.

VI-10. BOD is usually stated as a concentration, in parts per million by weight. Thus a BOD of 2 parts per million (ppm) means 2 pounds of oxygen are demanded per million pounds of liquid. When the concentration is multiplied by a given weight of sewage or effluent, the total pounds of BOD in that sewage or effluent are determined.

VI-11. Industrial waste loads are commonly expressed in terms of population equivalent (P.E.). For this purpose, one pound of BOD is assumed to be the equivalent of six persons, and P.E. is computed as the BOD in ppm times the flow in MGD times 8.34 divided by 0.17. (1 ppm equals 8.34 lbs. per million gallons and it is assumed that the per capita BOD contribution is 0.17 lbs. per day.)

VI-12. Dissolved oxygen (DO) is oxygen actually dissolved in a liquid, such as water or sewage effluent. Dissolved oxygen does not include air bubbles commonly seen

in water. It is usually expressed as either a concentration in parts per million by weight or as a percentage of saturation.

VI-13. Percentage of saturation is used to express the concentration of oxygen that water at a given temperature contains in comparison with the amount of oxygen that pure water can theoretically contain at the same temperature. Pure water at saturation theoretically contains a specific concentration of DO at a given temperature. At the same temperature, water 50 percent saturated contains one-half the concentration of DO that it did at 100 percent saturation. At 32 degrees Fahrenheit, 100 percent saturated water contains 14.62 ppm of DO. Therefore water at 32 degrees Fahrenheit containing 7.31 ppm of DO would be said to be 50 percent saturated.

VI-14. Water 100 percent saturated contains a greater concentration of DO at low temperatures than at high temperatures, as is indicated by the following table:

| Temperature (Degrees Fahrenheit) | % of Saturation | Concentration of dissolved oxygen (ppm) |
|---|---|---|
| 32 | 100 | 14.62 |
| 68 | 100 | 9.17 |
| 80 | 100 | 8.17 |

Thus increasing temperature decreases the concentration of DO that water can contain.

VI-15. Clean water in rivers and lakes exposed to the air is ordinarily saturated with dissolved oxygen, or very nearly saturated. When sewage is discharged into such water, the organic matter in the sewage begins to decompose and in so doing, to use up the dissolved oxygen. As the oxygen demand is fulfilled, the oxygen in the water is depleted. Depending on the available supply of oxygen and the demand, the dissolved oxygen will drop from saturated to perhaps 50 percent saturated or, if the demand is equal to or greater than the supply, to 0 percent saturated, which means that all of the dissolved oxygen has

been depleted. When all or nearly all of the available dissolved oxygen is depleted, anaerobic decomposition begins to take place, and noxious odors and gases are likely to be produced.

Dissolved oxygen resources in a stream are replenished by oxygenated inflow and by atmospheric reaeration.

When inflow to a stream carries more oxygen per unit volume than the stream itself, the inflow adds to the available oxygen resources of the stream. Inflow which generally adds DO to the canal includes lake water and sewage effluent.

Atmospheric reaeration (i.e., natural reaeration from the atmosphere) is a physical process which takes place when water is in contact with the atmosphere. When water is in contact with the atmosphere, the concentration of dissolved oxygen in the water tends toward a "saturation" level at which the partial pressures of oxygen in the two media are equal. When the DO of the water is lower than this possible saturation concentration, the partial pressure of oxygen in the water is lower than that in the air. This difference of pressures is the driving force by which the water takes up oxygen from the air in the ever present attempt to equalize these pressures. The greater the degree of oxygen depletion in the water, the greater the partial pressure difference, or driving force, and, hence, the faster the reaeration process. Reaeration of still water in a glass is quite slow, whereas in a flowing stream, turbulence and mixing result in a much faster process because the water is much more frequently brought into direct contact with the air.

VI-16. Organic matter, which exerts a biochemical oxygen demand (BOD), and thereby consumes the dissolved oxygen, is present in the canals and rivers of the Sanitary District, and is found in:

(a) Untreated combined sanitary sewage and storm runoff which spills into the canals from the overflows at the diversion chambers and which is

directly discharged into the canals and rivers at the pumping stations.

(b) Sewage effluent which is discharged into the canals at the Sanitary District's treatment plants.

(c) Treated and untreated industrial and other wastes which are discharged into the canals by industrial plants situated along the waters.

(d) Sludge beds which have accumulated along the bottoms of the waterways.

(e) Lake water which is diverted directly from Lake Michigan at the heads of the canal system.

(f) Surface runoff and ground water which runs into the canal system from the Chicago, Calumet and Des Plaines Rivers basins.

VI-17. The effect of decomposing organic matter in the waterways within the Sanitary District has been to reduce, and sometimes completely deplete dissolved oxygen supplies. Oxygen depletion is greatest in warm months when oxygen utilization is greatest and when natural replacement of oxygen from the atmosphere is least effective.

## C. Water-borne Wastes Discharged to the Illinois River Basin

### 1. *Public Health Service Study*

VI-18. The Public Health Service undertook to identify sources of pollution and to obtain quantitative data on the amount and nature of water-borne wastes, and the points of discharge to receiving waters of such wastes for the Illinois River basin.

### 2. *Municipal Wastes*

VI-19. The Public Health Service found that within the Illinois River basin in 1960 were 678 separate communities, institutions, and commercial establishments

which are served by 573 sewage works. The estimated total population equivalent (P.E.) before treatment is 10,561,000 of which 1,446,000 P.E. is discharged to the streams. P.E. of a waste is the calculated population which would normally contribute the same amount of BOD per day as the waste under consideration. Of the 573 systems, 63 percent provide secondary treatment, five percent primary treatment, and the remaining 32 percent little or no treatment. The three large Sanitary District treatment works serve approximately 69 percent of the sewered population in the basin, 76 percent of the total P.E. before treatment, and account for approximately 53 percent of the total load discharged.

3. *Industrial Wastes*

VI-20. The biochemical oxygen demand of all known sources of industrial wastes discharged directly to the Illinois River system was approximately 827,000 P.E. The principal sources of industrial pollution in the Illinois River system are from the following industries: textile, food and kindred products, petroleum, pulp and paper, and chemicals and allied products. The industrial wastes discharged directly to the Illinois River system by industries within the boundaries of the Sanitary District amounts to about 147,000 P.E., as measured by the BOD.

4. *Storm Overflows*

VI-21. The discharge of raw sewage and industrial wastes mixed with storm water during periods of storm runoff constitutes a source of pollution of the waterways in the Chicago area. During its study, the Public Health Service observed more than 400 sewer outfalls on the main channels and tributary streams, 105 of which discharged BOD loads in excess of five pounds per day. The upper Illinois River main stem has organic loadings in significant amounts from sources other than identified municipal and industrial waste discharges. The loads from identified

sources averaged about 200,000 pounds of ultimate BOD per day for the period of the Public Health Service study. The unidentified source loads averaged about 157,000 pounds of ultimate BOD per day for the same period. This figure includes storm spillage estimated at 56,000 pounds of ultimate BOD daily and industrial waste loads of 20,000 pounds of ultimate BOD daily.

## D. Water Quality Conditions of the Illinois River System

### 1. *Extent of Investigations*

VI-22. The field investigations by the Public Health Service of the water-quality conditions of the Illinois River system extended over a period of more than a year. The sampling program at 83 sampling stations began in April 1961 and continued through August 1962. In this period, the upper Illinois River system was studied for five separate monthly periods, the Calumet-Little Calumet system tributary to the upper Illinois River system was studied for one month and the lower Illinois River and its major tributaries for three months. The dates of sampling periods, and the number of days sampled at each location are tabulated below.

| LOCATION | SAMPLING PERIOD | DAYS SAMPLED |
|---|---|---|
| Upper Illinois River system | April–May, 1961 | 26 |
| Upper Illinois River system | June, 1961 | 22 |
| Upper Illinois River system | July, 1961 | 18 |
| Upper Illinois River system | August, 1961 | 16 |
| Upper Illinois River system | Jan.–Feb., 1962 | 24 |
| Calumet–Little Calumet | Feb.–March, 1962 | 20 |
| Lower Illinois River system | Nov.–Dec., 1961 | 21 |
| Lower Illinois River system | March–April, 1962 | 27 |
| Lower Illinois River system | July–August, 1962 | 31 |

In all, approximately 14,000 water samples were collected and a total of 91,300 laboratory tests were accomplished.

2. *Physical Appearance of the Illinois River*

VI-23. The physical appearance of the upper Illinois River reflects sources of pollution received. Debris, including rubbish and garbage, can be found floating on the surface of the Illinois River. Oil slicks and foam can be experienced throughout the length of the river. This condition also prevails for many miles of the lower river.

3. *Temperature Conditions*

VI-24. The observations made by the Public Health Service during the summer months of 1961 in the upper Illinois River system showed an increase in the temperature of the water of about 9 degrees Centigrade from the lake to Lockport. Part of this increase results from thermal loads imposed on the system. During the colder months the increase was less, ranging from 4° to 6° C., except in January and February of 1962 when smaller quantities of lake water were diverted and the increase was about 9° C.

4. *Hydrogen Ion Concentration (pH)*

VI-25. pH is not presently a critical factor in the water quality of the Illinois River.

5. *Dissolved Oxygen Levels*

VI-26. The pollution loads imposed on the upper Illinois River system are substantial and extensively deplete oxygen reserves. Individual observations of zero DO during the Public Health Service study indicate anaerobic conditions which favor development of nuisance conditions.

VI-27. The average observed DO concentrations in the water admitted to the main channel at the Wilmette inlet during the Public Health Service study are shown on Figures V-5 through V-8 of U. S. Ex. 10C. As the water progresses downstream rapid depletion was observed at all stations to the junction of the inlet waters of the Chicago River. The extent of the depletion was least during the cold months and greatest during the warmer seasons, when the

DO level approached zero above the confluence of the North Branch with the Chicago River. Beyond the confluence, a sharp rise in DO, caused by lake water entering the system, was observed; thereafter the DO content continued to decline. The DO depletion in the channel between the Chicago River inlet and Lockport during the study is shown on Figures V-5 through V-8 of U. S. Ex. 10C. The January drop was from ten to five milligrams per liter (mg/l).* Between the Calumet-Sag confluence and the Lockport dam there was little or no oxygen remaining during the summer months.

VI-28. Water at the Calumet-Sag Channel inlet was lower in DO than the other inlets, although much higher than at other downstream points. Downstream points on the Calumet-Sag showed progressive depletion of DO. The lowest DO, less than one mg/l, was observed during the summer period at points above the junction with the Sanitary and Ship Canal.

VI-29. The Grand Calumet and Little Calumet Rivers showed considerable oxygen depletion in the one month (February) these streams were studied. The greatest depletion occurred on the Grand Calumet, where DO dropped to four mg/l at two points. The DO content of the Grand

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* Milligrams per liter is the weight expressed in milligrams of dry solids per liter of solution. One milligram is a little less than four hundred thousandths of an ounce, and a liter is a little more than a quart. Analytical results may also be parts per million (ppm). Assuming that one liter of water, sewage, or industrial waste weighs one kilogram (2.2 pounds), one milligram per liter is equivalent to one part per million. When dealing with industrial wastes of high specific gravity, results should be expressed in milligrams per liter, with the specific gravity given. Results obtained in mg/l can be converted to ppm by the formula:

$$\text{ppm by weight} = \frac{\text{mg/l}}{\text{Specific Gravity}}$$

One ppm may be expressed as 8.345 pounds of dry solids to one million U.S. gallons of water. Occasionally analytical results may be expressed as parts per billion (ppb) when dealing with extremely low concentrations.

Calumet, at its confluence with the Calumet-Sag Channel, was consistently below that of the channel. Zero or near zero DO levels were observed at this point during most of the study.

VI-30. At Lockport, the flow of the upper Illinois River system passes through navigation locks, and through the hydroelectric power plant where aeration occurs. This raised the DO from near zero to about seven mg/l during the studies conducted during the months of April through August 1961. Between Lockport and the Kankakee River confluence, further depletion was observed. The DO dropped to about four mg/l. The mixing of high DO waters of the Kankakee River and further aeration on passage over the Dresden dam temporarily restored the DO of the river to near saturation at the point marking the beginning of the lower Illinois River.

VI-31. During the cooler seasons of study, namely November 1961 and March and April 1962, the average DO of the lower Illinois River was at or near saturation. Minor drops in DO in the stream reaches between dams were insufficient to be of concern from a water quality standpoint. During the summer study period, however, because of lower flows and higher temperatures, zones of oxygen depletion were evident in the lower river.

6. *Biochemical Oxygen Demand*

VI-32. According to Public Health Service data, the three Sanitary District treatment plants account for 53 percent of the BOD entering the Illinois River system. Their influence extends at a decreasing rate downstream. Other sources of BOD include the numerous storm water outlets and other outfalls in the upper river system and other outlets in the Peoria area in the lower river.

VI-33. During the April-May 1961 period, the BOD of incoming water at Wilmette averaged 5.5 mg/l. This level did not change appreciably until a point below the Northside sewage treatment plant discharge where there

was a sharp rise, to 9.0 mg/l. Beyond this point, the BOD varied between 8.5 and 5.5, gradually diminishing to the lower value until a rise to 11.0 mg/l at a point below the West-Southwest sewage treatment plant discharge. From this point on the BOD declined with a minor rise below discharges from the Joliet area.

VI-34. The Calumet-Sag averages during April and May 1961, showed an initial BOD of 4.0 mg/l gradually rising to a high of 8.5 mg/l below the Calumet treatment plant discharge, and slowly diminishing to 6.0 mg/l at its confluence with the Sanitary and Ship Canal. A similar pattern of increase in BOD followed by a decrease below the Calumet plant was observed during the other study periods.

VI-35. The June and July 1961 averages followed the same pattern exhibited generally by the April-May period.

VI-36. The pattern resulting from the August 1961 averages, although similar to the earlier patterns, showed an overall lower BOD. The Calumet-Sag Channel for this period of observation demonstrated a similar pattern, exhibiting lower values throughout its course.

VI-37. The January 1962 averages presented a pattern somewhat different from the other periods. Here the discharges from the Northside, Calumet, and Stickney treatment plants were more apparent than in other study periods. The BOD of the Grand Calumet tributary to the Calumet-Sag was considerably higher than the main channel, ranging between 10 and 30 mg/l throughout its course. The Little Calumet River averaged between five and ten mg/l during this winter period.

VI-38. In the lower river there were considerable increases in BOD below Peoria.

### 7. *Alkyl Benzene Sulfonate (ABS) Content*

VI-39. Alkyl Benzene Sulfonate or ABS is that portion of a common household or industrial cleaning compound that imparts foam and reduces surface tension to aid

in the removal of dirt particles by the cleaning compound. ABS compounds are new to the water environment. They have been used as substitutes for soap only in recent years. They pass through water and sewage treatment processes with only partial reduction in concentration; moreover, they are not readily attacked by stream purification processes. Consequently, ABS can be found for many miles below sources of waste water discharge. ABS is believed to be non-toxic to man in the concentrations found in contaminated waters; but it produces unsightly foams in streams at points of agitation or discharge over dams.

About July 1, 1965 the manufacturers who produce over 90 per cent of the ABS in this country ceased to manufacture ABS and are now manufacturing a more biodegradable material which is being used by the major formulators of synthetic detergents in the manufacture of their cleaning compounds. The amount of ABS being discharged into streams and lakes in this country should accordingly be greatly reduced as existing supplies of detergents containing ABS are used up.

Drinking water and water supply systems used by carriers and others subject to Federal quarantine regulations must conform to the Public Health Service Drinking Water Standards. In addition, these standards are recommended by the Public Health Service for evaluating the quality and safety of water supplies generally. ABS content of drinking water is limited to 0.5 mg/l by the U. S. Public Health Service Drinking Water Standards.

VI-40. During January 1962 except for the waters entering the inlets to the upper Illinois River system, waters from nearly every station in the upper river revealed ABS above the limits of 0.5 mg/l recommended by the United States Public Health Service Drinking Water Standards. Values as high as 2.0 mg/l were found below the principal treatment plant discharges.

VI-41. There was during November 1961 through August 1962, a portion of the lower Illinois River in which

the ABS values were above the limits of the Drinking Water Standards, particularly during the summer season when the low river flows prevailed.

8. *Sludge Deposits*

VI-42. The upper Illinois River contains considerable quantities of settleable organic and inorganic solids. The settleable organic solids have resulted in large and extensive deposits of sludge in the upper Illinois River which are responsible for a considerable portion of the demand on the oxygen assets of the stream.

9. *Nitrogen and Phosphate Concentrations*

VI-43. The phosphate load carried by the Illinois River is a nutrient factor contributing to the population increases of plankton and algae; those loads as observed by the Public Health Service are shown by Figures V-22 through V-24 of U. S. Ex. 10C. The Illinois River system carried loads of organic and ammonia nitrogen as observed by the Public Health Service and shown by Figures V-25 through V-28 of U. S. Ex. 10C. The oxygen-consuming (nitrogenous BOD) load due to the nitrogenous matter contributes to oxygen depletion in downstream portions of the Illinois River system.

10. *Toxic Metals*

VI-44. During January and February 1962 toxic metals such as copper, cadmium, chromium, nickel and zinc were present at various locations in the Illinois River system, but at concentration levels within the limits of the Public Health Service Drinking Water Standards.

11. *Radioactive Wastes*

VI-45. Under existing fallout conditions and controls by both the Atomic Energy Commission and State agencies, radiation levels in the Illinois River system are within the limits recommended by the Public Health Service Drinking Water Standards of 1962.

12. *Biological Conditions*

VI-46. The biological studies of the Public Health Service conducted during the period from July 1961 to June 1962 revealed biological degradation (scarcity or complete absence of clean-water biological forms) throughout the main stem of the upper Illinois River system, including the Calumet-Sag tributary system. Degradation was severe as far downstream as the confluence of the main stem with the Kankakee River. There was a gradual improvement in quality from that point downstream. Extreme biological depression occurred in certain reaches of the upper Illinois River system during the summer months when populations of organisms very tolerant to pollution, such as sludgeworms, were greatly reduced although bottom sludge banks exist. The flora and fauna of the lower Illinois River indicated further progress toward recovery in that organisms intolerant of low dissolved oxygen conditions or high concentrations of toxic and inhibitory materials were common in that reach of the stream.

13. *Bacteriological Conditions*

VI-47. Coliform levels experienced throughout the Illinois River system during the Public Health Service study are shown on Tables VII-1 and VII-2 of U. S. Ex. 10B. Starting with the low levels found in Lake Michigan water at the several inlets, the levels in the upper Illinois River system increased at numerous points due to additional waste discharges reaching the system. These coliform concentrations are of public health significance because of their association with waste discharges known to contain human fecal material. This danger is confirmed by the presence of varieties of pathogenic bacteria and enteroviruses. The lower Illinois River reveals evidence of heavy bacterial pollution throughout its length. The natural tendencies of stream purification and bacterial die-off are offset by fresh additions of pollution originating from tributary streams and cities located in the drainage basin.

VI-48. Coliform bacteria are important indicators of fecal pollution because the origin of most of this group of bacteria is in the intestinal tract of warm-blooded animals, including man. Consequently, the presence of coliform organisms in a body of water is an indicator of contamination of the water by fecal matter. As contamination of water by fecal matter is one avenue of transmission of certain water-borne diseases to humans, coliform organisms are utilized as indicators of possible pathogenic contamination. Increasing densities of coliform bacteria found in water are, therefore, related to the degree of pollution of enteric origin and to increasing health hazard to those exposed to the water.

VI-49. Fecal streptococci include any species of streptococci commonly present in significant numbers in the fecal excreta of humans or other warm-blooded animals.

The fecal streptococci likewise indicate the presence of fecal matter in water and may, at times, indicate it more specifically than coliform bacteria since some of the coliform bacteria abound and multiply in nature in water or soils, whereas the fecal streptococci generally do not multiply in bodies of water. In human feces, there are, on the average, three times as many coliform bacteria as fecal streptococci. In polluted waters the ratio varies. The demonstrated presence of fecal streptococci generally confirms the supposition that coliform organisms which are found in a certain water sample are of fecal origin. The tests may thus be of value where there is a question concerning the sanitary significance of coliform bacteria.

VI-50. The lake water entering the upper Illinois River system at Wilmette and the Chicago River is of relatively good bacterial quality, usually carrying only moderate or light densities of coliform bacteria and fecal streptococci. The inlet of the Calumet-Sag system at its mouth is frequently subject to intermittent pollution, probably resulting from reversal of flow direction. As the water moves down the waterway, the coliform and fecal streptococcus

densities are rapidly, and at times, sharply increased. The 1961 summer coliform densities increased from 230 per 100 milliliters (ml) to 390,000 per 100 ml in 15 river miles. The fecal streptococci increased from 320 per 100 ml to 3,400 per 100 ml in 11 river miles. The points of pollution appear to be distributed throughout the drainage basin indicating numerous points of entry. Sharp rises in coliform and fecal streptococci counts are encountered downstream from the Northside, Stickney, and Calumet sewage treatment plants.

VI-51. The winter 1962 coliform densities encountered in the upper Illinois River system were generally lower than those of the summer of 1961 at each corresponding point, whereas the reverse is generally true of the fecal streptococci; that is, the winter values for the streptococci were at times somewhat higher than those of the summer determinations. These relations may be due to the survival characteristics of the two types of organisms when released into bodies of water. The high concentration of coliforms and fecal streptococci, and the presence of species of the Salmonella group and viral agents in the upper Illinois River system is such that danger to health and welfare must be presumed to exist in any water uses involving human contact with these waters.

VI-52. The coliform and fecal streptococci densities in the lower Illinois River system are not of the magnitude found in the upper river, but they are substantial. In general the pattern for the three seasons (autumn conditions—November 1961; winter conditions—March 1962; summer conditions—July 1962) on the lower Illinois River was the same with the coliform values increasing at two points but reduced in numbers at points further downstream until the City of Peoria was reached. The effect of the Peoria wastes was reflected in the highest coliform values on the lower Illinois River with geometric mean coliform densities at the sampling point downstream from Peoria of 38,000; 17,000, and 210,000 per 100 ml in November, March, and July, respectively. The coliform densi-

ties at points below Peoria did not reduce at any points downstream as low as the lowest coliform densities at points immediately above Peoria. The coliform concentrations in the lower Illinois River system are such that some danger to health and welfare must be presumed to exist in any water uses involving human contact with these waters.

VI-53. In view of the gross pollution in the upper Illinois River system disclosed by the Public Health Service findings from its coliform and fecal streptococci investigation, a detailed investigation of the actual incidence of disease-producing bacteria and viruses in those waters was undertaken by the Public Health Service.

VI-54. Analyses of raw sewage in the Chicago sewers and effluent from Sanitary District treatment plants show the presence in both of a variety of infectious Salmonella bacterial species, and indicate that these organisms move through the present sewage treatment process and into the receiving streams.

Samples taken from raw sewage, sewage effluent, and river water were analyzed by the Public Health Service for the presence of bacteria of the Salmonella-Shigella group. Of the 26 samples, 13 were of raw sewage; ten were of sewage effluent; and three were of river water from points one to two miles downstream of effluent outfalls. No Shigella organisms were isolated up to January 1963; this group is rarely isolated from streams or sewage effluents. Of the 13 samples taken from raw sewage, seven samples contained Salmonella. Of the ten samples taken from sewage effluent, three samples contained Salmonella. Of the three samples taken from river water, one sample yielded Salmonella. Of all the samples, 16 different species of Salmonella were identified. Only one species belongs to the group containing primarily human pathogens. This sample was taken from raw sewage. The other strains are representative of the group naturally pathogenic to animals, but

also able to produce disease in man in the form of gastro-enteritis.

VI-55. Isolation and detection of enteroviruses in samples collected from points upstream and downstream of the Northside, Stickney, and Calumet Sanitary District Treatment Plants, as well as from the influent and effluent of those plants, show that some of these viruses survive the sewage treatment and are present in the waters of the upper Illinois River system.

Samples taken from raw sewage, sewage effluent, and river water were analyzed by the Public Health Service for the presence of enteroviruses. Of the 162 samples taken, 49 were from raw sewage, 44 were from sewage effluent, 37 were from river water upstream of the sewage treatment plants, and 32 were from river water downstream of the sewage treatment plants. The result of these tests, as shown by U. S. Ex. 10B, Table VII-4, are as follows:

FREQUENCY OF VIRUS ISOLATIONS IN MONKEY KIDNEY TISSUE CULTURES AND IN SUCKLING MICE FROM SEWAGE AND RIVER WATER SAMPLES*

Chicago, Illinois, Summer and Fall, 1962

| Type of specimens | No. of samples tested (1) | No. of samples containing virus (2) | Percent of virus isolations (3) | No. of Coxsackie virus isolations (4) | No. of poliovirus isolations (5) |
|---|---|---|---|---|---|
| Raw sewage ..... | 49 | 38 | 77.6 | 7 | 8 |
| Effluent ..... | 44 | 20 | 45.4 | 3 | 5 |
| River water above treatment plants.. | 37 | 10 | 27.0 | 5 | 3 |
| River water below treatment plants.. | 32 | 8 | 25.0 | 0 | 2 |
| Total ..... | 162 | 76 | 46.9 | 15 | 18 |

* As of December 31, 1962.

The survival through sewage treatment of enteroviruses and their presence in the waters of the upper Illinois River system confirms the serious contamination of the Illinois River and emphasizes the necessity of rigorous

safeguards in the form of water purification before the waters of the canal could be used as a source of drinking water.

VI-56. The Public Health Service studied various measures by which water quality conditions in the Illinois River system could be improved and determined which of those measures it considered feasible and reasonable. Among the measures recommended by the Public Health Service were a change in the basic accounting period for diversion flows from the calendar year to a water year terminating at the end of February and a modification of the accounting method to permit two years for achieving the required balance, when necessary. The Public Health Service computed the effects on water quality of the Illinois River system by improvements it found feasible.

VI-57. Having determined the present water quality of the Illinois River system and having computed the extent to which that quality can feasibly be improved, the Public Health Service formed an opinion that reduction of the present Chicago diversion from Lake Michigan under the existing regimen would not be consistent with the protection of the public health. The Public Health Service arrived at that opinion in the following manner: First, by the selection, in consideration of the present and expected uses of water of the upper Illinois River system, of various water quality parameters and the assignment to each parameter of a numerical value, the achievement of which would make the water satisfactory from the standpoint of protecting the public health and eliminating nuisance conditions. Secondly, by the estimation of the dilution flows required to meet these water quality parameters or criteria, under both existing and improved conditions. The flows thus estimated as necessary to achieve satisfactory quality were, under either present or improved conditions, greater than existing dilution flows.

# VII. Water Quality and Currents of Lake Michigan

## A. Water Quality Conditions of Lake Michigan

### 1. *Extent of Investigations*

VII-1. The Public Health Service conducted physical, chemical, biological, micro-biological, and radiochemical water quality investigations of Lake Michigan. Sampling operations in Lake Michigan began on April 24, 1962 and eight cruises were completed by December 6, 1962. A total of 358 stations were sampled during this period. Return trips were made to some stations and the total number of station stops or calls was 474.

The Lake Michigan sampling survey covered the entire lake and three harbors: Chicago, Milwaukee, and Racine. In sampling the lake, three principal areas of study were selected:

1. The deep-water main body of the lake.

2. The inshore area (waters adjacent to the shoreline).

3. The waters in and adjacent to principal harbors and tributaries.

At every station, sampling was performed in each zone of the thermal regime and at depths that, in total, represent the vertical profile at that station.

### 2. *Physical and Chemical Conditions*

VII-2. In general, the bulk of the waters of Lake Michigan are of good chemical quality, in that the concentrations of the constituents present would be acceptable to the present water uses and to anticipated future uses of these waters.

VII-3. Substances which in sufficient quantity could present difficulty in maintaining satisfactory water quality are ammonia nitrogen, total phosphate, silica and phenol. Lack of dissolved oxygen can also present similar difficul-

ties. The concentrations of these substances in the lake vary from time to time and from place to place. The variability of the concentrations of these substances was appreciable and these substances were likely to provide the greatest threat to satisfactory water quality management. The concentrations observed by the Public Health Service are shown on Tables 1a, 1b, 2 and Figures 1 through 18, of U. S. Ex. 20.

VII-4. There was little or no deterioration in the quality of the water in the main body of Lake Michigan as revealed by samplings at stations located ten miles or more from shore.

VII-5. Inshore sampling at one mile, four miles, seven miles and ten miles from shore indicated some water quality deterioration in areas adjacent to populated sectors of the lake. Ammonia nitrogen levels were highest in the southwest sector; phosphate was also highest at depths other than the surface. The observed concentrations of phenol in the southwest inshore area were high enough at times to require that municipal water systems which use Lake Michigan as a source of water provide additional treatment therefor. The low concentrations of phosphate found at the surface may be due to uptake by planktonic organisms.

VII-6. Of all areas studied, Milwaukee harbor was found to have water of the poorest chemical quality. The concentrations of ammonia nitrogen, phosphate, ABS, phenol and BOD, and DO observed by the Public Health Service in Milwaukee Harbor are shown by Figures 8, 16, 17, 18, and Tables 1b, 2, and pages 27 and 28 of U.S. Ex. 20.

VII-7. Degradation in Milwaukee harbor with respect to the chemical quality of the water was significant. This significant degradation was evidenced by the high concentrations of ammonia nitrogen, phosphate, ABS, phenol and BOD, and the low concentrations of DO observed.

Some of the tests conducted by the Public Health Service also revealed evidence of southward movement of waters from this harbor.

VII-8. Of the BOD discharged to Milwaukee harbor in 1961 from known waste sources, the two Jones Island sewage treatment plants, both of the activated sludge types, contributed an average daily load of 50,600 pounds, or 65 percent of the total.

VII-9. With Milwaukee harbor as an illustration of the degree of chemical water quality degradation resulting from the return of sewage effluents to the lake, the return of any large portion of Chicago's effluent would be likely to produce similar effects on the surrounding waters and accelerate the changes in nitrogen and phosphate toward the critical levels now being approached in the southwest inshore quadrant of the lake.

3. *Biological Conditions*

VII-10. The center of Lake Michigan yielded concentrations of phytoplankton (suspended microscopic plant life) in the 0-500 per ml range, and light penetration was generally more than six meters. The middle of the lake was decidedly oligotrophic; that is, it was deep, clear and contained little organic material. The flora was predominated by the diatoms *Synedra, Asterionella, Tabellaria* and *Fragilaria.* These are forms that have typified the planktonic algae of Lake Michigan for many years. They are similar to the flora of Lake Superior and are typical of other lakes that are oligotrophic. Many Lake Michigan samples have greater numbers of phytoplankton than in Lake Superior. Lake Superior averages about 200 per ml in some shoreline areas. *Cyclotella,* one of the genera of algae which are not typical of oligotrophic lakes and which are common inhabitants of nutrient-enriched waters, sometimes occurred abundantly in Lake Michigan samples dominated by *Asterionella, Fragilaria, Tabellaria* and *Synedra. Melosira, Cyclotella,* and *Stephanodiscus,* all genera of algae

which are not typical of oligotrophic lakes and which are common inhabitants of nutrient-enriched waters, were the genera that predominated samples from Milwaukee harbor and most of the shoreline stations from Milwaukee to Chicago. Along the Michigan shoreline, *Cyclotella-Stephanodiscus* predominated and *Melosira* were numerous in many samples. Lake waters adjacent to Wisconsin and Michigan harbors were predominated by *Melosira* and *Cyclotella*. Within the ten-mile contour, total phytoplankton counts averaged about 1,500 per ml, and less than 200 per ml at sampling stations beyond the ten-mile contour. Relatively high total phytoplankton counts of 1,000-5,000 per ml were found at many stations along the shoreline. In comparison, Lake Superior averages about 200 per ml at shoreline stations and much less at the center of the lake.

VII-11. Long-term records of plankton populations in Lake Michigan at Chicago indicate a gradual rise over the past 30 years.

VII-12. Total counts of phytoplankton in Lake Michigan observed by the Public Health Service are shown in Table 1 and on Figures 1 through 7 of U. S. Ex. 21; densities of predominant genera of phytoplankton observed are shown in Tables 2 through 4 of U.S. Ex. 21.

VII-13. Inorganic nitrogen and dissolved phosphorus are essential for algal growth. Comparison between these nutrient concentrations in Lake Michigan and the phytoplankton data shows that the densities of phytoplankton generally followed the same pattern as nutrient concentrations. The averages for nitrate nitrogen and total phosphate were 0.12 mg/l and 0.01 mg/l, respectively; inshore concentrations as high as 0.36 mg/l and 0.27 mg/l, respectively, were found. Uptake by plankton in inshore areas effected low concentrations of dissolved phosphorus. Total counts of phytoplankton in Lake Michigan observed by the Public Health Service ranged from 1,000-5,000 per ml at many of the sampling stations one, four, seven, and 10 miles from shore with slightly higher counts along the

eastern shore. Beyond 10 miles from shore the densities of phytoplankton diminished greatly. Counts in this middle area of the lake were rarely more than 500 per ml.

VII-14. Increased density of phytoplankton (or planktonic algae) is a manifestation of eutrophication, or lake aging. Increased concentration of nutrients may under certain conditions increase the density of algal growth. An overabundance of planktonic algae may result in a green, murky water which may produce unpleasant odors and unsightly scums. As the transparency of the water decreases, sunlight is denied the rooted aquatic plants on the lake bottom. In the deeper areas of a eutrophic lake, more particularly below the thermocline, dissolved oxygen values may be drastically reduced due to the oxygen demand exerted by the decay of biological materials. Algae grow and die and are succeeded the next year by another crop of algae. As the algae die, they tend to settle to the lake bottom and are attacked by microorganisms that, along with the macroanimal forms in the bottom ooze, exert an oxygen demand.

VII-15. The charting of phytoplankton densities in a lake demonstrates localized and overall effects of nutrients, and provides valuable insight as to the biological productivity of the lake.

In addition, a determination of the kinds of planktonic algae that predominate permits appraisal of the effects of wastes on areas influenced by streams tributary to the lake. For example, some genera of algae such as *Cyclotella*, *Stephanodiscus*, and *Melosira* are common in midwestern streams, but *Asterionella*, *Fragilaria*, and *Tabellaria* are forms common to Lake Superior and Lake Michigan. Therefore, the lake areas influenced by the tributaries can be defined by plots of the kinds and numbers of planktonic algae.

VII-16. Historically, nutrient enrichment of lakes has increased biological productivity (i.e., eutrophication or lake aging). Increasing densities of planktonic algae

are the primary manifestation of eutrophication. When nutrients for the growth of aquatic plants become available the planktonic algae develop. As the concentration of nutrients becomes greater and other conditions are favorable the density of algal growth also may become greater. Sawyer in his work on the Madison lakes gave 0.3 mg/l of nitrate nitrogen and 0.01 mg/l of phosphate phosphorus as levels at which nuisance conditions may occur. Water filtration plants experience difficulty from algal problems through tastes and odors and clogging of sand filters, and industrial water users must combat slime and corrosion.

The nutrients that support planktonic algae also promote the development of attached algae which cover all suitable substrata wherever sufficient light can penetrate. Lake Erie has exhibited luxuriant growths of an attached algal form called *Cladophora* for many years and more recently these algae have become a nuisance in certain areas of Lake Ontario and Lake Michigan. They break loose as they mature, or during storms, and litter the beaches, foul fishing nets, and clog water intake screens.

The eutrophication of a lake is accelerated by the addition of nutrients other than those from natural sources. Sewage contains high concentrations of the nutrients required for algal growth and has been responsible for the induced eutrophication of many lakes throughout the world. The conventional sewage treatment facility removes only part of the growth nutrients in sewage, and thus permits substantial quantities of nutrients to be added to the receiving waters.

Lake Michigan is considered an oligotrophic lake, or one that is deep, clear, and contains little organic material.

VII-17. The changing character of the benthic fauna in Lake Michigan is reflected in increased populations in the past 30 years of sludgeworms, which prefer a habitat of organic sediment, and decreased populations of amphipods, which prefer a habitat of sand or gravel and clean, clear water. This probably has been caused by the continu-

ous sedimentation of organic matter that has gradually altered the habitat to one increasingly more favorable to sludgeworms. As the organic sedimentation continues, the benthic fauna will change, and eventually become dominated by organisms typical of a eutrophic lake.

VII-18. Lake Michigan receives wastes from a number of tributary streams and waste outfalls. From the phytoplankton data it appears that some of those wastes, containing nutrients, do not disperse evenly throughout the lake, but tend to follow the shorelines where they effect quantities and kinds of phytoplankton quite different from those ordinarily found in oligotrophic lakes.

VII-19. Inside the Milwaukee harbor breakwater the phytoplankton was dominated by *Melosira* and *Cyclotella-Stephanodiscus*. The benthic fauna consisted of sludgeworms; scuds did not exist. At stations in the vicinity of Milwaukee but outside the breakwater, sludgeworms also predominated but pulmonate snails and leeches were also present. Total counts of phytoplankton inside and outside the Milwaukee harbor breakwater observed by the Public Health Service are shown in Table 1 of U.S. Ex. 21; densities of predominant genera of phytoplankton inside and outside the Milwaukee harbor breakwater observed are shown in Table 2 of U.S. Ex. 21.

The Milwaukee harbor area reflects the impact of waste discharges on lake biota in a selected area of Lake Michigan. Inside the Milwaukee harbor breakwater both the phytoplankton and benthic fauna were dominated by organisms favoring organic enrichment. As a result, Milwaukee harbor is considered biologically degraded. At sampling stations in the vicinity of Milwaukee but outside the breakwater, organisms favoring organic enrichment also predominated. This area of the lake is also biologically degraded but to a lesser degree.

VII-20. The dominance of *Melosira* and *Cyclotella* in the Milwaukee area of the lake was due to the availability of nutrients. The subsequent persistence of these organ-

isms at many of the one and four mile stations south from Milwaukee to near Chicago is attributed to one or a combination of the following: (1) a lack of mixing with Lake Michigan waters, (2) a transport of nutrients coincidental with the organisms, (3) the addition of nutrients and organisms by waters emanating from Racine, Kenosha, and Waukegan harbors and waste outfalls.

The relatively high total phytoplankton counts of 1,000-5,000 per ml found at many stations along the shoreline is attributed to the warmer waters of the littoral zone (which extends from the water's edge to the lakeward limit of rooted aquatic vegetation) and nutrient availability. The slightly greater density on the Michigan shore is probably due to the prevailing westerly wind that causes the water to be warmer on the Michigan side of the lake. The prevailing westerly wind would also tend to hold the plankton-laden water against the eastern shore. In addition, a counterclockwise movement of water in the southern basin (as is suggested by tracing *Melosira* and *Cyclotella* from Milwaukee to Chicago) would tend to transport nutrients to the Michigan shoreline.

VII-21. The pattern of particulate organic matter concentrations in both the southeast and southwest sectors of Lake Michigan followed very closely those for phytoplankton counts where generally the plankton was at its highest density near the shoreline and diminished at stations farther from shore. In the northern basin, although not sampled extensively, results from nine of the ten stations indicated low concentrations of organic matter.

VII-22. Light penetration deeper than 12 meters was observed at three stations beyond ten miles from shore in the southern basin in Lake Michigan and three stations in the northern basin, two of which stations were beyond ten miles and one of which was four miles offshore. The deepest light penetration was 18 meters found at one station centrally located in the northern basin. The lowest values were less than one meter in Milwaukee harbor. In the lake

proper the lowest values were at one-mile stations off Gary, Indiana. There was considerable difference in light penetrations at the inshore and mid-lake sampling areas, shown by the large number of inshore stations where values were less than six meters. Penetration less than two meters was observed at 21 stations in the southwest quadrant. Most of those low readings were at stations on the one-mile contour along the Wisconsin and Indiana shores.

VII-23. On August 27, 1961, and on August 16, 1962, at the Oak Street and Montrose beaches in the Chicago Park District, it was observed that growths of attached algae had broken off and had been deposited on these Chicago beaches, causing nuisances from its litter and decay. The windrows of algae lining the beaches became foul-smelling after a few days' exposure to the summer heat. Flies and insects covered the decaying mass. There have been other instances in recent years of certain Lake Michigan beaches in the Chicago Park District being fouled with algae washed in from the lake.

VII-24. Algae growth caused by discharge of sewage effluents has already interfered with recreational use of the shoreline areas of Lakes Michigan, Huron, Erie and Ontario, and has been the subject of official concern and investigation by the Water Resource Commission of the State of Michigan and the Water Resource Commission of the Province of Ontario, Canada. Shoreline accumulations of algae have already appeared in shoreline areas in the southern basin of Lake Michigan, including occasionally some of the beaches at Chicago, and have actually caused the closing of beaches at Milwaukee. High algae populations in the Great Lakes water supplies have already materially interfered with water treatment plant operation, reducing rates of production and impairing the ability to treat the raw water.

VII-25. Examination of filamentous algal growths (which require a hard substratum, or attachment surface) on boats, breakwater, buoys, and in harbors from

Burns Ditch, Indiana, to Green Bay, Wisconsin, showed that practically any submerged solid provided a surface for the growth of such algae. Since the nutritional requirements of the filamentous algae are similar to the other algae, the presence of filamentous algal growths indicates that concentrations of phosphorus, nitrogen and other necessary growth factors are present in the shoreline areas between the southern tip of the lake and Green Bay.

VII-26. In local areas in Lake Michigan, particularly adjacent to Wisconsin and Michigan harbors, there is evidence of increased biological activity known as eutrophication or lake aging. This is shown first, by phytoplankton counts of 1,000-5,000 per ml, second, by the alteration of the lake bottom to one increasingly more favorable to sludgeworms, third, by nutrient concentrations of nitrate nitrogen and total phosphate of as high as 0.36 mg/l and 0.27 mg/l, respectively, and fourth, by instances such as the fouling of beach waters by algae at Oak St. and Montrose beaches in Chicago. In addition, due to the availability of nutrients near Milwaukee, the diatoms *Melosira* and *Cyclotella*, common inhabitants of nutrient-enriched waters, dominated in the Milwaukee area and persisted to near Chicago.

In view of these facts, further annual addition of 7,460 tons of nitrogen and 918 tons of phosphorus contained in 750 cfs, of Sanitary District sewage effluent (as shown in U. S. Ex. 18) would result in greater frequency of the periods of high biological productivity. This would hasten the day when eutrophy will be manifested in a virtual population explosion of phytoplankton.

4. *Microbiological Conditions*

VII-27. Data collected by the Public Health Service on coliform concentrations in Lake Michigan are shown on Tables 1, 4, 7 through 10 and Figures 1 through 5, and 13 through 15 of U.S. Ex. 22. The bacterial quality of Lake Michigan water is generally good in deep water; the quality

decreases in varying degrees toward the shoreline and in city harbors. The coliform findings indicate the presence of pollution of fecal origin in some shoreline and harbor areas. Coliform concentrations in those areas at times exceeded the level regarded as the safe limit for water used as a source of public water supply where chlorination is the only treatment provided.

VII-28. Water in the northern half of Lake Michigan is of better quality than in the southern half of the lake. The coliform and fecal streptococcus findings in the Milwaukee harbor indicate the presence of pollution. The same may be said of the Racine harbor as well as of the waters adjacent to Whiting and Gary, and Hammond, Indiana, although the pollution encountered was not as intense as that of the Milwaukee harbor.

VII-29. At a distance of one mile offshore along the western shore from Milwaukee, Wisconsin, to Gary, Indiana, the coliform levels were frequently in the 100-1,000 ml range, representing substantial pollution in the one mile zone. The highest coliform densities were encountered in water contiguous to the cities of Milwaukee and Racine, Wisconsin; Chicago, Illinois; and Hammond and Gary, Indiana.

VII-30. In Milwaukee harbor, 15.9 percent of a total of 76 samples tested contained coliform bacteria in the 10,000-40,000 per 100 ml range. One of the samples collected in Milwaukee harbor contained fecal streptococci densities of 19,000 per 100 ml; this sample was collected just north of the mouth of the Milwaukee River. In Racine harbor, 38.2 percent of the 34 samples in the study contained coliform levels in the range of 1,000-10,000 per 100 ml. The streptococcal densities from the Racine harbor ranged from ten to 610 per 100 ml. All samples in the Chicago harbor study contained fewer than 1,000 coliform bacteria per 100 ml.

86.7 percent of the samples in the Chicago harbor study contained fewer than 500 coliform bacteria per 100

ml; 46.7 percent were in the 1-50 per 100 ml range, and 20.0 percent were in the 1-10 per 100 ml range. Higher coliform levels (100-1,000 per 100 ml) were encountered in an area immediately adjacent to the mouth of the Chicago River (both inside and outside the breakwater harbor) and extending south of the harbor for approximately two miles in the waters about one-half mile or less offshore.

Coliform densities are so high in city harbors and adjacent areas receiving effluent from sewage treatment plants, industrial wastes and storm overflows from combined sewers, that a grave threat to health must be presumed to exist through human contact with these waters.

Fecal streptococcus levels, as well as the coliform bacteria, indicate gross pollution to Milwaukee and Racine harbors.

Coliform concentrations at points up to two and one-half miles offshore in the vicinity of Chicago bathing beaches, are often in excess of acceptable limits for swimming and other recreational uses.

VII-31. On September 14, 1961, as the result of an unusually heavy rain, the lock gates off the mouth of the Chicago River were opened to eliminate the possibility of flooding. As a result the flow of the Chicago River was directed lakeward and large quantities of raw, bacterially-polluted sewage, were released into Lake Michigan.

Immediately thereafter the Public Health Service undertook the systematic sampling of the lake water in the immediate vicinity of the lock and controlling works. The Public Health Service found that the bacterially polluted water so introduced into the lake maintained its identity for at least three days.

VII-32. Lowest total bacterial densities were observed in the central body of lake water with increasing densities occurring in relation to the placement of cities and towns. The densities and distribution observed by the Public Health Service are shown on Tables 2, 3, 5 and 6 and Fig-

ures 6 through 12, and 16 through 18 of U. S. Ex. 22. Total bacterial densities in water generally correspond to the decomposition of organic matter. Thus increasing total bacterial densities usually indicate deterioration in the sanitary quality of water through the presence of pollutants contributing to the addition of nutrients to the water.

VII-33. Public Health Service laboratory studies showed microbial forms pathogenic to man survive in samples of Lake Michigan water for varying periods; some forms survived longer than coliform bacteria. The discharge to Lake Michigan of sizable quantities of treated waste waters, now being discharged to the Illinois River, would increase the densities of coliform bacteria and other microbial forms in the vicinity of the outlet. This would increase the potential hazards to public health in the use of waters in the area, and heighten the need for protective measures—including, but not limited to: secondary treatment and chlorination of waste waters before discharge to the lake and complete treatment with continuous vigilance in the operation of municipal water supplies taken from the lake.

5. *Radioactive Concentrations.*

VII-34. Radiation levels in Lake Michigan are generally within acceptable limits. Water sample radioactivity analyses reveal only a few moderately high results. The few alpha results greater than the limits recommended by the Public Health Service Drinking Water Standards of 1962, namely three micromicrocuries per liter, were all in the southern half of Lake Michigan and all except one were more than ten miles from shore. The few moderately high beta results found (20 to 112 micromicrocuries per liter) were evenly distributed between deepwater and inshore samples and randomly distributed throughout the lake.

## B. Movement and Dispersal of Pollutants in Lake Michigan

### 1. *Factors Involved*

VII-35. The principal factors which determine the fate of waste inputs in Lake Michigan are (1) existing current regime, (2) winds, (3) topography and (4) density difference between the pollutant and lake water.

### 2. *Lake Currents*

#### a. *Previous Studies*

VII-36. The previous major studies of currents in Lake Michigan were three in number. Harrington of the United States Weather Bureau in the years 1892 through 1894 released over 1,500 drift bottles in the lake, of which only 203 were recovered during the three-year period. It is on the basis of those returns that Harrington prepared the first map of Lake Michigan surface currents.

VII-37. In 1954-1955, Johnson of the United States Bureau of Fisheries, released 6,260 drift bottles and envelopes of which some 2,870 were recovered. Johnson's results indicated that during 1954 no stable pattern of surface currents existed, and that in general the drift was from west to east, and the north-south movements were about equal. According to Johnson, a similar pattern existed in 1955, except that the drift in the eastern areas was mainly to the north.

VII-38. A 1958 study by Ayers and others published by the Great Lakes Research Institute, represented the results of a series of synoptic surveys in which they applied a modification of the dynamic height method and published the first map of Lake Michigan showing subsurface water movement.

None of the past studies showed net circulation, maximum current speeds, effects of storms, or detailed inshore circulation. All three past investigations were limited in scope and disclosed the random variations found in the

surface layers. Only Harrington in the 1895 studies attempted to show that a prevailing pattern existed.

### b. *Objectives and Procedures of Public Health Service Study of Lake Michigan Currents*

VII-39. The Public Health Service undertook by its study of Lake Michigan currents to determine the variations in physical characteristics, temperature and density, of water within Lake Michigan; to measure the water movement patterns over a period of time; and to develop, from considerations of cause and effect, a theoretical basis for generalizing the observed conditions.

VII-40. In predicting the effect of waste inputs on Lake Michigan water quality, it is known that the dispersal of waste-bearing waters from a point of input to the lake is accomplished by some combination of three processes: (1) molecular diffusion, (2) turbulent mixing, and (3) mass transport. The relative importance of each process will depend on physical conditions in the lake. For example, in completely quiescent waters the predominant process would be molecular diffusion. Turbulence (the existence of randomly-varied water velocities) in the vicinity of the point of input will greatly accelerate the rate of dispersal over that effected by molecular activity alone. If, superimposed on this random turbulence, there is a prevailing velocity, then the water mass as a whole, and the accompanying waste waters, will move in that direction.

VII-41. Molecular diffusion is a complex random motion directly associated with molecular motion and accelerated by the thermal agitation of individual molecules. It is the least important motion for pollutants in Lake Michigan in comparison with the effects of larger-scale movements.

VII-42. Turbulent mixing is a complex random motion not directly associated with the agitation of individual molecules. Turbulence affects the dispersal rate of pollut-

ants in Lake Michigan much more than does molecular diffusion. The wind, acting both directly and indirectly, is the chief force causing water motion in Lake Michigan. It is the chief force overcoming inertia and stability, resulting in internal turbulence. Wind stress on the water surface can cause waves, set-up, and currents, and if terminated after a sufficiently long period, may result in a seiche. If water temperatures are vertically isothermal, the wind could stir the whole lake. Wind results in waves and orbital particle motion to depths of at least half a wave length if thermal stratification is not too strong. If the wind blows from the same direction for a few hours, it will cause set-up; that is, wind stress will drag surface water to the side of the lake opposite to the direction of the wind, causing a measurable piling up of water against the shore. Mixing can occur while water is moving toward the shore and while part of the piled-up water is escaping by moving parallel to the shore or by reverse flow as a subsurface current. In addition, when the wind either stops blowing or shifts direction, the piled-up water begins to return to the opposite side of the lake. Often it surges back and forth across the lake several times with a period determined by basin geometry and fluid density; this phenomenon is called a "surface seiche." The seiche, of course, results in further, though less important, mixing. If there is significant density stratification, an "internal seiche" may be started. The internal seiche, like the surface seiche, is a wave form at a density interface, though in this instance there is water above and below, while for the surface seiche air is above and water below. Periods of internal seiches are longer and amplitudes are very much greater (ten times and 1,000 times, respectively) than surface seiches. Because of the large amplitudes, internal seiches can accomplish more mixing.

VII-43. Mass transport or advection is roughly the opposite of turbulent mixing, and refers to linear translation or gross motion of a water parcel. In Lake Michigan the wind is the chief cause of advection. Tides are negli-

gible for most purposes, having a range of some 3/100 of a foot. Seiches are important to advection only in restricted areas, such as the Straits of Mackinac. Precipitation minus evaporation, although not known in definite detail, is small enough to be neglected in this instance. Because of the large area of a transverse cross-section of the lake, net flow-through produces very low velocities of advection; indeed, flow in the Straits of Mackinac is often reversed by seiches and wind-tilt.

VII-44. Many of the theoretical concepts of water movements in the Great Lakes have defied testing in the past because of the lack of adequate instrumentation. Recently invented current measuring equipment, including the Savonius rotor and the Woods Hole meter, and improved data processing equipment were used by the Public Health Service to study the mass water movements of Lake Michigan. The current meters, containing automatic recording devices, were placed at a number of fixed stations throughout Lake Michigan, at depths of 30, 50, 75 and 100 feet and each succeeding 100-foot level. From time to time the data recorded by the current meters was collected and processed.

c. *Results from Public Health Service Current Meter Study*

VII-45. Current meter data from a single station offshore of Chicago for the period May to July 1962 showed a predominant flow for all depths from the northwest which indicated such flows could persist for more than four consecutive days.

VII-46. Current meter data of approximately 16,000 current velocity readings from three stations offshore of Chicago from December 1962 to March 1963 showed a prevailing clockwise movement. Earlier studies in the spring of 1962 indicated a counter-clockwise rotation.

VII-47. Current meter data of approximately 55,000 current observations from six meters spaced along a line

from Milwaukee, Wisconsin to Muskegon, Michigan (the northern boundary of the southern basin of Lake Michigan) for the period December 1962 to April 1963 showed a general clockwise flow over the eastern two-thirds of the basin most of the time and some variability of currents very close to the western shore.

VII-48. The Public Health Service studies indicate that a relationship between winds and currents exists. A northwesterly wind (i.e., from the northwest) appears to produce a definite flow from the south along the west shore. A southwesterly wind produces a flow from the north along the western shore and if persistent may produce a counterclockwise pattern in the entire southern basin. In general, only onshore winds would carry the surface water directly to the beaches. In summer onshore winds, in the Chicago area, account for 39 percent of the time and in winter 29 percent of the time, as shown by Weather Bureau records.

VII-49. Perhaps one of the most critical conditions which would occur with respect to the discharge of effluent into the southern basin of Lake Michigan is when there is little or no current, thus permitting a build-up of an effluent over a long period of time. This mass or pool of effluent built up could then, in essence, move directly on a beach or to a water intake with little or no dilution. Under certain conditions the dilution factor for an effluent discharged into southern Lake Michigan would not exceed five; that is, one part effluent to five parts of lake water.

VII-50. Current data show there is no single current regime in southern Lake Michigan. There are seasonal periods when prevailing currents are shown to be in a northerly or southerly direction depending on the direction of the wind field over the lake and the thermal structure of the water. Calm periods in the water of Lake Michigan's southern basin can be expected about 10 to 20 percent of the time for as long as 24 hours. Rotary currents and slicks occur and tend to restrict dispersal, and confine and channel the movement of pollutants.

VII-51. The orientation, symmetry, latitude and bottom topography of Lake Michigan's southern basin is such that water masses therein retain their identity for several hours, or even several days, and disperse at a very slow rate.

VII-52. Based on the drogue studies made by the Public Health Service it appears that a water mass could not be expected to have a dilution ratio much greater than 1.2 over a period of several hours. If these conditions are nearly typical of the average dispersion rate, then an effluent could remain, during calm periods, at its initial state of dilution with lake water for many days. With regard to the fate of pollutants discharged into Lake Michigan near Chicago, physical factors indicate that a great variety of conditions exist which would tend to permit concentrated effluents to move to the water intakes or beach areas during any period of the year.

3. *Lake Temperatures*

VII-53. Field observations by the Public Health Service of temperature changes in Lake Michigan began in September 1961 and continued during the winter, spring, summer and fall of 1962. Temperature profiles were made throughout the lake at 47 sampling station sites. Temperature measurements were made in the deeper portions of the lake during the winter of 1961-62.

VII-54. Knowledge of temperatures within the waters of a lake and variations in water temperature, from place to place and from time to time, illuminates such questions as density stratification, extent and effectiveness of mixing, and consequent variations in water quality.

VII-55. Stratification in a lake means that its waters are divided into layers having identifiable differences in temperature, density, or other characteristics with rather sharply defined boundaries or zones of transition between layers. Thus, a lake in which the temperature was either

constant or varied uniformly from top to bottom would not be thermally stratified. A deep lake in the temperate zone usually stratifies, however, especially during the summer period. Very shallow lakes rarely stratify, due to constant mixing from top to bottom by wind action. However, during prolonged calm periods in mid-summer, even shallow lakes will stratify for short periods of time. A typically stratified lake is divided into three layers: the top layer, called epilimnion; the bottom layer, called the hypolimnion; and a zone of rapid temperature change called the thermocline. The thermocline is normally defined as any abrupt change in temperature which would indicate that there are two vertically separated masses of water. There may also be: secondary thermoclines, where more than one exists; winter thermoclines, where colder but less dense water lies over warmer but denser water; and pseudo or false thermoclines, sometimes produced by unusual local conditions.

VII-56. In Lake Michigan the epilimnion varies from a few feet in thickness in late spring or early summer to over 200 feet in late fall, but is normally about 60 feet thick in the warm summer months and about 120 feet thick in winter. The thermocline normally ranges about 20 feet thick but can be over 50 feet in thickness or as little as two feet. The hypolimnion encompasses all the water below the thermocline.

VII-57. An overturn is a descriptive term denoting vertical mixing or circulation from top to bottom of the entire lake. If the lake is shallow a complete overturn may occur. Lakes which are extremely deep or sheltered from the wind may experience only a partial or incomplete overturn. An overturn may occur when the lake is isothermal and therefore approximately the same density. Most lakes in the temperate zone have an overturn in the spring and fall. In Lake Michigan a fall overturn occurs after the water in the lake has cooled and become vertically isothermal, and is characterized by the sinking and mixing of cold, dense water from the surface, displacing the warmer

and lighter water below. Cooling continues until the lake reaches the temperature of maximum density and the water mass offers little resistance to mixing from the wind energy transferred by late fall storms. The temperature of maximum density of water varies with pressure and therefore with depth, being about 4°C, or about 39°F., at the surface and decreasing about 0.06°C per 100 feet of depth. The density-temperature relationship of water is illustrated on Ill. Ex. 648 and 650, and Figure 2 of U. S. Ex. 25. In Lake Michigan the bottom portion of the northern basin remained at the temperature of maximum density throughout the period September 1961 through December 1962. This zone of constant temperature was found to extend from the 600-foot level downward. The level probably varies from year to year depending on the severity of the winter. A spring overturn begins in the southern basin of Lake Michigan when the surface water temperature rises to about 4°C (about 39°F.), and the lake becomes vertically isothermal. As the lake continues to gain heat it again stratifies. Ill. Ex. 649 is included in the Appendix to this Report to illustrate graphically the phenomenon of overturn.

VII-58. Temperature profiles show that a seasonal overturn occurs in the southern basin of Lake Michigan, the maximum depth of which is about 565 feet.

VII-59. Since the water below 600 feet in the northern basin remains at maximum density throughout the year, no evidence exists to indicate that mixing (due to overturn) occurs below this depth.

VII-60. Inshore vertical cooling and mixing occurs rapidly but the horizontal exchange with the main body of the lake appears to occur at a slower rate. The rate of exchange, vertically or horizontally, is unknown. On January 25, 1962 inshore temperatures were near 0.2 degrees Centigrade, whereas the mid-lake temperatures were almost 2.3 degrees Centigrade. The boundary zone between these two water masses, the inshore water and midlake, was

sharp. This boundary zone suggests that lateral mixing did not occur rapidly during this period of the year.

VII-61. The northern basin lags 30 days or more behind the southern basin during the late spring and early summer warming period.

VII-62. The southern basin cools at a more rapid rate than the northern basin.

VII-63. Typical temperatures for Lake Michigan for a season or month of the year are difficult to define. The temperature range during one month varies considerably between the two basins at any one time. The temperature range for any given month may be expected to vary widely from year to year depending upon the severity of the winter or the calmness of the summer.

VII-64. Variations of thermocline conditions from one end of the lake to the other are characteristic of summer conditions in the lake.

VII-65. Inertial waves on the thermocline, usually occurring during calm periods following a strong wind, can produce alternating periods of warm surface water and cold deeper water at a water works intake. Under certain conditions, pollutants discharged into the lake could lie on the thermocline (because of similar densities) and be brought to the surface during the summer period, by several means, including tilting or oscillations of the thermocline.

VII-66. Internal waves with periods of several minutes were observed to change the position of the thermocline as much as seven feet per hour.

VII-67. There is great variability, with respect to both location and time, of the water temperatures in Lake Michigan.

## C. Effect on Lake Michigan of Sewage Effluent Return

VII-68. From the long range viewpoint, the proposed discharge to Lake Michigan of 750 cfs of treated effluent from the Sanitary District would result in a gradual increase in dissolved solids, nutrients, ABS, and what have been referred to as the "exotic" organic compounds. Because mixing is slow there would be greater concentrations of these materials in the vicinity of points of waste discharge and along the shores. This has been shown by the concentrations of nutrients in the vicinity of Milwaukee and the metropolitan Chicago complex, for example, where concentrations are substantially higher than in the center of the lake. This is further borne out by the much greater concentration of algae in the same areas as contrasted with the numbers found in the center of the lake. The more serious problem would seem to be the nutrients such as nitrogen and phosphorus and the development of algal problems. This would occur much sooner than the buildup of other chemicals and would limit many water uses. Under present conditions algal buildups have reached a point where they are affecting some water uses. They have interfered to some extent with the use of bathing beaches at Milwaukee, Chicago, and along Michigan shores of Lake Michigan and, at times have shortened filter runs on water treatment plants. The addition of more nutrients would result in more frequent algal blooms and blooms of greater intensity reaching critical levels in areas adjacent to the points of discharge. The algae might then become so numerous as to impede the operation of the Chicago water filtration plants and impair the esthetic value of the lake and its shoreline for recreational purposes.

VII-69. Of an equally serious nature are the local effects which can be anticipated with the return of substantial quantities of treated waste effluent. The variability the Public Health Service observed in lake currents indicates that currents can carry wastes in any direction at any

particular depth. Further, Public Health Service studies showed that there will be extended periods when wastes would be carried directly to the waterworks intakes or directly toward the bathing beaches on the shore. On March 14-20, 1963 the Public Health Service observed a continuous current from the south-southwest which persisted for more than six days with velocities from near zero to 0.77 feet per second. The Public Health Service found no evidence of the existence of a current which would sweep these wastes away from the Chicago area continuously. Furthermore, the Public Health Service current studies have clearly shown that this direct movement from discharge to intake or shore could occur whether the wastes lie on the bottom, stay on the thermocline, perhaps at mid-depth, or rise to the surface. Wastes would remain most concentrated under relatively low wind conditions and would tend to move as a mass, being continually fed from the discharge point so long as the wind and current directions remains substantially unchanged. Dispersion and mixing would take place very slowly under these relatively low wind conditions. Actual observation has shown little if any mixing taking place during the first two days after discharge, and the achievement of a dilution ratio of only four or five to one after four days. Identifiable masses of such wastes from industrial sources have been observed to move more than 20 miles in the lake and to maintain their identity for more than seven days. There would, therefore, be times then when these treated wastes would reach the intakes or the bathing beaches relatively undiluted, that is, with a dilution ratio of somewhat less than five. Even with chlorination some of the more persistent enteric pathogens might survive as might some of the viruses. These conditions could occur during the periods when the load on the water filtration plants would be greatest and when the bathing beaches were in use. Lake water at bathing beaches subject to sewage effluent at some other large cities on the Great Lakes is contaminated to the extent that local public

health officials have closed some of these bathing beaches to public use.

VII-70. The science of virology is virtually in its infancy. In the present state of the art, laboratory methods for isolation and identification of viruses are not practical for routine use in the testing of water. Present chemical techniques do not provide adequate tools for the routine control of chlorination processes so as to permit the maintenance of adequate free chlorine residuals for the inactivation of viruses in sewage. Scientific knowledge of the viricidal efficiency of water treatment and sewage treatment is confined to laboratory experiments of limited scope and applicability. It is known that virus particles can pass through the filtration process under conditions which might happen unintentionally for short periods of time in actual water treatment plants under modern practices, and that the viricidal efficiency of chlorine is considerably less than for bacteria, and is subject to wide variations. There is not known at this time any technique adaptable to field operating conditions which can insure the consistent removal of all viruses from a raw water supply subject to sewage pollution. Until more scientific knowledge of the nature of viruses is obtained, and certain methods for their inactivation in the routine operation of water treatment plants are devised, it would not be justifiable from the viewpoint of public health to subject any water supply to any contaminant known to contain or thought likely to contain pathogenic viruses, if an alternative method of disposing of the contaminant is available.

VII-71. Infectious hepatitis is the only viral disease positively known to be transmitted by drinking water, but numerous other viruses can be found in water. The failure to identify other viral diseases as water-borne may be due to the general lack of information on the clinical illnesses that many of the viruses produce and the relative insensitiveness of present epidemiological techniques. Public health statistics are commonly limited to a few diseases

which are serious and epidemic, and will not indicate significant differences in the incidence of viral diseases as between communities which use polluted sources of water and those which do not.

VII-72. Sanitary engineering and public health authorities are expressing increased concern over the potential toxic effects of newly-developed organic chemical contaminants present in public water supplies. Many chemical water pollutants are resistant to attack by bacteria in the activated sludge process, and such substances persist in receiving waters for considerable periods of time. Chicago's water treatment plants were not designed and cannot undertake to remove from the raw water all chemical contaminants which might be injurious to public health. There are no adequate procedures for identification of such substances under conditions of routine water production, there is no known treatment for removal of such substances if their presence were established, and there is not adequate information as to which chemicals are dangerous to human health, or in what quantities. Persistent chemical wastes which would reach the southern basin of Lake Michigan in the proposed discharge of sewage effluent would thus constitute a potential hazard to public health, the seriousness of which is not at this time fully known.

VII-73. The impact of a discharge of a large volume of sewage effluent on the southern basin of Lake Michigan would be more severe than occurs in other parts of the Great Lakes and their connecting waterways. Cities discharging significant volumes of effluent into other parts of the Great Lakes and their connecting waterways do so under hydrological conditions much superior to those which would obtain at Chicago. Lake Michigan as a whole discharges only about one percent of its total volume annually, and the relatively shallow submarine ridge running between Milwaukee, Wisconsin and Grand Haven, Michigan re-

tards the exchange of water between the southern and northern basins.

VII-74. The National Conference on Water Pollution meeting in Washington in December 1960 stated as its Recommendation No. 1:

> "That this Conference express its conviction that the goal of pollution abatement is to protect and enhance the capacity of water resources to serve the widest possible range of human needs, and that this goal can be approached only by accepting the positive policy of keeping water as clean as possible, as opposed to the negative policy of attempting to use the full capacity of water for waste assimilation." (Proceedings, p. 564.)

VII-75. The discharge into Lake Michigan of sewage effluent from the Sanitary District's treatment plants would change Chicago's water source into an unprotected and at least intermittently a contaminated one.

VII-76. It is the opinion of the Public Health Service that the discharge of treated effluent to Lake Michigan would not be in the best interest of the protection of the public health in the use of the lake for water supply and recreation; the damage to the water quality of Lake Michigan from such discharges over an extended period would be great; and future uses of Lake Michigan would be impaired. Furthermore, the damage, once initiated, would not be terminated by the cessation of the discharge of the wastes causing the damages. The ratio of net annual outflow to the volume of Lake Michigan (approximately 1 to 100) is such that it would require a very long period of time—many decades—after cessation of such discharges before the quality of Lake Michigan waters would be restored to the level existing prior to the start of the discharge of treated wastes.

## VIII. Navigation and Other Uses of the Illinois Waterway

### A. Description of the Illinois River System

VIII-1. The Illinois River basin extends southwesterly across the State of Illinois from Chicago to the Mississippi River at Grafton, Illinois; northerly to a point west of Milwaukee, Wisconsin; and easterly almost to South Bend, Indiana. The natural drainage area totals about 28,200 square miles, divided as follows: 1,000 square miles in Wisconsin, 3,200 square miles in Indiana, and the remaining 24,000 square miles in Illinois.

VIII-2. In addition to the natural drainage area, part of the Lake Michigan watershed has been made tributary to the Illinois River by the construction of the Sanitary and Ship Canal and the Calumet-Sag Canal. The exact size of the natural drainage area normally tributary to Lake Michigan which has been made tributary to the Illinois River by construction of these canals at Chicago has not been surveyed. Estimates of the area range from 685 square miles to 810 square miles. The former figure has been used to compute the diversion at Chicago.

VIII-3. A map of the Illinois River basin showing its sub-drainage areas, Figure II-2 of U. S. Ex. 10C, is included in the Appendix to this Report.

VIII-4. The line of demarcation between the upper Illinois River basin and the lower Illinois River basin as those terms are employed in these Findings is the junction of the Kankakee River with the Illinois River. The area upstream of the confluence of the Kankakee River with the Illinois River is referred to as the upper Illinois River basin.

### B. Federal Permits and Congressional Authorizations

VIII-5. On June 26, 1930, a War Department Permit, Ill. Ex. 500E, was issued to the Sanitary District. The Permit is included in the Appendix to this Report.

VIII-6. In H. Rept. 1265, dated April 23, 1930, which accompanied H.R. 11781, 71st Congress, which subsequently became the River and Harbor Act of 1930, it was stated in the concluding paragraph in the section dealing with the Illinois waterway:

> "As shown by the estimates prepared by the district engineer the 9-foot channel heretofore adopted by Congress can be secured by various flows of water, even as low as 1,000 cubic feet per second. Decreasing the flow increases the dredging but not in any serious amount." [p. 140]

In this same House report, in the section recommending deepening of the connecting channels in the Great Lakes, and the construction of compensating works in the St. Clair and Niagara Rivers, it was further stated:

> "The special board agrees with the joint international board that compensating works should be constructed in Niagara and St. Clair Rivers to compensate for diversions and for enlargement of the lake outlets. The works proposed in St. Clair River are a series of submerged rock sills, the exact number to be determined as the work progresses, estimated to cost $2,700,000. Contraction works are proposed in the Niagara River just above Fort Erie. They would consist of a rock-filled timber crib, a stone weir, and submerged sills, estimated to cost $700,000, with $5,000 annually for maintenance. Further enlargement of the St. Clair River to provide for 24-foot or 22-foot navigation would necessitate additional compensating works estimated to cost $200,000 for 24-foot navigation and $100,000 for 22-foot navigation. The special board estimates, on the basis of a diversion at Chicago of 8,500 second-feet, that the Chicago Drainage District should contribute $1,750,000 to the cost of the compensating works, as contemplated in the permit granted by the Secretary of War. It further states that while the amount of the Chicago diversion may

be changed before the compensating works are constructed, the cost of such works to the United States would not be materially affected." [p. 147]

VIII-7. The President on July 3, 1930, approved and signed H.R. 11781 which thereby became the River and Harbor Act of 1930. The portion dealing with the Illinois River and authorizing an appropriation for the improvement of the Illinois waterway from Lake Michigan to Utica, Illinois, follows:

"Illinois River, Illinois, in accordance with the report of the Chief of Engineers, submitted in Senate Document Numbered 126, Seventy-first Congress, second session, and subject to the conditions set forth in his report in said document, but the said project shall be so constructed as to require the smallest flow of water with which said project can be practically accomplished, in the development of a commercially useful waterway: *Provided*, That there is hereby authorized to be appropriated for this project a sum not to exceed $7,500,000: *Provided further*, That the water authorized at Lockport, Illinois, by the decree of the Supreme Court of the United States, rendered April 21, 1930, * * * is hereby authorized to be used for the navigation of said waterway: *Provided further*, That as soon as practicable after the Illinois waterway shall have been completed in accordance with this Act, the Secretary of War shall cause a study of the amount of water that will be required as an annual average flow to meet the needs of a commercially useful waterway as defined in said Senate document, and shall, on or before January 31, 1938, report to the Congress the results of such study with his recommendations as to the minimum amount of such flow that will be required annually to meet the needs of such waterway and that will not substantially injure the existing navigation on the Great Lakes to the end that Congress may take such action as it may deem advisable." [46 Stat. 918, 929]

This portion of the Act embodies what was known as the Blaine amendment, which was offered by Senator Blaine of Wisconsin on the floor of the Senate as a substitute for the original provisions of the bill relating to the Illinois waterway and which, as slightly modified, was adopted. As passed by the House of Representatives the bill had provided that nothing in it should be construed as authorizing any diversion of water from Lake Michigan. The Senate Committee on Commerce in reporting the bill had proposed an amendment providing that "the diversion of water from Lake Michigan shall be so controlled by the Secretary of War under the supervision of the Chief of Engineers, as to meet the needs of a commercially useful waterway . . ., from Lake Michigan to the Mississippi River and to conserve fully existing interests of navigation on the Great Lakes: *Provided*, That nothing in this act shall prejudice an action at law or any [sic] equity respecting the diversion of water from the Great Lakes watershed." [S. Rept. 715, 71st Cong., p. 3] This amendment was not adopted, however, the Blaine Amendment being substituted for it by majority vote of the Senate.

VIII-8. The debate in the Senate on the Blaine amendment took place on June 17, 18 and 19, 1930. Excerpts from the debate on June 17, 1930 follow:

> "Mr. VANDENBERG. Mr. President, I wish to proceed to discuss in a preliminary way the substitute now pending for the moot paragraph in the river and harbors bill describing the Illinois waterway. [72 Cong. Rec. 10996]
>
> . . .
>
> "Mr. President, Major General Jadwin, while at the head of the Engineering Corps of the Government, wrote a very pertinent paragraph upon this subject. Referring, in House Document No. 4 of the Sixty-ninth Congress, to the extent of this navigation upon the Great Lakes, he said:

> 'This navigation is of immense volume, and its benefits to the Nation in direct savings due to low transportation charges by water far exceed that anticipated for a successful Illinois channel, being conservatively estimated to be at least $125,000,000 per year, sufficient to amortize annually the entire Federal navigation investment in lake harbors and channels.'
>
> . . .

"There is the proposition submitted to Congress by the engineers, first, that this canal can be built successfully and operated successfully with a thousand cubic second-feet of water from Lake Michigan. . . .

"Mr. President, it is very important indeed to bear this basic fact in mind as we proceed, because it is the crux of the entire proposition so far as the Chicago and Illinois contention is concerned. Remember that under the Supreme Court decree in 1938 they will be entitled to 1,500 cubic-second feet, plus domestic pumpage, which is now 1,700 feet and which increases at the rate of 100 feet per year and which by 1938 probably will amount to at least 2,500 feet. Then the flow from other rivers entering above Lockport adds something like 750 feet more. In other words, under the terms of the Supreme Court decree, which is all we ask should be recognized, under its very terms there is inevitably bound to be a flow of something like 4,750 feet at Lockport in 1938. That is more than four times the flow which is described in Senate Document No. 126 as the base of the project which we are asked to adopt. It is almost five times the basic and essential flow.

"Despite the orally expressed wish of General Brown for 'more latitude' in the flow from Lake Michigan, neither he nor those for whom he pleads can escape the plain mandate in the language of the engineers' report as contained in Senate Document

No. 126, printed on April 7, 1930, at the instance of the junior Senator from Illinois [Mr. GLENN].

. . .

"There it stands. The Illinois waterway can be built with a flow of 1,000 cubic second-feet, and the estimates which we are asked to approve are made upon the basis of that flow, and that flow can be provided probably four or five times over by the pending Blaine substitute. [72 Cong. Rec. 10998]

. . .

"Every inch of water by which the levels of the Great Lakes are reduced is at times a matter of serious economic concern to the vast Great Lakes commerce to which I previously adverted. It is a matter of concern to every cargo ship and to every lake harbor when the natural level of the Lakes is at low cycle. Because these natural levels have been at high cycle the last two years, some of our critics have conveniently invited us to forget that such conditions are not standard and permanent. They have closed their minds to the inevitable recurrence of the low cycle in years to come; and, behind a well-ordered smoke screen, they have tried to develop the thesis that water diversion at Chicago has ceased to be of importance and has become wholly academic.

. . .

". . . The needs of the Great Lakes are not to be assessed at a fortuitous moment of relatively high water. They must be estimated out of the experience of the years which proves that relatively low water always returns. [72 Cong. Rec. 10999]

. . .

"Mr. MCCULLOCH. The decree of the Supreme Court specifically provides that any interested party can appeal to the court for a review for the purpose of having the decree modified. Is not that so?

"Mr. VANDENBERG. I am very glad the Senator brought that up. The Senator, of course, is entirely correct. . . . I believe that Illinois and Chicago can go back to that court—we, the complaining States—can go back to that court, and on a good-faith showing of legitimate facts, I have no doubt in my mind whatever that ample relief either way will be cheerfully granted.

. . .

"Mr. GLENN. In connection with the interrogatory propounded by the Senator from Ohio, is it not likewise true that the flow of 1,000 or 1,500 cubic feet permitted by the Supreme Court decision for the navigation of the Chicago River, as a result of improved methods of sanitation or sewage disposal, upon application of any interested party could be cut in two, could be cut to 500 or even 250 feet possibly? In other words, is it not an unstable, unfixed, indefinite amount that is stated?

"Mr. VANDERBERG. I think the Senator from Illinois may state a correct proposition of law, but if the Supreme Court should cease to be a stable and reliable agency upon which to depend for a rational pronouncement upon a situation of this character, then I am afraid we will never find the forum upon which we can depend.

. . .

"Mr. GLENN. The Supreme Court has said that if there is an improvement in plans for sewage disposal, then the Lake States, Michigan or Ohio, or anybody interested, can come in, and the flow, upon a proper showing, can be cut down.

"Mr. VANDENBERG. That is true, as I understand it, although I hesitate to pass upon the legal phase.

"Mr. GLENN. If that is true, under the Blaine amendment no one knows how much water will be

available for the Chicago waterway canal. We may have the 1,500 feet, we may have 1,000 feet, we may have 500 feet, we may have even less. It is an unstable, indefinite, unfixed amount upon which nobody can depend. It is all open to changing conditions and improved science.

. . .

"Mr. VANDENBERG. . . . I think the Senator from Illinois is entirely justified in the point he makes that an appeal to the court can work both ways.

"Mr. GLENN. Or either way.

"Mr. VANDENBERG. I will not deny that for a moment, but I do deny that there is in that situation any such hazard as he describes. [72 Cong. Rec. 11000]

. . .

"Mr. BLAINE. Mr. President, it is not my purpose this afternoon to go into a detailed discussion of the subject under consideration. It will be my purpose to endeavor to interpret the amendment which I have proposed and the results that will flow therefrom if it is adopted, and also to analyze the amendment proposed by the Committee on Commerce and the results that would flow from that amendment if it is not rejected. [72 Cong. Rec. 11002]

. . .

"In the Supreme Court of the United States, in the case of Wisconsin and others versus the State of Illinois, in order for the Supreme Court to have a basis upon which it came to the conclusion to which it did come, the court took the view that the 1,500 cubic feet-seconds, to which it refers, is water that is used for navigation with respect to the port of Chicago and is not in a legal sense a diversion of water.

"The Supreme Court also took the view that the pumpage—that is, the water which is pumped for domestic purposes for the city of Chicago—was not in

a legal sense a diversion of water. The amount of pumpage for the city of Chicago, as shown by the proof in this litigation and, of course, as is admitted, consists of 1,700 cubic feet-seconds and with the 1,500 cubic feet-seconds which is a part of the navigable water with respect to the port of Chicago, constitutes 3,200 cubic feet-seconds that flows lawfully down the canal constructed by the State of Illinois. It is also shown by the testimony that there is an accretion to the amount that flows down that canal by way of pumpage of about 100 cubic feet-seconds per year.

"The opinion of the Supreme Court in the case of the State of Wisconsin and others against the State of Illinois provides that a decree shall be issued and the decree has been entered to the effect that 'on and after December 31, 1938, the said defendants are enjoined from diverting as above in excess of the annual average of 1,500 cubic second-feet in addition to domestic pumpage.' Thus by January 1, 1939, if the accretion by way of pumpage is 100 cubic feet-seconds per year, the total amount of flow down that canal will be 4,000 cubic feet-seconds. As the distinguished Senator from Michigan [Mr. VANDENBERG] has said, that is four times as much water as is needed for a commercially useful waterway." [72 Cong. Rec. 11003]

VIII-9. Excerpts from the continued debate in the Senate on the Blaine amendment on June 18 and 19, 1930, follow:

"Mr. DENEEN. . . .

. . .

"The special master recommended that the sanitary district be required to construct sewage plants for the disposal of a part of its sewage at a cost of $178,000,000. He recommended further that during the eight years required to construct the sewage disposal plants, the diversion of water from Lake Michigan into and through the Chicago River be permitted

to the amount of 8,500 cubic feet per second until July 1, 1930; that a flow of 6,300 cubic feet per second be permitted to be diverted from Lake Michigan until December 31, 1935; that thereafter and until December 31, 1938, the diversion of 5,000 cubic feet per second be permitted; and that after the latter date the flow should be reduced to 1,500 cubic feet per second in addition to the diversion permitted to the city of Chicago for domestic purposes of the city, estimated at about 1,700 cubic feet per second [72 Cong. Rec. 11087]

. . .

"Gen. Edgar Jadwin's testimony appears in the report of the special master of October, 1929, at pages 92-93, as follows:

> 'When the ultimate practical treatment of the sewage is accomplished it is believed that the needs of navigation in the Chicago and Calumet Rivers proper may be found not to exceed a flow of clear water from the lake averaging 1,500 cubic feet per second, augmented by the natural run-off of the Chicago and Calumet Rivers watersheds and the effluents from the treatment plants. This would give an annual average flow of about 3,200 cubic feet per second at Lockport. . . .' [72 Cong. Rec. 11089]

. . .

"Mr. BLAINE. . . .

"At the end of 1935 there would be 5,000 cubic second-feet, plus the pumpage. That pumpage in 1928, as I recall, was estimated, or measured, as I understand, to be 1,700 second-cubic feet.

"Mr. COPELAND. Is not the Senator mistaken about it being 5,000 cubic feet. Is not the correct figure 1,500 cubic feet, plus the pumpage?

"Mr. BLAINE. No. On December 31, 1935, there would be the 5,000 second-cubic feet plus the pumpage.

"Mr. COPELAND. If the Senator will pardon me, is that the understanding of the Senators from Illinois?

"Mr. BLAINE. I am reading from the Supreme Court opinion. I am stating what the Supreme Court said, that—

> 'On and after December 31, 1935, unless good cause be shown to the contrary, the said defendants are enjoined from diverting as above, in excess of an annual average of 5,000 cubic feet-seconds in addition to domestic pumpage.'

"Mr. COPELAND. Then when we come to December 31, 1938.

"Mr. BLAINE. Then, when we come to December 31, 1938—that is eight years hence—

> 'Said defendants are enjoined from diverting as above in excess of an annual average of 1,500 cubic feet-seconds in addition to domestic pumpage.'

"That amount, plus the pumpage in 1928, would aggregate 3,200 cubic feet; the additional pumpage being estimated at 100 cubic feet-seconds a year. So, on the present basis, there would be 200 additional cubic feet down that canal, or 3,400 cubic feet; and in the next eight years, assuming the same amount of extra water would be pumped, it would be 3,400 cubic feet plus 800 cubic feet, or a total of 4,200 cubic feet, which would flow down this waterway under the decision of the Supreme Court. The other day I said 4,000 cubic feet-seconds, and overlooked the increase in pumpage for the last two years on the estimate of 100 feet additional per year that would continue to flow until the arrangement was modified by Congress.

"Mr. COPELAND. Mr. President, suppose after the project is finished it is found that the amount of water which could be diverted under the decision of the court is not sufficient to operate the project and that 500 feet or 1,000 feet more are needed, what would happen to

the project in the period between that time and the action of the Congress?

"Mr. BLAINE. This bill provides for compensating works in the waterway and authorizes an appropriation. Those works of course will proceed after the passage of this measure, when an appropriation shall be made, and likewise the construction of the proper locks and dams and all the necessary and material construction for the waterway will proceed. Those two projects will proceed together; they will go along side by side.

"In the meantime, after they have proceeded, then the Chief of Engineers will ascertain the facts and report to the Congress on or before January 31, 1938, the result of the studies of the engineers, and make a recommendation, so that at that time the Congress of the United States will know what the construction has been; it will know what the compensating works will do; it will know what is necessary for this waterway, and of course Congress will then proceed to determine the question upon the recommendation of the Chief of Engineers." [72 Cong. Rec. 11182]

VIII-10. The Blaine amendment was adopted by the Senate on June 19, 1930. Thereafter the conferees of the Senate and House of Representatives recommended that the House agree to the Blaine amendment, which it did on June 24, 1930. In the course of the debate upon the conference report in the House of Representatives on that day Representative Dempsey, the chairman of the House conferees, stated:

"The purpose of that provision, if the gentleman will permit me to say so, was one which was intended to be helpful to the waterway. There was some question in the minds of the representatives of Illinois, whether they would have the right to use the water for navigation, and that provision was put in to clear up any possible doubt as to the right of the use of that

water for navigation purposes. It was intended for the benefit of the waterway and not to hamper or shackle it. [72 Cong. Rec. 11632]

. . .

". . . The Senate amendment for the survey by the engineers is to determine what amount of water is necessary for navigation of the Illinois River with a 9-foot channel—

. . .

". . . The gentleman from Illinois' suggestion with reference to this condition of affairs was this: There are 6,500 feet of water going down the Illinois River—that was the decision of the Supreme Court—until 1935, and after that 5,000 feet until 1939. After the 1st of January, 1939, 1,500 plus the pumpage, making a total in 1939 as it is now estimated of 3,200 feet. However, the pumpage has increased 100 feet per year for the last five years and at the same rate for eight years we would have an additional 800 feet, which would make 4,000 feet.

"The Illinois waterway will be completed probably by 1935. What it is intended for these engineers to do, as I understand it—and this is my individual opinion—is in the operation of that waterway to ascertain how much water is needed for the navigation and commercial use with a 9-foot waterway, with the smallest flow which can make it useful. [72 Cong. Rec. 11633]

. . .

". . . This is accomplished in the pending bill; we already had the two oceans connected by the Panama Canal, but our two great inland systems of waterways—the Great Lakes and the Mississippi system, with 9,000 miles of canalized rivers—have no connection, and the Great Lakes had no connection with the sea. These two, the only missing links, are supplied in this bill through the improvement of the Illinois

River and the taking over of the New York Erie and Oswego Canals.

. . .

". . . However, the one aim of uniting and combining all of our waterways is accomplished by it, and that once for all." [72 Cong. Rec. 11634]

VIII-11. Acting under the provisions of the River and Harbor Act of 1930, the Secretary of War transmitted to the Congress under date of December 7, 1933, the report of Major General E. M. Markham, Chief of Engineers, subsequently incorporated in House Document 184, 73d Congress, making the following findings, observations and recommendations, among others:

"2. It [the waterway from Lake Michigan to the mouth of the Illinois River] was opened to navigation March 1, 1933. . . .

. . .

"4. The Chicago Drainage Canal was constructed for the purpose of diverting the sewage of Chicago from the lake frontage of the city to safeguard the city water supply. On a complaint of various States bordering on the Great Lakes that the diversion of water lowered the levels of the Great Lakes to the serious injury of the companion States and their citizens, a decree was entered by the Supreme Court of the United States on April 21, 1930, enjoining the State of Illinois and the Sanitary District of Chicago from diverting water in excess of an annual average of 6,500 cubic feet per second on and after July 1, 1930, 5,000 cubic feet per second after December 31, 1935, and 1,500 cubic feet per second after December 31, 1938; these amounts to be in addition to domestic pumpage. The limitation on diversion was based on the construction by the Chicago Sanitary District of sewage treatment plants to purify the sewage of the city. The River and Harbor Act of July 3, 1930, specifically authorizes

the water within the limitation of the decree for the use of navigation on the Illinois Waterway. . . .

"5. The district engineer reports that the domestic pumpage during the summer season, when low water may be expected in the rivers, will be about 1,700 cubic feet per second, bringing the total annual supply from the drainage canal into the Illinois River to an annual average of 3,200 cubic feet per second. This supply will not, however, be uniform, as the normal flow must be held down to permit an excess diversion during local storms so that sewage-contaminated water will not be carried into the lake. He finds that the reliable flow with an annual average diversion of 1,500 cubic feet per second from the lake will be about 2,400 cubic feet per second. This supply is ample to meet all requirements of lockage in the completely slackwatered section of the waterway extending from Lake Michigan to Starved Rock. It is not sufficient to maintain the present channel in the section of the river below Starved Rock. By completing the slackwatering of the portion of the river below that point through the construction of a new lock and dam near La Grange and another near Peoria, and dredging the heads of the pools, at a total estimated cost of $9,121,000, the present channel dimensions can be maintained after the diversion has been reduced to 1,500 cubic feet per second. The dams would be modern structures of the movable type so that flood heights would not be increased and with locks 110 feet wide and 600 feet long.

. . .

"9. While the district engineer finds that an annual diversion of 1,500 cubic feet per second, increased by domestic pumpage, is ample to provide an adequate flow to meet all requirements of lockage, seepage, leakage, and evaporation on the waterway, he concludes that the determination whether this flow will provide a flow suitable from a sanitary standpoint for a com-

mercially useful waterway can be made only by experience after the sewage treatment plants at Chicago are completed. He points out that the weight of expert testimony is to the effect that the effluent from the sewage treatment plants will be inoffensive, but that the program is on such an unprecedented scale that such predictions must contain an element of uncertainty; and that no reliable process of calculation can predict the effect of raw sewage in stormwater runoff and of accumulated sludge deposits.

. . .

"12. The Board [of Engineers for Rivers and Harbors] reports that the minimum average annual diversion of water from Lake Michigan that will be required to meet the direct needs of navigation for a commercially useful waterway in the Illinois River and that will not substantially injure the existing navigation on the Great Lakes is 1,500 cubic feet per second, as prescribed by the Supreme Court decree, but that the indirect needs of such a waterway in the matter of securing satisfactory sanitary conditions for those aboard vessels or employed at terminals cannot be determined until the waterway has been fully completed and the diversion limited to 1,500 cubic feet per second for a sufficient period of time to observe the conditions that may then exist. . . .

"13. After due consideration of these reports, I concur in general in the views and recommendations of the Board. The report conclusively shows that aside from sanitary requirements, the minimum annual average flow from Lake Michigan required to meet the needs of a commercially useful waterway in the Illinois River, is a direct diversion of 1,500 cubic feet per second in addition to domestic pumpage by the city of Chicago. It does not appear possible to arrive at a conclusive determination whether this flow will afford suitable sanitary conditions on the waterway after the

sewage purification plants at Chicago have been completed and placed in operation. This flow will not substantially injure the existing navigation on the Great Lakes. In order, however, to maintain the channel dimensions provided in the present project in the Illinois River with the flow above specified, it will be necessary to construct two locks and dams in the Illinois River at LaGrange and Peoria respectively, and dredge the heads of the pools created by these dams at an estimated cost of $9,121,000, and to complete the lock and dam in the Mississippi River at Alton at an estimated cost, in addition to the funds already provided, of $4,471,000. To afford an adequate commercially useful waterway it is necessary, whatever the diversion, to widen the existing channels to 300 feet, increased at the bends, at an additional cost of $6,409,000, bringing the total for the Illinois River to $15,530,000. This expenditure is amply justified by the benefits to commerce and navigation resulting from the provision of an adequate waterway from the Great Lakes and the enormous industrial center at Chicago to the widespread system of inland waterways being provided on the Mississippi River and its tributaries.

"14. . . . Having in view the international as well as the national interest in the diversion of water from Lake Michigan, I do not consider it appropriate that the Chief of Engineers should be afforded discretionary power to increase the diversion. The present discharge of untreated sewage produces as bad sanitary conditions in the Chicago Drainage Canal and in the portion of the Illinois Waterway immediately below Lockport as those which may be expected with the reduced diversion after the sewage treatment has been completed in accordance with the intent of the decree of the Supreme Court. The situation is one which unquestionably demands a remedy, but the remedy should, in my opinion, be afforded first by the purification of the sewage, and second, if that prove

inadequate, by a moderate and reasonable draft of water from Lake Michigan. Until the need is established for a greater diversion than that now provided by law, I see no reason for a modification of the present legislation.

"15. I therefore recommend that no change be made for the time being in the water authorized to be used for the navigation of the Illinois River under the provisions of the River and Harbor Act approved July 3, 1930; . . ." [pp. 3-7]

VIII-12. Accompanying the report of the Chief of Engineers set out in House Document 184, 73d Congress, was the report of Lt. Col. Dan I. Sultan, the district engineer at Chicago, dated September 26, 1933. Among other things, Colonel Sultan's report stated:

"90. *Domestic pumpage.*—The water supply of the entire Chicago area, with the exception of a few suburbs lying west of Chicago, is derived from Lake Michigan and is discharged as sewage through the Chicago Sanitary and Ship Canal. The amount of water pumped from the lake varies from day to day and from season to season. The pumpage during the year 1932 varied from an average of 1,575 cubic feet per second in April to an average of 1,775 cubic feet per second in August. For some years to come, the annual average will be about 1,700 cubic feet per second.

. . .

"94. *Probable variations in flow at Lockport after December 31, 1938.*—In order that a reserve or credit may be built up for use at times of heavy run-off in Chicago, it will be necessary to divert less than the average flow during a large part of the year. Studies made by the Chicago Sanitary District engineers indicate that after the diversion is reduced to 1,500 cubic feet per second on December 31, 1938, the total flow at

Lockport will be distributed approximately as shown by the following table:

Estimated total flow at Lockport after Dec. 31, 1938

| Pumpage | Diversion (cubic feet per second) | Total flow at Lockport (cubic feet per second) | Days per year | Percentage of time |
|---|---|---|---|---|
| 1,700 | 700– 750 | 2,400– 2,450 | 234 | 64 |
| 1,700 | 750– 850 | 2,450– 2,550 | 18 | 5 |
| 1,700 | 850– 1,000 | 2,550– 2,700 | 15 | 4 |
| 1,700 | 1,000– 1,300 | 2,700– 3,000 | 17 | 5 |
| 1,700 | 1,300– 1,700 | 3,000– 3,400 | 14 | 4 |
| 1,700 | 1,700– 2,200 | 3,400– 3,900 | 10 | 3 |
| 1,700 | 2,200– 2,900 | 3,900– 4,600 | 11 | 3 |
| 1,700 | 2,900– 3,900 | 4,600– 5,600 | 10 | 3 |
| 1,700 | 3,900– 5,500 | 5,600– 7,200 | 12 | 3 |
| 1,700 | 5,500– 8,400 | 7,200–10,100 | 12 | 3 |
| 1,700 | 8,400–11,300 | 10,100–13,000 | 8 | 2 |
| 1,700 | 11,300–13,300 | 13,000–15,000 | 3 | ¾ |
| 1,700 | 13,300–15,300 | 15,000–17,000 | 1 | ¼ |
| [1]1,700 | [1]1,500 | [1]3,200 | | 100 |

[1] Average.

. . .

"96. The total flow from the canal at Lockport consists of (1) the drainage from the Chicago River and its branches; (2) drainage from that portion of the Calumet district lying west of Gary; (3) the domestic and industrial pumpage or water supply for the Chicago area; and (4) the diversion from Lake Michigan through the North Shore Channel, the Chicago River, the Calumet River, and the Indiana Harbor Canal. The least variable component is the domestic and industrial pumpage. As has been shown, the flow at Lockport is of variable quantity which may range from a minimum in dry weather of about 2,400 cubic feet per second, to a maximum of 17,000 cubic feet per second, decreasing automatically to 12,000 cubic feet per second, in about 4 hours. The minimum flow of 2,400 cubic feet per second, it appears, may occur 8 months during the year, in order to build up a reserve

or credit which may be drawn upon during periods of heavy run-off.

"97. *Flow required for operation of waterway, Lockport to Starved Rock.*—The four pools comprising the Illinois Waterway have all been dredged to a depth of 10 feet, with 1 foot additional paid for if removed by the contractor. In order that the full project depth may be available at all times, even in periods of unusually low water, the normal pool levels, or project planes, from which these depths have been measured, have all been taken as flat pools. In other words, no part of the project depth is dependent upon a computed slope based upon a certain flow of water. It follows, therefore, that the minimum flow required for maintaining full project depth in the waterway is not a certain flow which will maintain a certain slope, but the flow required for lockages, plus the amount lost in seepage through the sides and bottom of the waterway, plus the leakage through the locks and dams, plus the amount lost in evaporation.

"98. As all of the locks are uniform in length and width, the flow required for lockages is determined by the amount necessary to operate the lock having the greatest lift. The lock of greatest lift is at Lockport, where the lift at times of high level in Lake Michigan may be 43 feet. The area of this lock chamber is 74,725 square feet and the volume of water required for a lockage is 3,214,250 cubic feet. If a lock full of water is required every 30 minutes, which is considered the maximum requirement, the flow needed for lockages would amount to 1,786 cubic feet per second. The adjacent small lock, which is used for small boats, has a width of 22 feet and a usable length of 130 feet. Assuming a lock full of water is used every 30 minutes, the maximum requirement for this lock is 70 cubic feet per second. The amount of water lost in seepage and evaporation in the Sanitary Canal need not be esti-

mated, because the flow of water is measured at the lower end of the canal. The leakages at Lockport through the large and small locks, the two sector gates, the old controlling works, and the powerhouse gates average about 125 cubic feet per second. The total maximum requirement at Lockport is, therefore, about 1,980 cubic feet per second. The minimum flow available under the Supreme Court decree, as modified to protect the water supply of Chicago—namely, about 2,400 cubic feet per second for about 234 days during the year—is therefore sufficient for lockages and leakages at Lockport." [pp. 48-50]

VIII-13. The Congress in the River and Harbor Act of 1935, 49 Stat. 1028, 1035, provided with respect to House Document 184, 73d Congress, and the project recommended by it and House Document 180, 73d Congress (which related to the Calumet-Sag channel, also authorized by the River and Harbor Act of 1930), as follows:

"That the following works of improvement of rivers, harbors, and other waterways are hereby adopted and authorized, to be prosecuted under the direction of the Secretary of War and supervision of the Chief of Engineers, in accordance with the plans recommended in the respective reports hereinafter designated and subject to the conditions set forth in such documents; . . .

. . .

"Illinois Waterway, Illinois; House Documents Numbered 180 and 184, Seventy-third Congress."

VIII-14. Under date of September 3, 1958 the Acting Secretary of the Army transmitted to the Congress a report by Major General E. C. Itschner, Chief of Engineers, subsequently incorporated in House Document 31, 86th Congress. Accompanying the report of the Chief of Engineers were reports by the Board of Engineers for Rivers and

Harbors and the district engineer. The Chief of Engineers made the following findings, observations and recommendations:

"2. After full consideration of the reports secured from the district and division engineers, the Board recommends modification of the existing project for the Illinois Waterway, Ill. and Ind., to provide for construction of supplemental locks, 110 feet wide and 1,200 feet long, at Lockport, Brandon Road, Dresden Island, Marseilles, Starved Rock, Peoria, and La Grange; generally in accordance with the plan of the district engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable; at an estimated cost to the United States of $114,652,000 for construction and $399,000 annually for maintenance and operation in addition to that now required: *Provided*, That prior to construction, local interests agree that they will assume title to, and maintain and operate the new bridge across the lower approach to the Brandon Road lock when the bridge is placed in service.

"3. The average annual flow to provide the water requirements for the modified Illinois Waterway is estimated to be about 1,826 cubic feet per second at such time as the amount of traffic contemplated develops. The presently authorized diversion is an annual average of 1,500 cubic feet per second in addition to domestic pumpage. During the past 10 years the annual domestic pumpage has varied from a minimum of 1,607 to a maximum of 1,805 cubic feet per second for an average of 1,686 cubic feet per second for the 10-year period. Accordingly, the presently authorized diversion of 1,500 cubic feet per second, in addition to the domestic pumpage, would provide an adequate water supply for operation of the proposed duplicate lock system.

"4. After due consideration of these reports, I

concur in the views and recommendations of the Board." [pp. 1-2]

The report of Col. J. B. W. Corey, Jr., district engineer, which was transmitted with the report of the Chief of Engineers, states, among other things:

"31. The effects of duplicate locks on diversion . . . are summarized below:

"(a) *Diversion.*—Commencing on January 1, 1939, the amount of water diverted from the Lake Michigan watershed into the Illinois Waterway was limited by decree of the United States Supreme Court on April 21, 1930, in the case of *State of Wisconsin, et al. v. The Sanitary District of Chicago, et al.*, to an annual average of 1,500 cubic feet per second in addition to domestic pumpage. Since domestic pumpage averages about 1,600 cubic feet per second, the total diversion, measured at Lockport, averages about 3,100 cubic feet per second. It is estimated that the present annual average diversion including domestic pumpage would be sufficient for operation of the system of duplicate locks proposed in this report in handling a prospective waterway commerce of 55 million tons annually." [p. 24]

VIII-15. The Congress in the River and Harbor Act of 1962, 76 Stat. 1173, 1175, provided with respect to House Document 31, 86th Congress, and the project recommended by it, as follows:

"SEC. 101. That the following works of improvement of rivers and harbors and other waterways for navigation, flood control, and other purposes are hereby adopted and authorized to be prosecuted under the direction of the Secretary of the Army and supervision of the Chief of Engineers, in accordance with the plans and subject to the conditions recommended by the

Chief of Engineers in the respective reports hereinafter designated: . . .

. . .

"Illinois Waterway, Illinois and Indiana: House Document Numbered 31, Eighty-sixth Congress, is approved and there is hereby authorized the sum of $40,000,000 for initiation and partial accomplishment of the project."

C. WATER USES IN THE ILLINOIS RIVER SYSTEM

1. *Public Health Service Inventory*

VIII-16. The Public Health Service in 1962 completed an inventory of the water uses of the Illinois River basin which inventory included a quantitative determination of the amounts of water used for municipal and industrial purposes and the extent of use for navigation, fish and wildlife, recreation, irrigation, power and waste assimilation.

2. *Navigation*

VIII-17. The Illinois waterway extends from the Mississippi River about 38 miles above St. Louis, Missouri, to Chicago, Illinois, a distance of approximately 326 miles. It provides the connection between the Mississippi River-Ohio River navigation system and the Great Lakes. The Illinois waterway is completely canalized and comprises the following segments: (a) The Illinois River from its mouth at Grafton, Illinois, to the confluence of the Kankakee and Des Plaines Rivers, a distance of 273 miles; (b) the Des Plaines River to Lockport, a distance of 18.1 miles; (c) the Sanitary and Ship Canal to Sag Junction, a distance of 12.4 miles; and (d) the Calumet-Sag project, which provides for a connection to the deep-draft project at Lake Calumet, the upper limit of Calumet Harbor, via the Calumet-Sag Channel, the Little Calumet River, and the Calumet River, a total distance of 23.8 miles from Sag Junction to Lake Calumet. An alternative route to Lake Michigan is also

provided from Sag Junction to Chicago harbor via the Sanitary and Ship Canal and the Chicago River, a distance of 22.1 miles.

VIII-18. The Illinois waterway has a usable depth of nine feet in all the channels. There are seven Federal locks on the Illinois River, Des Plaines River, and the Sanitary and Ship Canal, with lifts ranging from ten to 40 feet. There is an eighth Federal lock in the Calumet River portion of the Calumet-Sag project between the mouth of the Grand Calumet River and the entrance to Lake Calumet.

VIII-19. The Illinois waterway, in addition to serving Chicago and nearby industrial areas in Indiana, also serves several important manufacturing cities along its route, including Joliet, Ottawa, LaSalle, and Peoria. It traverses a highly developed agricultural area, and is adjacent to important coal fields. Freight commerce on the waterway has increased since the improved channel to Chicago was opened, from 1,695,000 tons in 1935 to about 31,000,000 tons in 1964, averaging approximately 28,300,000 tons per year during the period 1955 through 1964. The principal commodities are coal, petroleum products, sand, gravel, stone, grain, sulphur, iron and steel products.

VIII-20. As shown in Finding VIII-14, the Corps of Engineers recommended the modification of the Illinois waterway by the construction of seven supplemental or duplicate locks, 110 feet wide and 1,200 feet long.

VIII-21. As shown in Finding VIII-15, the Congress approved the recommendation of the Corps for the modification of the Illinois waterway and authorized the sum of $40,000,000 for the initiation and partial completion of the project.

VIII-22. As shown in Finding VIII-14, the water requirements for operation of the modified Illinois waterway at such time as the amount of traffic contemplated develops has been estimated by the Corps to be an annual average

flow of 1,826 cfs. The Corps contemplates about 55,000,000 tons annually by the year 2000. The presently authorized diversion from Lake Michigan of 1,500 cfs, in addition to domestic pumpage of 1,700 cfs, would provide an adequate water supply for operation of the modified Illinois waterway.

3. *Power*

VIII-23. Use of the Illinois River system for hydroelectric power production is limited by the relatively flat topography of the area. Two-tenths of one percent of the power produced in the basin is by hydroelectric plants.

VIII-24. Most of the power in the Illinois River basin is generated by thermoelectric (fuel) plants. There are 57 existing fuel plants in and serving the Illinois River basin. The fuel plants use water for condenser cooling and house service. Condenser cooling uses 95 percent of the total plant pumpage. House service water is used for bearing cooling, transportation of ash, and housekeeping. The condenser cooling water is taken from the stream upon which the plant is located, given periodic chlorination, passed through the condenser, and returned with a temperature increase of approximately 10°F. The combined estimated pumpage of the 57 fuel plants is 11.3 billion gallons per day.

VIII-25. The combined water requirement of the 11 fuel plants situated along the Illinois River system in the Chicago metropolitan area is such that the flow in the system is used several times. Their total pumpage is 4,510 MGD, or 210 percent of the mean flow as recorded at Lockport.

4. *Fish and Wildlife*

VIII-26. There is practically no sport fishing in the upper Illinois River system. In the lower Illinois basin are many large shallow (three to four feet deep), floodplain lakes with sport fishing for crappies, drum, bluegills, bass, catfish, and carp. The fishing pressure is high with

Rice Lake, downstream from Peoria, and Lake Chautauqua producing the larger catches. The latter is connected with the Illinois River only during times of flooding. The Bureau of Sport Fisheries and Wildlife, United States Department of Interior, manages the Lake Chautauqua Wildlife Refuge. Lake Chautauqua is heavily fished, particularly in the spring season. Commercial fishing is limited to the main stream of the lower Illinois River and the flood-plain lakes.

VIII-27. The many flood-plain lakes of the Illinois River have been used as waterfowl shooting areas for many years. Chautauqua Wildlife Refuge is a stopover for thousands of the birds that use the Mississippi flyway in their migrations. There has been a marked decline in duck population in the lower Illinois River part of the Mississippi flyway, particularly among the diving ducks that feed on small snails and clams. The flood-plain lakes once were very rich in these small molluscs, but since 1952 the molluscs have diminished in number due to silt-destruction of the rooted aquatic plants, the normal habitat of molluscs.

5. *Recreation.*

VIII-28. Within the lower Illinois River basin are approximately 60,000 acres of water in sloughs and shallow, flood-plain, backwater lakes flanking the river channel. These lakes are used for public fishing, boating and swimming, and duck-hunting.

VIII-29. In parts of the Cook County Forest Preserve District, and in the numerous parks along tributary streams, are many water-oriented recreational attractions which are used for picnicking, boating, water skiing and angling.

VIII-30. The Illinois waterway between the Chicago harbor at Lake Michigan and Joliet is used by pleasure craft principally for transit between Lake Michigan and the Illinois River. Lockages of pleasure craft during 1960

for the seven locks along the Illinois waterway, were 7,889 craft upbound and 8,586 craft downbound.

6. *Irrigation*

VIII-31. In 1960 an estimated 5,000 acres were irrigated in the Illinois portion of the Illinois River basin, of which over half of the acres were irrigated from wells. The greatest density of irrigation is in the Chicago-Kankakee area. Fields are generally small, averaging about 15 acres. Flowers, nursery plants, and vegetables are the main crops irrigated, and the water here is largely taken from the streams and ditches. Some cash-crop and livestock farmers irrigate in the western portion of the Illinois River basin. Field crops are irrigated in an area along the Illinois River from Peoria southward.

VIII-32. Approximately 6,400 acres are irrigated within the Indiana portion of the Illinois River basin, primarily in the Kankakee River sub-basin. Over 80 percent of this irrigation is from wells. Corn is the leading irrigated crop both in acreage and dollar value, with hay and forage crops second.

VIII-33. Approximately 400 acres are irrigated in the Wisconsin portion of the Illinois River basin. Corn is the leading crop in both acreage and dollar value, while planted hay is the second largest crop produced.

7. *Municipal Water Use*

VIII-34. According to the data collected by the Public Health Service in 1961 and 1962, the upper Illinois River basin contained about 5,729,000 persons, or about 81 percent of the total population of the Illinois River basin. The upper Illinois River basin, according to the Public Health Service data, used about 1,191,000,000 gallons of water per day, or about 208 gallons per capita per day. About 1,121 MGD, or 94 percent of the municipal water supplied in the upper Illinois River basin, was withdrawn directly from Lake Michigan through the water intake cribs, treat-

ment, and distribution systems of Chicago, Evanston, Wilmette, Kenilworth, Winnetka, Glencoe, Highland Park, Hammond, Gary-Hobart, Highwood, and the Great Lakes Naval Training Station. These are the only municipal systems serving the upper Illinois River basin and the Lake Michigan basin which use Lake Michigan as a direct water source. These systems also serve about 90 adjoining communities located farther from the lake.

Municipal water is water pumped through community systems and is used for domestic, commercial, industrial and other uses.

Almost all of the municipal water used in the upper Illinois River basin is discharged after use into the streams and canals which comprise the upper Illinois River basin, although a part of the municipal water used by the communities within the North Shore Sanitary District is discharged, after use, into Lake Michigan.

VIII-35. The Illinois River is not used as a source of municipal water supply until it reaches Peoria, Illinois. At Peoria, the supply comes from three sources: conventional ground-water wells, an infiltration gallery with induced recharge from the Illinois River, and a new water plant drawing directly from the river. Depending on river water elevations, Grafton, Illinois can take its water supply from the Illinois River, from the Mississippi River, or from wells. Other municipal surface water supply sources are located away from the main stem on tributaries of the Illinois River.

VIII-36. In the Illinois River watershed, according to the data collected by the Public Health Service in the years 1961-1962, 5,374,000 persons served by surface water supplies (including Lake Michigan) use 1,179 MGD or about 220 gallons per capita-day. Such surface water sources supply an estimated 87 percent of the water used in the Illinois River basin and serve 75 percent of the population. Lake Michigan accounts for 1,121 MGD or 95 percent of the surface water supplied, serving 4,950,000 persons. Within the

Illinois River basin this accounts for about 69 percent of the population served from surface and subsurface sources combined.

VIII-37. According to 1961-1962 data, almost all communities outside the Chicago metropolitan area use ground water as a source of municipal water. Several communities in the Chicago area also use ground water sources for water supply. Ground water sources in the Illinois River basin serve an estimated 1,761,000 persons with 169 MGD, which amounts to about 96 gallons per capita per day. Ground water is used by 25 percent of the population served by municipal supplies, but accounts for only 13 percent of the volume of water supplied in the basin.

8. *Industrial Water Use*

VIII-38. The industrial use of water in the Illinois River basin, exclusive of any waters supplied through community systems, and other than for power generation, is about 1,500 MGD. This water is returned, less evaporation and consumption, to the basin after use and is available for re-use. Total municipal and industrial water use in the basin, excluding power generation, is about 2,900 MGD. Surface sources provide most of the water used by industry. In 1959, 1,400,000,000 gallons per day were used for manufacturing and processing. Industries other than power plants in the basin that use surface waters are steel and other metals, mining and quarrying, oil refining, chemicals, cement, beverage and food processing, paper and paper products, and railroads. About one billion gallons per day of surface water are used for manufacturing and processing by industries located in the upper Illinois River basin. The Sanitary and Ship Canal provides 184 MGD to industry. Oil refineries located along the canal use 123 MGD; the balance is distributed among manufacturing, steel and other metals, and chemical industries. The Calumet River supplies 670 MGD to industry, about 98 percent of which is used by the steel industry.

VIII-39. The Commonwealth Edison Company has nine thermal electric generating plants or stations situated on the Illinois waterway. They are the Northwest, Fisk, Crawford, Ridgeland, Will County, Joliet, Calumet, Dresden and Powerton stations. The locations of eight of these plants are shown on Ill. Ex. 707.

VIII-40. Each of the nine Commonwealth Edison Company electric generating stations situated on the Illinois waterway uses water from the waterway for the purpose of cooling turbine condensers. Increases in the temperature of the cooling water entering the turbine condensers during warm weather reduce the capacity or output of the turbine-generator units, and reduce the degree of efficiency at which the units operate.

VIII-41. In 1966 the Northwest, Fisk, Crawford, Ridgeland, Will County and Joliet generating stations of Commonwealth Edison Company will have a total installed rated capacity of 4,786,667 kw distributed as follows: Northwest 165,000 kw, Fisk 624,167 kw, Crawford 648,500 kw, Ridgeland 600,000 kw, Will County 1,107,000 kw and Joliet 1,642,000 kw.

VIII-42. Commonwealth Edison Company's thermal electric generating plants currently experience a reduction of output during the months of July, August and September because of increased water temperatures. Reducing the flow of water in the Illinois waterway would increase the temperature of the remaining flow during those months and would further reduce the capacity and efficiency of the Commonwealth Edison Company thermal electric generating plants using such water for cooling purposes at such times. The reduction of 1,600 cfs in the flows in the Illinois waterway proposed by the plaintiffs would reduce the summer peaking capacity of such plants by approximately 100,000 kw. The cost to Commonwealth Edison Company of that amount of capacity was estimated at approximately $17,000,000. Such a loss in capacity would have to be re-

placed and it was estimated that it would cost between $12,000,000 and $15,300,000 at 1962 construction rates. The same reduction would result in a reduction in the efficiency of the generating units involved. This would result in an increase in operating expenses which was estimated at more than $305,000 per year. The losses in capacity and efficiency to the Commonwealth Edison Company plants for reductions in flow between 500 cfs and 1,600 cfs would be proportional to the losses resulting from the 1,600 cfs flow reduction. The cost of installing and operating cooling towers at Commonwealth Edison Company plants to prevent losses in capacity and efficiency which would result from reduced flows would be substantially greater than the cost of replacing such lost capacity.

VIII-43. Eighteen buildings in Chicago's central business district, including the Mandel-Lear Building, Tribune Tower, 333 North Michigan, Prudential Building, Wrigley Building, Stone Container Building, Sun-Times Building, Pure Oil Building, United of America Building, Marina Towers, Chicago Central Office Building, Merchandise Mart, Morton Salt Building, Kemper Building, Riverside Plaza, Hartford Insurance Building, Union Station and America Fore Building use water from the Chicago River and South Branch of the Chicago River for cooling their air conditioning systems, as do many other mercantile and industrial buildings.

The reduction of 1,600 cfs in the flows in the Illinois waterway proposed by plaintiffs would require modifications and additions to air conditioning systems of at least nine large commercial buildings using Chicago River water. It was estimated that such modifications and additions would cost at least $515,000 at 1962 prices. The cost of constructing cooling towers in lieu of making such modifications and additions would be substantially greater.

VIII-44. Office buildings such as those situated in Chicago's central business district have an ever increasing demand for additional air conditioning capacity because

increasing use of more illumination and office machinery adds heat to the existing heat loads of a building and must be offset by additional cooling capacity in order to maintain desired temperatures.

VIII-45. The Pure Oil Company has a refinery at Lemont, Illinois, situated on the east side of the Sanitary and Ship Canal approximately ten miles upstream of Joliet, which uses water from the canal for cooling purposes in its refining operation. The reduction of 1,600 cfs in the flows in the Illinois waterway proposed by plaintiffs would require modifications and additions to the Pure Oil Company refinery that were estimated to cost approximately $850,000 at 1962 prices, exclusive of the cost of possible shutdowns necessitated by such modification. It was estimated that the resulting additional operating costs would be approximately $125,000 per year, exclusive of maintenance and depreciation.

VIII-46. The Corn Products Company has a corn processing plant located on the east side of the Sanitary and Ship Canal at the intersection of Sixty-third Street and Archer Avenue in Argo, Illinois. This plant, the largest food plant in the world, processing 100,000 bushels of corn daily, uses water from the canal for cooling purposes in its processing operation. The reduction of 1,600 cfs in the flows in the Illinois waterway proposed by plaintiffs would require modifications and additions to the Corn Products Company Plant that it was estimated would cost approximately $1,800,000 at 1962 prices, and would result in additional operating expenses of approximately $25,000 per year. It was estimated that while such modifications were being made there would be loss of production by the plant of a value of $250,000.

9. *Hydroelectric Power Production*

VIII-47. There is a hydroelectric power plant having an installed capacity of approximately 20,000 kw at the control works at Lockport, Illinois. The capacity of this

plant exceeds the flows in the Sanitary and Ship Canal which are available for power. A 1,000 cfs reduction in the diversion at Chicago would reduce the amount of electric energy generated at this plant by something in excess of 20,000,000 kwh per year.

## IX. Navigation on the Great Lakes - St. Lawrence System.

### A. General Description of the System

IX-1. The five Great Lakes together with their connecting channels (the St. Marys River, the Straits of Mackinac, the St. Clair River, Lake St. Clair, the Detroit River and the Welland Canal) and the St. Lawrence River provide a national and international route for the movement of waterborne commerce to ports situated on the Great Lakes, to coastal and overseas ports. The area tributary to the Great Lakes is rich in natural resources which give rise to much of the commerce on the Great Lakes. Commerce on the Great Lakes, primarily the movement of bulk commodities, has been a vital factor in the development of the entire region.

IX-2. The Great Lakes basin and immediately adjacent areas today represent one of the largest industrial concentrations in the world. This concentration is a result of the immediate availability of iron ore, limestone, and coal of the Great Lakes region brought together economically by low cost water transportation. These are the principal factors in the concentration of iron and steel production on the shores of the Great Lakes. Similiarly, these same factors are, in large part, responsible for the development of all the manufactories and other industries dependent on iron and steel which are situated on the shores of the Great Lakes. This concentration has resulted in this area largely due to the availability of low cost water transportation. Shipment by Great Lakes freighter is by far the

cheapest form of transportation available for the bulk commodities produced on or near to the shores of the Great Lakes. The economy of the entire basin would be adversely affected by any factors which would increase the cost of such transportation, including a permanent lowering of water levels, and would be benefited accordingly by any permanently higher water levels to the extent that they resulted in a reduction of such cost.

## B. Connecting Channels and Canals

### 1. *Dredged Depths*

IX-3. All the connecting channels in the Great Lakes system (with the exception of the Welland Canal, which has been dredged by Canada to a depth of at least 27 feet) have recently been dredged under the supervision of the Corps of Engineers to a minimum depth of at least 27 feet below their low-water datum planes. The design depths and status of completion of this work as of April, 1963 are shown on L.S. Ex. 721. The dredged depths in the connecting channels are, in the opinion of the Corps, designed to permit passage of vessels drawing 25.5 feet of water when the level of the controlling lake is at low water datum. Draft (as the term is used in these Findings) is the distance between the waterline of a vessel and its bottom.

IX-4. In designing channels adequate to permit a vessel drawing 25.5 feet of water to move through them when the level of the controlling lake is at its respective low-water datum plane, the Corps of Engineers provided certain clearances. In determining the amount of clearance necessary the Corps of Engineers considered the following: the type of material comprising the bed of the channel, the exposure of a particular location in a channel to wind and waves which produce vertical movement of ships, and a factor of safety to cover such eventualities as displacement of material by propeller wash, which results in a reduction of effective channel depths at given locations. The allow-

ances determined to be necessary by the Corps for the factors of exposure and type of channel bottom are:

0.5 feet—sheltered, soft bottom channels
1.5 feet—exposed, soft bottom channels
1.5 feet—sheltered, hard bottom channels
2.5 feet—exposed, hard bottom channels

In addition, the Corps determined that an allowance be made for the tendency of a vessel to squat or settle down at the stern when underway. The Corps allowed up to a maximum of 2 feet for squat in dredging the connecting channels, depending upon probable vessel speeds at the location being considered. The determination of this figure was based on its judgment that squat increases as a vessel's speed increases. Allowances similar to those provided for in the connecting channels are made by the Corps when designing harbor improvements.

IX-5. Generally Lake Erie has been about 0.5 feet higher with respect to its low water datum (LWD) plane than Lakes Superior, Michigan and Huron have been with respect to their LWD planes. Therefore, the Corps of Engineers takes this into consideration when designing depths in harbors and channels influenced by Lake Erie levels.

IX-6. More than $600,000,000 has been spent by the Federal Government in dredging harbors and connecting channels in the Great Lakes. The total cost of the deepening and widening of the current connecting channels project was estimated in 1964 to be $125,500,000. The total cost to the Federal Government by May 31, 1960 of improvements in the connecting channels prior to the current project, other than operating and maintenance costs, was $88,587,100. The total operation and maintenance costs of these channel improvements to the same date was $44,187,800, while the annual operation and maintenance costs are estimated to be $2,220,000.

IX-7. Civil works projects are undertaken by the Corps of Engineers in accordance with specific Con-

gressional authorization after the Corps, at Congressional request, has made a study of the proposed navigation improvement. For each project the Corps develops a benefit-cost ratio. The estimated construction costs and the anticipated benefits of the proposed improvements, reduced to an average annual basis for a 50-year period, are compared to determine the benefit-cost ratio. With respect to navigation improvements made under the supervision of the Corps on the Great Lakes, the anticipated benefits are the expected savings to the general economy or the national welfare in the cost of transporting expected future commerce as a result of the proposed improvements. In calculating the benefit-cost ratio for the current deepening of the connecting channels project, the expected savings in only three principal commodities were considered. These are iron ore, grain and stone. Furthermore, only 50 percent of the projected annual commerce in stone, approximately that used in the steel industry, was considered, and only 65,000,000 tons of iron ore of the projected 82,000,000 tons of that commerce. This figure for iron ore was used because the Corps believed that only 65,000,000 tons will take advantage of the increased depths available due to the limiting depths which are estimated will continue to obtain at certain receiving docks. Ordinarily, the Corps does not recommend the construction of a project unless the anticipated benefits exceed the estimated costs. The benefit-cost ratios developed by the Corps for Great Lakes projects are based on a navigation season of approximately eight months. The Corps presently believes that the benefit-cost ratio of the current project to deepen the Great Lakes connecting channels to a minimum depth of 27 feet, including harbor improvements to permit shipping to take full advantage of the increased depths in the connecting channels, will be higher than the 1.78 to 1 developed in the survey report which recommended that the project be undertaken.

IX-8. The current project for deepening and enlarging the connecting channels in the Great Lakes will have no effect on the levels of Lakes Erie and Ontario, as these

lakes are downstream from the channels being deepened; nor will the work have any effect on levels of Lake Superior, because the outflow of that lake is controlled by regulating structures at Sault Ste. Marie. The deepening of the channels in the St. Marys River below St. Marys Falls will reduce by about 0.12 foot the depth over the lower lock sills at Sault Ste. Marie.

2. *St. Marys River and Locks*

IX-9. Marine traffic between Lakes Superior and Michigan-Huron transits the St. Marys River in which there are five parallel locks at Sault Ste. Marie, Michigan and Ontario, which permit vessels to bypass the rapids in the river. With a cargo volume exceeding 130,000,000 tons in the peak year, it is frequently referred to as the busiest ship canal in the world. About 80 percent of the iron ore produced in the United States is transported to steel mills via this route. The four parallel American locks in this 70-miles-long river are named MacArthur, Poe, Davis and Sabin, each of which has a lift of about 21.7 feet. The MacArthur lock is 800 feet long, 80 feet wide, with a depth over the sills of 31 feet. The Davis and Sabin locks are 1,320 feet long, 80 feet wide, with a depth over the sills of 23 feet. The Poe lock was 704 feet long, 95 feet wide, with a depth of 16.6 feet over the sills. However, in 1962, work began to replace the Poe lock, increasing its size to 100 feet wide, 1,000 feet long and 32 feet deep over the lock sills. The authorization provided that changes in the plan could be made which, in the discretion of the Secretary of the Army, and the Chief of Engineers, were advisable. Representations by navigation interests and studies by the Corps indicated that the lock size should be increased to accommodate vessels of the size which could possibly be anticipated during the life of the project. Therefore, the Secretary of the Army in October 1962 authorized increasing the lock size to 110 feet wide, 1,200 feet long and 32 feet deep over the lock sills. Construction of this enlarged Poe Lock had started by 1963 and is scheduled to be completed in the fall

of 1967. Opposite the U. S. locks in the St. Marys River, there is a single Canadian lock.

The volume in tons* of cargo passing through the St. Marys River for the years 1958 through 1964 was as follows:

| *Year* | *Tons of Cargo* |
|---|---|
| 1958 | 79,588,107 |
| 1959 | 74,791,222 |
| 1960 | 95,434,888 |
| 1961 | 84,218,159 |
| 1962 | 83,217,124 |
| 1963 | 88,413,190 |
| 1964 | 98,143,303 |

The average annual commerce through the St. Marys River in the period 1953-1964 equalled 97,902,571 tons.* Total commerce on the St. Marys River in 1953, the highest on record, was 132,989,000 tons.

3. *Straits of Mackinac*

IX-10. Marine traffic between Lakes Michigan and Huron passes through the naturally broad and deep Straits of Mackinac. Navigation improvements in the Straits have consisted of the removal of the Poe Reef Shoal and the dredging of some other reefs and shoals. The channels in the Straits have been dredged to a depth of 30 feet, are now stable, and it is believed that they will require no maintenance work in the future.

4. *St. Clair River, Lake St. Clair and Detroit River*

IX-11. Marine traffic from Lake Superior and Lakes Michigan-Huron to Lake Erie passes through the St. Clair River, Lake St. Clair and the Detroit River, a distance of about 84 miles. The average annual tonnage shipped through the Detroit River during the period 1953 through 1964 was approximately 112,193,391 tons.

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* As used in these findings the term "ton" means a unit of weight equal to 2,000 pounds unless otherwise specifically described.

5. *Welland Canal*

IX-12. The 27-feet-deep Welland Canal in Canada now handles all vessel traffic between Lakes Erie and Ontario. There is a drop of about 327 feet between these lakes. There are eight locks including one guard lock in the canal. The total lift of all locks is about 327 feet. The canal is designed to accommodate vessels drawing up to 25.5 feet of water.

Based on 1965 estimates of the increase in traffic between Lakes Erie and Ontario, and based on plans for twinning the locks which were current in 1965, it is estimated that the capacity of the Welland Canal will be reached about 1985. The Senate and House Committees on Public Works in 1958 authorized a study by the Corps of Engineers of the feasibility of constructing an All-American Canal through the State of New York from Lake Erie to Lake Ontario to handle the predicted increase in traffic. Such a study is now under way by the Corps.

IX-13. The Welland Canal is about 28 miles long, 200 feet wide at the bottom, 310 feet wide at the surface and has a minimum depth of 27 feet. The canal has eight locks, all of which, except for the single guard lock, are located between Lake Ontario and the town of Thorold, Ontario. Locks 1, 2, 3, and 7 are single locks, locks 4, 5, and 6 are double locks. The locks are 859 feet long, 80 feet wide, and have a depth of 30 feet over the gate sills. Each lock is provided with a pond for storing water to provide for filling the lock. Each pond is provided with an overflow weir, which permits excess water to spill into the canal below the lock.

IX-14. Lock 4 in the Welland Canal has the highest lift, 52.9 feet, and governs canal water use for lockage, since it uses the most water per lockage, each filling requiring the equivalent of 42.1 cfs for one day.

IX-15. In 1964 the total tonnage passing through the Welland Canal was 51,416,382 tons, in 1959 it was 27,435,491 tons, and in 1958 it was 21,274,194 tons.

IX-16. Approximately 300 cfs of water is discharged from the Welland Canal into the Welland River by a number of routes. All of this discharge into the Welland River flows eastward in that river and is available for hydroelectric power generation. However, this discharge does, in effect, constitute flow through another outlet for Lake Erie, and as such lowers the level of the lake.

IX-17. The mean monthly discharge of water through the Welland Canal during the period January, 1927 through May, 1960, exclusive of approximately 300 cfs which is discharged into the Welland River is reflected on Ill. Ex. 543.

IX-18. The Welland Canal operates for navigation about 8.5 months per year, roughly April 1 to December 15.

IX-19. Normally about 6,400 cfs of the water diverted through the Welland Canal is used to generate power at the De Cew Falls generating station of the Hydro-Electric Power Commission of Ontario. Of this amount 5,000 cfs is considered to be the additional water made available by the Long Lake-Ogoki diversion. The rights to the exclusive use of 5,000 cfs of this water by Canada are governed by the exchange of notes between the United States and Canada in 1940 which were affirmed by the 1950 Niagara Treaty.

IX-20. The amount of flow available for power in the Niagara River is dependent in part upon the water diverted therefrom for navigation purposes. Therefore, increased use of the Welland Canal or construction of the All-American Canal would reduce the flow available for power. Any reduction in the flows required for navigation will increase the flow available for power.

6. *St. Lawrence Seaway*

IX-21. Navigation from Lake Ontario through the St. Lawrence River is accomplished by a series of locks and channels constituting the St. Lawrence Seaway, which

permit ocean vessels having drafts of up to 25.5 feet, which is 11.5 feet greater than those which could be accommodated prior to the construction of the seaway, to enter the Great Lakes. The St. Lawrence Seaway Development Corporation has constructed, in the United States territory, navigation works with a minimum depth of 27 feet in channels and the 10-miles-long Wiley-Dondero Ship Canal, with two locks, the Eisenhower and Snell, having a combined lift of about 82 feet. The locks have a usable length of 768 feet (they are 860 feet long between gates) and are 80 feet wide and 30 feet deep over the sills. The Canadian Seaway Authority constructed seaway facilities including a 27-feet-deep waterway and five locks of the same minimum size as the American locks. Four locks are in the Canadian section between Montreal and Cornwall and one is in the Iroquois Canal, which bypasses the Iroquois Dam. The Power Authority of the State of New York and the Hydro-Electric Power Commission of Ontario jointly spent more than $300,000,000 for works common to both power and navigation.

Although the St. Lawrence Seaway has been dredged to a minimum depth of 27 feet, safe draft in the Seaway was limited in 1959 to 25 feet by the Seaway Authority. Safe draft in the entire seaway as of April 10, 1963 was increased by order of the Seaway Authority to 25.5 feet.

A total of 39,309,029 tons was shipped through the St. Lawrence Seaway in 1964. A total of 6,779 vessels transited the St. Lawrence River section of the seaway in 1964, of which 577 were of United States registry, 3,491 were of Canadian registry and 2,711 were registered under the flags of other countries. It has been estimated by the St. Lawrence Seaway Development Corporation that seaway traffic in 1968 and thereafter will amount to 50,000,000 tons annually.

For the shipping season of 1960, 42 regular lines of overseas vessels published service to Lake Michigan. Other ocean lines terminated in Lake Erie; about 50 regular ocean services are now committed to the Great Lakes. In

1960 there were large numbers of charter vessels available for special movements between the Great Lakes and the high seas. For the year 1960 shipping directories listed 196 shipping enterprises which represented a combined Great Lakes ocean and charter business which probably involved 1,000 individual ships.

## C. Ports and Harbors

### 1. *General Description*

IX-22. The Great Lakes possess few natural harbors and extensive improvements have been required to develop harbors by constructing protective structures such as piers and breakwaters, and by dredging channels from deep water to the docks in harbor basins or in inner river channels. A comprehensive Great Lakes harbor study authorized by resolutions of the House and Senate Committees on Public Works in 1956 is in progress by the Corps of Engineers to determine the possibility of further deepening and other improvements at 34 existing United States harbors. Interim reports on 31 of these harbors had been issued by the end of June 1965, and in 21 cases recommendations were made for deepening all or part of these harbors to accommodate vessels drawing 25.5 feet of water at LWD. Currently, the Corps of Engineers is deepening all or part of the federally maintained projects in some Great Lakes harbors not already deepened to enable them to accommodate vessels drawing 25.5 feet of water at LWD.

IX-23. There are at least 275 ports, waterways and channels in American waters on the Great Lakes which are of sufficient importance to be recognized in the statistics of Waterborne Commerce (1964 ed.) compiled by the Corps of Engineers.

IX-24. Deep draft harbors, either publicly or privately maintained, are now located on each of the Great Lakes. Brigadier General James Stratton (U. S. Army, retired), a witness for the Lake States, reviewed published

data for the purpose of determining the depths which prevailed in portions of some deep-draft harbors in 1960. The following table reflects the results of General Stratton's review.

| LAKE SUPERIOR | 1960 Depths at LWD | |
|---|---|---|
| Taconite, Minn. | 26′ | |
| Silver Bay, Minn. | 26′ | |
| Two Harbors, Minn. | 26′ | |
| Duluth–Superior, Minn., and Wisc. | 25′ | |
| Ashland, Wisc. | 25′ | |
| Presque Isle, Mich. | 26′ | |
| Marquette, Mich. | 25′ | |
| LAKES MICHIGAN–HURON | | |
| Lime Island, Mich. | 22′ | |
| St. Ignace, Mich. | 18′ | |
| Gladstone, Mich. | 21′ | |
| Drummond Island, Mich. | 23′ | |
| Port Dolomite, Mich. | 25′ | |
| Port Inland, Mich. | 25′ | |
| Manistique, Mich. | 18′ | |
| Escanaba, Mich. | 22′ | (ore terminals)* (petroleum terminals) |
| Menominee, Mich., and Wisc. | 21′ | |
| Sturgeon Bay, Wisc. | 22′ | |
| Green Bay, Wisc. | 22′ | |
| Kewaunee, Wisc. | 20′ | |
| Two Rivers, Wisc. | 18′ | |
| Manitowoc, Wisc. | 21′ | |
| Sheboygan, Wisc. | 21′ | |
| Port Washington, Wisc. | 21′ | |
| Milwaukee, Wisc. | 21′ | |
| Racine, Wisc. | 19′ | |
| Kenosha, Wisc. | 21′ | |
| Waukegan, Ill. | 18′ | |
| Chicago River, Ill. | 20′ | |
| Calumet, Ill., and Ind. Harbor | 25′ | |
| Calumet, Ill., and Ind. River and Lake | 21′ | |

* Material in parenthesis indicates portion of harbor covered by General Stratton's review.

| | 1960 Depths at LWD | |
|---|---|---|
| Indiana Harbor, Ind., Harbor | 25′ | |
| Indiana Harbor, Ind., Canals | 22′ | |
| Buffington, Ind. | 26′ | |
| Gary, Ind. | 26′ | |
| St. Joseph, Mich. | 21′ | |
| South Haven, Mich. | 19′ | |
| Holland, Mich. | 21′ | |
| Grand Haven, Mich. | 21′ | |
| Muskegon, Mich. | 21′ | |
| Ludington, Mich. | 18′ | |
| Manistee, Mich. | 21′ | |
| Frankfort, Mich. | 18′ | |
| Traverse City, Mich. | 21′ | |
| Charlevoix, Mich. | 18′ | |
| Cheboygan, Mich. | 21′ | (coal) |
| | 20′ | (petroleum) |
| Calcite, Mich. | 25′ | |
| Stoneport, Mich. | 25′ | |
| Alpena, Mich. | 20′ | (stone and coal) |
| | 18′ | (petroleum) |
| Alabaster, Mich. | 23′ | |
| Bay City, Mich. | 24′ | (coal) |
| | 22′ | (petroleum) |
| Saginaw, Mich. | 22′ | |
| Port Huron, Mich. | 20′ | |
| St. Clair, Mich. | 20′ | |

LAKE ERIE

| | | |
|---|---|---|
| Detroit River, Mich. | 25′ | |
| Rouge River, Mich. | 21′ | |
| Trenton Channel, Mich. | 21′ | |
| Toledo, Ohio | 25′ | (iron, coal and grain terminals) |
| | 22′ | (petroleum) |
| Marblehead, Ohio | 22′ | |
| Sandusky, Ohio | 21′ | |
| Huron, Ohio | 25′ | |
| Lorain, Ohio | 25′ | |

| | 1960 Depths at LWD | |
|---|---|---|
| Cleveland, Ohio: | | |
| Outer Harbor | 25′ | |
| Old River | 23′ | |
| Upper Cuyahoga River | 23′ | (iron, coal, stone and grain) |
| | 22′ | (petroleum) |
| Fairport | 24′ | |
| Ashtabula | 24′ | |
| Conneaut, Ohio | 25′ | |
| Erie, Pa. | 25′ | (iron ore) |
| | 21′ | (stone, coal, grain and petroleum) |
| Buffalo, N. Y.: | | |
| Outer Harbor, South | 25′ | |
| River Channels | 22′ | |
| Tonawanda, N. Y. | 21′ | |
| Niagara River, N. Y. | 21′ | |

LAKE ONTARIO

| | | |
|---|---|---|
| Rochester, N. Y. | 20′ | |
| Great Sodus, N. Y. | 20′ | |
| Oswego, N. Y. | 21′ | (coal and grain) |
| | 18′ | (petroleum) |

ST. LAWRENCE SEAWAY

| | | |
|---|---|---|
| Ogdensburg, N. Y. | 21′ | (coal) |
| | 18′ | (petroleum) |
| Massena, N. Y. | 20′ | |

Deep draft Canadian harbors on the Great Lakes are:

| LAKE SUPERIOR | 1960 Depths at LWD | |
|---|---|---|
| Fort William–Port Arthur, Ont. | 27′ | (iron ore) |
| | 23′ | (stone, coal, grain and petroleum) |
| Marathon, Ont. | 20′ | (stone) |
| | 18′ | (petroleum) |
| Michipicoten, Ont. | 21′ | |
| Sault Ste. Marie, Ont. | 23½′ | (iron ore, stone, coal) |
| | 19′ | (petroleum) |

| LAKES MICHIGAN–HURON | 1960 Depths at LWD |
|---|---|
| Little Current, Ont. | 21′ (coal) |
| | 19′ (petroleum) |
| Britt, Ont. | 21′ (coal) |
| | 20′ (petroleum) |
| Byng Inlet, Ont. | 18′ |
| Parry Sound, Ont. | 22′ |
| Port McNicoll, Ont. | 23′ |
| Midland, Ont. | 24′ |
| Collingwood, Ont. | 24′ (grain) |
| | 22′ (petroleum) |
| Owen Sound, Ont. | 23′ (coal and grain) |
| | 18′ (petroleum) |
| Goderich, Ont. | 23′ |
| Sarnia, Ont. | 23′ |
| **LAKE ERIE** | |
| Sombra, Ont. | 20′ |
| Walkerville, Ont. | 25′ |
| Windsor, Ont. | 25′ (coal) |
| | 19′ (petroleum) |
| Amherstburg, Ont. | 20′ |
| Erieau, Ont. | 21′ |
| Port Stanley, Ont. | 21′ (coal) |
| | 20′ (petroleum) |
| Port Burwell, Ont. | 22′ |
| Port Maitland, Ont. | 22′ |
| Port Colborne, Ont. | 27′ (iron ore, petroleum) |
| | 25′ (stone and coal) |
| | 19′ (grain) |
| **LAKE ONTARIO** | |
| Welland, Ont. | 25′ |
| Thorold, Ont. | 25′ |
| Port Weller, Ont. | 25′ |
| Hamilton, Ont. | 23′ |
| Clarkson, Ont. | 24′ |
| Port Credit, Ont. | 21′ |
| Toronto, Ont. | 21′ (coal) |
| | 23′ (grain) |
| | 19′ (petroleum) |

| | 1960 Depths at LWD |
|---|---|
| Oshawa, Ont. | 21′ |
| Cobourg, Ont. | 20′ |
| Picton, Ont. | 26′ (iron ore) |
| | 20′ (coal) |
| Kingston, Ont. | 18′ (coal) |
| | (petroleum) |
| | 22′ (grain) |
| ST. LAWRENCE SEAWAY | |
| Prescott, Ont. | 18′ (coal) |
| | 27′ (grain) |
| Morrisburg, Ont. | 18′ |
| Montreal, Que. | 27′ |
| Sorel, Que.* | 27′ |
| Three Rivers, Que.* | 27′ |

The Corps of Engineers has recommended deepening portions of channels adjacent to terminals in the federally maintained projects in the following harbors to these depths at low water datum:

| | |
|---|---|
| Duluth–Superior, Minn. and Wisc. | 28′ |
| Presque Isle, Mich. | 28′ |
| Menominee, Mich., and Wisc. | 24′ |
| Milwaukee, Wisc. | 28′ |
| Muskegon, Mich. | 27′ |
| Saginaw, Mich. | 25′ |
| Gladstone Harbor, Mich. | 24′ |
| Rouge River, Mich. | 25′ |

Greater depths are provided in the lake approaches to a number of these harbors.

IX-25. Docks used in Great Lakes ports fall generally into one of five categories, as follows:

(a) *The natural bank.* This type of dock is generally used for storage of bulk commodities such as coal, iron ore and stone, directly on the ground some distance back from the shoreline and unloaded at the site by self-unloaders. Lowering the water level might necessitate additional dredging to provide adequate

* Denotes tidewater ports.

draft for vessels and might cause a decrease in storage capacity by reducing the soil carrying capacity or requiring bulk material to be stored at a greater distance from the shoreline.

(b) *Timber deck on timber piles.* This type of dock is used mostly by marinas. The lowering of the water level might require dredging to maintain channel depth or the provision of ladders or secondary platforms for access to boats.

(c) *Relieving platform on piles.* This type of dock consists of a concrete platform and bulkhead—sometimes wood—supported on open wood or concrete piles back to the shoreline at which point timber or steel sheeting is used as a bulkhead. The structure is then tied back to deadmen. The relieving platform is generally at such an elevation that the tops of the piles would be below the water surface. In the use of wood piles, it is important that they remain submerged to prevent decay. The relieving platform is generally filled to the top of the dock elevation and may or may not be paved. Lowering of the water level to an elevation which exposes the top of the wood piles might cause considerable damage and in severe cases might require replacement of the dock. Additional dredging might be needed to maintain minimum channel depth.

(d) *Bulkhead.* This type of construction consists of wood or steel sheet piling, anchored to deadmen at some distance back from the face of the sheeting and beyond the angle of repose for the soil encountered. Back fill is placed behind the sheet piling and the channel in front is dredged to desired depth. A change in conditions, such as lowering the water level, might reduce stability of the structure or require a commensurate reduction in storage capacity.

(e) *Relieving platform on bulkhead.* This type of construction is employed to deal with heavy loads which would otherwise produce excessive lateral pres-

sures against the sheet piling. A massive platform is supported by timber or reinforced concrete piles and relieves the sheet piling of the bulkhead from the lateral pressure of loads above the level of the platform. If timber piles are used, the pile cutoff needs to be at or below the minimum water level to prevent decay of the wood piling. If the water level is lowered sufficiently below the top of the wood piles, dry rot is likely to take place and in time the usefulness of the dock may be reduced or heavy maintenance work may be required.

The docks, pilings, bulkheads, wharves and berthing spaces at some marine facilities on the Great Lakes are presently deteriorated, inadequate, overloaded and in need of repair or replacement.

IX-26. In some instances, e.g., the Rouge River and Erie harbor, local interests on the Great Lakes have not furnished the guaranties, facilities, alterations in existing structures, lands, easements or rights of way to the Federal Government which it may require in connection with the channel and harbor improvements proposed to be made in various ports. As a result, Federal harbor and channel improvement projects have either not been undertaken or have been deferred or halted.

2. *Minnesota Ports*

IX-27. The principal Lake Superior ports in the State of Minnesota are Duluth, Taconite Harbor, Silver Bay and Two Harbors. These Minnesota ports and Superior, Wisconsin, traditionally lead other Great Lakes ports in shipments of iron ore. Annual shipments of iron ore are usually greater than annual shipments of any other bulk commodity on the Great Lakes. Located at the western end of the Great Lakes water system, the ports are in the center of grain producing and iron ore mining areas of North America and grain and iron ore constitute the primary bulk commodities shipped from Minnesota. Minnesota ports are equipped for

the rapid handling of bulk cargoes. The cargo capacity of many of the largest bulk grain and ore vessels loading at Minnesota docks may be limited by water depths existing in the connecting channels and the lower Great Lakes.

Considerable investments have been made to continue Minnesota ports as bulk cargo ports and as leading grain shipping locations.

Improvements at Minnesota docks which have been made by private companies are also designed to take full advantage of the connecting channels project and to accommodate the larger ocean vessels. These dock improvements include dredging of dockside berths to depths available in the connecting channels, and in some instances, even deeper; sheet piling of dock facilities for lateral support; improved receiving capacity from rail and truck facilities; and improved vessel loading devices. These changes allow maximum cargo loading and reduce loading time by avoiding costly delay, thereby keeping shipping costs competitive with other ocean ports offering the same commodity for shipment.

The public and private improvements at Minnesota ports, made at considerable cost to permit loading of vessels to the drafts available in the connecting channels, are based upon the continued use of the Great Lakes for waterway transportation. This is particularly true in the case of bulk cargo, where loading to the maximum legal capacity is usually sought for lake and ocean vessels leaving Lake Superior ports.

Cargo capacity of ocean vessels is limited by levels available in the lower Great Lakes and connecting channels, to the extent that such levels do not permit the ships to load to a point where they will be sailing at greater than 25.5 feet fresh water draft when they reach the Welland Canal. When ships cannot load to this point, they must top off cargoes at ocean ports, which results in delay and expense.

IX-28. The twin ports of Duluth in Minnesota and Superior in Wisconsin serve a large trade area and during

the ten-years period, 1954 through 1963, handled an annual average of 44,940,983 tons of cargo. During the same period Duluth-Superior was the fifth largest port in the United States from the standpoint of tonnage handled. There are 8,000 to 10,000 vessel passages through the harbor during an average navigation season. During 1964, 299 ocean vessels called at Duluth-Superior. Total exports to foreign countries shipped through that harbor in that year were 3,221,613 tons, while total imports equalled 51,392 tons.

Excluding the newly constructed public marine terminal, there are 58 principal docks in the harbor of Duluth-Superior. There are 10,000 to 12,000 vessel passages through the harbor during an average navigation season. Lake approaches to the twin harbors range in depth up to 32 feet at LWD, while some portions of the harbors have 27 to 28 foot depths at LWD. No other Great Lakes harbor is better equipped for the rapid handling of bulk cargoes. In some instances an average cargo of 13,000 long tons (units weighing 2,240 pounds) of iron ore can be loaded in about three hours. During 1959, the first operating season of the St. Lawrence Seaway, 235 foreign vessels with carrying capacities ranging up to 20,000 net tons when sailing at maximum salt water load-lines sailed into the harbor. These ships ranged up to 650 feet in overall length, and had a maximum salt water load-line ranging from 14 feet 3 inches to 33 feet 8½ inches.* Of these 235 vessels, 158 had maximum salt water drafts of 25 feet or more. Duluth is only 93 miles further from the Atlantic Ocean than Chicago by steamer track, but geographically it is 240 miles further inland in a westerly direction, and 450 miles further inland in a northwesterly direction. It is an important marketing area to the north and west of such other lake ports as Milwaukee, Chicago, Detroit, and Toledo.

Grain storage facilities in the port of Duluth-Superior have a capacity of 68,750,000 bushels. The port has the largest marine grain storage and handling capacity in the

* To convert a ship's salt water draft to its relative fresh water draft, multiply the salt water draft by 1.0256.

United States and is second in storage capacity only to Fort William-Port Arthur on the North American Continent.

The public marine terminal of Duluth, constructed to coincide with the opening of the St. Lawrence Seaway, was financed by a $10,000,000 appropriation authorized by the Minnesota legislature in 1957. The new terminal can berth 11 vessels 500 feet in length and is dredged to a depth of 30 feet, LWD, at dockside.

3. *Wisconsin Ports.*

IX-29. Outer harbor development of the City of Milwaukee to 1959 represents an investment approaching $20,000,000. The Federal Government has expended about $8,000,000 in the construction of breakwater protection and channel improvements. Portions of Milwaukee harbor are open to navigation throughout the year for intralake traffic. The Port Director of the City of Milwaukee, a witness for the Lake States, estimated that the replacement value of port facilities in the port of Milwaukee is in excess of $100,000,000. It is one of the important harbors on the Great Lakes, and in the year 1964 handled 469,000 tons of overseas waterborne commerce. The port has handling equipment for the loading and unloading of cargo. Milwaukee has built a municipal port with berthing space capable of handling expected St. Lawrence Seaway commerce, including a recently completed general cargo pier with facilities for simultaneous berthing of five ocean vessels. Some outer harbor slips have been dredged to depths of 27 feet at LWD. Other improvements have been made in the harbor, including new roadways and railway track to serve it. Milwaukee is also a center of ship repair activity.

Milwaukee is one of the leading ports in the development of ocean commerce and has had direct trade links with about 150 major ports of the world located on four continents. It provides overseas shipping service for approximately 250 United States inland cities.

Some docks in the river portion of the Milwaukee harbor are just barely stable. Increasing the dockside depths in this portion of the harbor could not be accomplished without some danger of dock wall collapse.

IX-30. Traffic at 13 Wisconsin ports as reported by the Corps of Engineers in net tons was as follows:

| | 1964 | 5 Years Average 1960-1964 |
|---|---|---|
| Ashland, Wis. | 632,463 | 1,251,121 |
| Duluth–Superior | 42,996,795 | 37,774,174 |
| Green Bay | 2,516,659 | 2,756,732 |
| Kenosha | 59,190 | 60,187 |
| Kewaunee | 1,153,493 | 1,061,265 |
| Manitowoc | 2,126,582 | 2,042,313 |
| Marinette–Menominee | 453,553 | 581,843 |
| Milwaukee | 6,381,442 | 7,324,305 |
| Port Washington | 733,015 | 655,484 |
| Racine | 115,420 | 124,009 |
| Sheboygan | 464,391 | 462,738 |
| Sturgeon Bay | 312,593 | 649,136 |
| Two Rivers | 79,786 | 133,515 |

The cost to the Federal Government of new work done in these ports through June 30, 1965 was $37,787,073. Maintenance work done in these harbors up to June 30, 1965 amounted to $25,615,082, for a total of $63,402,155 spent by the Federal Government for improvements in Wisconsin harbors.

4. *Michigan Ports*

IX-31. St. Joseph Harbor, Michigan. The project depths at LWD in the federally maintained portions of this harbor are: 24 feet in the entrance channel, 21 feet in the channel between the piers to Benton harbor channel and 17.3 feet in the Benton harbor channel.* Waterborne com-

* The descriptions of depths in these harbors are intended to indicate what is graphically illustrated on L.S. Ex. 366A.

merce for the five years ended with 1964 has averaged approximately 437,477 tons annually. Included in this five-years average was the average annual intraport movement of 23,450 tons of sand and gravel removed from the St. Joseph River. 1964 tonnage, including intraport movement of 14,050 tons of sand and gravel removed from the St. Joseph River, was approximately 448,803 tons. The traffic consists primarily of petroleum products, coal, limestone, sand, gravel and crushed rock.

In 1955 the Corps of Engineers recommended enlargement of the turning basin to enable use of the port by self-unloading bulk carriers in the 500-600 feet class. The 1955 Corps of Engineers report states: "The present trend toward the use of larger and more economical vessels has resulted in a greater use of the St. Joseph Harbor by such vessels than was anticipated."

IX-32. South Haven Harbor, Michigan. The project depths at LWD in the federally maintained portions of this harbor are: 21 feet in the entrance channel to the shoreline, 19 feet in the channel to the turning basin.* An average of 101,026 tons of commerce was handled over the five-years period ending in 1964. 1964 tonnage for this harbor was all inbound (except for 152 tons), was carried in 66 vessels and was approximately 81,225 tons. Most of the commerce consists of limestone, sand, gravel, woodpulp and pig iron.

IX-33. Holland Harbor, Michigan. Project depths at LWD in the federally maintained portions of this harbor are: 23 feet in the entrance channel, decreasing to 21 feet at inner piers; channel depth in the Black River is 21 feet.* Waterborne commerce for the five-years period ending in 1964 has averaged approximately 248,809 tons; the total commerce in 1964 amounted to 193,238 tons and was carried in 31 vessels.

IX-34. Grand Haven Harbor and Grand River, Michigan. Project depths at LWD in the federally maintained portions of this harbor are: entrance channel 23 feet deep,

channel in the Grand River to Ferrysburg 21 feet deep.* Waterborne commerce for the five-years period ending in 1964 averaged 2,893,500 tons for Grand Haven and 1,479,738 tons for Grand River. The 1964 waterborne commerce was 2,598,375 tons for Grand Haven and 1,375,668 tons for Grand River. Of this total of 3,974,043 tons, 1,375,668 tons were intraport shipments. Movements from the harbor consisted of sand, gravel and crushed rock. Receipts consisted principally of coal, petroleum and limestone.

IX-35. Muskegon Harbor, Michigan. The Port of Muskegon is the natural outlet of the Muskegon River to Lake Michigan. The river expands to form Muskegon Lake, a natural harbor basin five miles long, one to two miles wide, and 30 to 40 feet deep. Fourteen piers and wharves are located in the harbor with a considerable amount of frontage available for future expansion. Project depths at LWD in the federally maintained portions of this harbor are 27 feet in the entrance channel.*

Waterborne commerce for the five-years period ending in 1964 averaged 3,349,972 tons. The total 1964 commerce amounted to 3,349,682 tons. Principal receipts were coal, petroleum products, cement and limestone. Principal shipments were petroleum products, construction aggregates and motor vehicles.

IX-36. Alpena Harbor, Michigan. Project depths in the federally maintained portions of the harbor are 21 feet in the entrance channel in Thunder Bay, 18.5 feet deep at docks in the Thunder Bay River.* A private channel dredged to 23 feet deep in 1960 is provided by a local cement company. Waterborne commerce for the five years ending with 1964 has averaged 2,477,204 tons annually. In 1964, total waterborne commerce of 2,716,226 tons was handled. Coal accounted for about 88 percent of the receipts, while nonmetallic minerals totaled 100 percent of total 1964 shipments.

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* The descriptions of depths in these harbors are intended to indicate what is graphically illustrated on L.S. Ex. 366A.

During 1964, of 377 outbound vessels, 260 had loaded drafts of 19 to 22 feet, inclusive. The other vessels were loaded to lesser drafts.

IX-37. Saginaw and Bay City, Michigan. Both cities are located on the Saginaw River, Bay City near the mouth of the river and Saginaw about 20 miles upstream from the mouth. The Corps of Engineers has recommended that a 14-miles channel in Saginaw Bay be deepened to 27 feet at LWD to the angle in the channel near the mouth of the river, that the approach channel be made 26 feet deep and the river channel 25 feet deep. The Corps' recommendation is reported in L.S. Ex. 716. The prior bay channel was 24 feet deep with 22-feet depths maintained in the river.* The deepening project was authorized in the River and Harbor Act approved October 23, 1962. Waterborne commerce at Saginaw and Bay City, during the five-years period ending in 1964 averaged 5,498,706 tons. In 1964, the total commerce was 5,874,886 tons.

The Wickes Corporation has a marine terminal located at Bay City. The corporation's Michigan Bean Company Division has 21 storage elevators in the area, and its Saginaw Grain Company Division maintains a shipping dock at Saginaw. It purchases grain products from farmers in the Saginaw Valley and stores them in elevators for sale to domestic and foreign markets. Over 136,595 tons of grain in bulk were loaded aboard lake ships at the Wickes Corporation's facility at Bay City in 1964.

IX-38. Detroit, Michigan. The port of Detroit is generally described as including the Detroit River and its tributaries from its head at Windmill Pointe light on Lake St. Clair to its mouth at the Detroit River light in Lake Erie, extending 31 miles. In 1964 the port of Detroit, including facilities on the Trenton Channel, handled 33,062,-222 tons of cargo.

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* The descriptions of depths in these harbors are intended to indicate what is graphically illustrated on L.S. Ex. 366A.

IX-39. Whereas the banks of the Detroit River are relatively stable, the banks of the Rouge River and the area at its mouth are most unstable. The Rouge River originally made a sharp, northward bend before entering the Detroit River. This bend limited the size of vessels which could traverse the Rouge. In 1923 the Short Cut Canal was opened, permitting easier access to the upper reaches of the Rouge. There are approximately 155 marine installations in the entire port of Detroit area; 113 of them are along the Detroit River, and 42 on the Rouge River.

The stability of banks along the Rouge River and the Detroit River adjacent to the Rouge has been critical for many years. Composed primarily of clays having a high moisture content, the soil is usually in a saturated state from the surface down to hardpan approximately 85 feet below grade. The average shearing stress of these clays is 100 pounds per square foot for the top layer compared to an average value for clays of 125 pounds per square foot or more. The shearing resistances of the soils along the Rouge River are extremely low. The fluctuation of water levels in the river affects the stability of the river banks. The water levels of the river already are subject to substantial seasonal variations from the average, running from a high of 576 to a low of 571; and at times of seasonal lows the stability of the banks and the danger to adjacent property are correspondingly increased.

The majority of the dock foundations and bulkheads do not extend to hardpan and thus are subject to movement as the soil moves. It is, therefore, necessary to reinforce or rebuild these facilities when bank failures occur. To dredge any appreciable amount beyond existing limits in the Rouge River would necessitate reconstruction of a majority of the dock structures and extension of their foundations to hardpan. In addition, it would be necessary to reduce the slope of the banks to a slope of 2½ to 1 or less.

IX-40. The majority of Great Lakes ports are formed at river mouths. Water levels in these rivers downstream from the upper limits of Corps' lake harbor projects gen-

erally fluctuate along with levels of the lakes into which the rivers empty.

IX-41. The total federal cost of improvements to all completed harbors in the State of Michigan on the Great Lakes as of June 30, 1965 was $48,837,791. The federal operation and maintenance costs of these harbor improvements in the State of Michigan up to June 30, 1965 were $45,141,430, and the estimated annual operation and maintenance costs were $1,900,000.

The benefit-cost ratio of the deepening of portions of the Muskegon harbor (Mich.) is estimated at 4.7 to 1, of the Saginaw River (Mich.) is 1.3 to 1, of Presque Isle harbor (Mich.) 25.8 to 1; Ontonagon harbor (Mich.) 1.5 to 1, Gladstone & Kipling channels (Mich.) 2.3 to 1, Rouge River (Mich.) 2.0 to 1, Detroit River, Trenton Channel (Mich.) 4.4 to 1.

5. *Pennsylvania Harbor*

IX-42. Erie harbor, Pennsylvania, is located on the south shore of Lake Erie, in a bay formed by Presque Isle Peninsula and the mainland of Pennsylvania. It is 78 miles by water westerly of Buffalo, New York and 102 miles easterly of Cleveland, Ohio. The bay opens to the east, is about 4½ miles long parallel to the mainland, and has a maximum width of about 1½ miles, and an area of 5¼ square miles.

IX-43. Erie harbor, in its original condition in 1778 was nearly landlocked by the Presque Isle Peninsula, the only entrance being at the east end through a narrow and tortuous channel, variable in position with a depth of about six feet.

IX-44. Through June 30, 1965, the Federal Government had spent a total of $7,445,609 of which $4,328,798 was spent for maintenance of the harbor and $3,116,811 was spent for new work at Erie. This does not include federal money spent on shore protection projects on Presque Isle Peninsula.

IX-45. In 1945 Congress authorized, subject to obtaining satisfactory assurances of local cooperation, the construction of a 23-feet deep approach channel to the westerly docks in Erie harbor. As of August 1, 1965 the project was dependent upon the City of Erie lowering a water intake line. As of that date the city had no plan to do that work.

IX-46. In 1959, the Federal Government spent approximately $145,000 to widen the turning basin in Erie harbor, and an additional $62,000 to maintain project depths and water clearance levels in the channel and the turning basin. In that year alone, Congress also appropriated $1,729,000 to deepen the channel depths and approaches to the port.

IX-47. As of June 30, 1965, in existence and 40 percent complete, was a project of the United States Army Corps of Engineers for the port of Erie which provided for:

a. An entrance channel, 29 feet deep, 500 feet wide lakeward of the entrance piers, and 300 feet wide between the piers;

b. A channel, 28 feet deep in soft material and 29 feet in hard material, from the inner end of the piers to the harbor, 300 feet wide and 2,100 feet long suitably widened at the inner end;

c. A basin, 28 feet deep in soft material and 29 feet in hard material, 1,500 feet wide, the eastern limit about 2,000 feet long and the western limit about 1,300 feet long with a tapering channel in the southeasterly corner leading to the ore dock, no dredging to be done within 50 feet of the harbor line;

d. A basin, 21 feet deep, extending westerly from the 28-feet area to a line perpendicular to the harbor line and 200 feet west of the city dock, the southerly limit of the basin being 50 feet from the harbor line;

e. An approach channel, 23 feet deep and 300 feet wide, from the 28-feet basin to and including a turning basin of the same depth 1,200 feet long by 1,000 feet wide at the westerly docks [But see Finding IX-46];

f. An additional harbor area 18 feet deep, of about 35 acres, extending westerly from the 21-feet area and northerly from the harbor line, to natural deep water in the bay.

g. Harbor entrance piers 360 to 450 feet apart, of timber-crib substructure with concrete superstructure, extending to the 14-feet contour in the lake, the north pier to have a length of about 3,248 feet and the south pier to have a length of about 2,215 feet, further extension lakeward of the north pier to be made when required to meet advance of said contour; and

h. A timber-crib breakwater 1,200 feet long (original length, 2,530 feet) with stone superstructure, extending from the inner end of the south pier toward the mainland, to maintain a closure at the eastern end of the harbor, and for plant growth and emergency protection work on the peninsula. The costs of said project were $4,880,518 (excluding costs and expenditures of $154,500 from contributed funds for maintenance). An estimated $3,761,500 for dredging was needed for the completion of the above project.

IX-48. As of August 1, 1965 local interests at Erie had no plans to deepen the berth alongside the Pennsylvania Railroad's grain elevator at Erie to the depths available in the federally-maintained portion of the harbor.

IX-49. The City of Erie is an important industrial center. Approximately 220 manufacturing establishments produce over 800 items, and employ over 40,000 people. There are two iron and steel producing plants which depend upon iron ore and stone shipped through the harbor.

An important product of western Pennsylvania is petroleum. This petroleum contains a paraffin base which places it in demand for use in lubricating delicate machinery, and is shipped through the port of Erie to various parts of the world. Erie is also a transfer point for coal destined for other Great Lakes ports, for stone principally for local consumption, and for iron ore for western Pennsylvania and Ohio.

IX-50. As part of a program to develop the port and port facilities of Erie, the City of Erie purchased the Duquesne Marine Terminal in 1957, at a cost of $505,000 and appropriated about $200,000 for its development between 1957 and 1965. In addition, in that period of time, the Commonwealth of Pennsylvania expended or made available over $4,194,600, of which over $525,000 has been used for dredging slips and approaches immediately adjacent to the terminal. The City of Erie and private interests have provided docks and channels within the bay, the aggregate costs of which were estimated to be in excess of $3,000,000 as of 1964. Substantial investments have been made to provide heavy lift equipment which can handle cargo of about 65 tons with a single lift and thus enable the port to handle heavy machinery and equipment. Other terminal and transfer facilities at the port of Erie are described in L.S. Ex. 621, pp.13-14.

IX-51. The number of vessels going to and from the Duquesne Terminal (excluding foreign vessels and vessels transporting iron, coal, stone, grain and other bulk materials) increased from 16 in 1959 to 48 in 1960. The number of ships calling at the Terminal and sailing via the Seaway was 66 in 1961 and 35 in 1964.

IX-52. In 1964, a total of 2,766 vessels arrived at Erie harbor carrying a total of 896,805 tons of cargo. Of this total number of vessels arriving, more than 90 percent had drafts of 15 feet or less. In the same year, 2,767 vessels departed this harbor carrying a total of 1,035,453 tons of

cargo, consisting chiefly of coal. Of the total number of vessels departing, more than 90 percent had drafts of 12 feet or less. The depths available in Erie harbor prior to the improvements made therein by the Corps of Engineers in 1959, were adequate to accommodate vessels being loaded with coal.

IX-53. In the years 1960-1964 a combined total of 228 overseas ships discharged and loaded cargo at Erie harbor. The maximum was 66 overseas ships in 1961 and the minimum was 35 ships in each of the years 1963 and 1964. Tonnage exported and imported at Erie was 27,463 in 1964.

IX-54. Vessel traffic at Erie harbor is now limited to vessels with drafts of 25.5 feet when the level of Lake Erie is at low water datum. Anticipated foreign commerce will be by vessels with an over-all length of about 460 feet and beam of about 63 feet, with cargo dead-weight capacity of about 8,200 tons at a fresh-water draft of 25.5 feet.

IX-55. In 1959, five different foreign ships were grounded in Erie harbor, and the Erie Port Commission had to free these vessels at its own expense.

IX-56. The purpose of the programs undertaken by the Federal, State and local Governments and private interests and the great investments made pursuant thereto is to utilize the potentials of Erie as a heavy lift port, and to allow the passage in the port of Erie of vessels loaded to maximum depths which use the St. Lawrence Seaway and connecting channels.

IX-57. The Corps of Engineers has estimated the increase of overseas traffic at Erie from 74,000 tons in 1965 to 224,000 tons 50 years from then, with a rapid rise in traffic anticipated in the early period to 1975. The use of deep-draft ocean ships and the development of the terminal facilities at Erie will be instrumental in the expansion of shipping services, port facilities and related services.

D. SHIPPING

1. *Navigation Seasons*

IX-58. Shipping activity continues in some areas of the Great Lakes on a 12-months basis. The United States Coast Guard, pursuant to the Coastwise Load Lines Act of 1935 is authorized to establish loadlines for vessels of U.S. registry of 150 gross tons or over, loading at, or proceeding to sea from, any port on the Great Lakes. The Coast Guard has delegated this authority to the American Bureau of Shipping, which agency actually establishes the loadlines for Great Lakes' vessels. In establishing these loadlines due consideration is given to, and differentials are made for the various types and character of vessels, the trades in which they are engaged, the age and condition of the vessel and its probable stability if damaged. The loadlines, or Plimsoll marks, are etched on the hull of the vessel and an owner or master causing a vessel to load to a draft in excess of its applicable loadline is subject to various sanctions. A loadline is normally assigned for each of the four draft navigation seasons.

The navigation season for the loadlines assigned by the Coast Guard is subdivided as follows:

| | |
|---|---|
| Midsummer | May 16 to September 15 |
| Summer | May 1-15 and September 16-30 |
| Intermediate | April 16-30 and October 1-31 |
| Winter | November 1 to April 15 |

The maximum or high lake levels during a given year usually occur within the five-months period, May through September. The minimum levels usually occur during the winter or closed season of navigation. The details of each lake's annual high and low cycles are set out in Findings III-11, III-14, III-17 and III-22.

IX-59. The Great Lakes lie in a sub-arctic climate and during the winter months, ranging from December to March, interlake shipping is largely suspended. Ocean

commerce between the Great Lakes and the high seas is suspended during the winter months. Car ferries operate on the lakes on a year-round basis, but they do not generally engage in interlake traffic.

2. *Great Lakes Fleet*

IX-60. The Corps of Engineers classifies vessels on the Great Lakes according to size as follows:

| | Length in Feet | Average Maximum Loadline Draft (feet) | Average Cargo Per Foot of Immersion (tons) |
|---|---|---|---|
| Class 1 ..... | Under 400 | 20.3 | 470 |
| Class 2 ..... | 400-499 | 20.4 | 610 |
| Class 3 ..... | 500-549 | 21.9 | 780 |
| Class 4 ..... | 550-599 | 22.4 | 920 |
| Class 5 ..... | 600-649 | 25.6 | 1160 |
| Class 6 ..... | 650-699 | 26.3 | 1270 |
| Class 7 ..... | 700 and over | 26.8 | 1370 |

| Class | Average Midsummer Loadline Draft | Average Summer Loadline Draft | Average Intermediate Loadline Draft | Average Winter Loadline Draft |
|---|---|---|---|---|
| 1 | 20.3 | .....not available..... | | |
| 2 | 20.4 | 20.2 | 19.7 | 19.0 |
| 3 | 21.9 | 21.4 | 20.6 | 19.7 |
| 4 | 22.4 | 21.9 | 21.0 | 20.0 |
| 5 | 25.6 | 25.0 | 24.0 | 22.9 |
| 6 | 26.3 | 25.7 | 24.7 | 23.6 |
| 7 | 26.8 | 26.2 | 25.2 | 24.0 |

At the present time, there is at least one vessel on the lakes with a maximum midsummer loadline of 27.35 feet.

IX-61. The United States and Canadian fleet of bulk carriers and self-unloaders on the Great Lakes in 1964 totaled 393 ships of which 116 vessels were in Classes 5, 6 and 7. It is estimated that by 1985 more than 75 percent of that fleet will be in these classes.

At the end of 1964 there were 507 vessels in the Great Lakes fleet, of which 292 were of United States registry and 215 were of Canadian registry. The number of Great Lakes vessels of Canadian registry in 1963 was 213.

Prior to World War II, the fleet was composed generally of vessels ranging from 450 to 600 feet in length with beams of 55 to 65 feet, maximum drafts of 21 or 22 feet, and carrying capacities of from 8,000 to 13,000 tons. Since 1949, however, many of the vessels that have been built range between 602 and 730 feet in length, from 67 to 75 feet in beam, with maximum drafts of from 24.5 to 27.35 feet. Maximum carrying capacities of these vessels range from 15,680 to 27,440 tons. Some of the new vessels are faster than some of the vessels built prior to World War II, averaging 16 to 18 mph. Some of the newer and larger vessels have up to 115 tons carrying capacity per inch of immersion.

The general trend is to build larger ships, with greater cargo capacity and greater speeds, primarily because of the operating efficiencies involved. It is probable that in the year 1985 most new vessels will be over 700 feet in length, and it is possible that a few will be 800 feet long with carrying capacities approaching 30,000 tons. In 1959, approximately 66 per cent of the U.S. Great Lakes bulk ore freighters and approximately 58 per cent of the Canadian Great Lakes bulk ore freighters were more than 40 years old. It is probable that all ships more than 60 years old will be replaced by 1985. Of the total Great Lakes bulk freighter fleet (U.S. and Canadian) approximately 60 per cent had been in service for more than 35 years in 1960. When these ships are replaced with the newer, larger vessels, lake levels will become even more significant, since average vessels of Classes 5, 6 and 7 are not able to load to their maximum capacity at all seasons when the lakes are at LWD.

IX-62. Recorded passages of deep draft ships engaged in both United States and Canadian commerce through the St. Marys Canal for the years 1950-1952 are as follows:

| | Draft | Trips | |
|---|---|---|---|
| 1950 | 24-26 feet | 719 | |
| 1951 | 24-26 feet | 915 | 1059 |
| | Over 26 feet | 144 | |
| 1952 | 24-26 feet | 854 | 1071 |
| | Over 26 feet | 217 | |

IX-63. The type and design of vessels operating on the Great Lakes have been largely determined by the operating conditions encountered thereon. The typical bulk freighter has its power plant located aft, and its wheel house and crew's quarters at the extreme forward end, thus providing a long, unobstructed cargo hold in the center of the vessel.

The overall length and beam of vessels transiting the St. Lawrence Seaway are limited by lock size to a maximum 730 feet and 75 feet, respectively. The draft of such vessels is limited by order of the Seaway Authority to 25.5 feet. In designing vessels to engage in commerce through the Seaway an architect can incorporate no presently known refinement to significantly add cargo carrying capacity in a vessel, and still remain within the physical limitations imposed by the seaway. Similarly, the length and beam of vessels transiting the St. Marys Falls Canal are limited by the size of the locks in that canal.

### 3. *Carriage of Bulk Commodities*

#### a. *In General*

IX-64. The majority of the commerce on the Great Lakes consists of bulk commodities such as iron ore, grain, limestone, coal and petroleum products. Net tons of these commodities shipped in the 1946-1964 period as reported by the Lake Carriers' Association are:

| | ORE | COAL | GRAIN | STONE | PETROLEUM | TOTAL |
|---|---|---|---|---|---|---|
| 1946 .... | 66,479,521 | 53,726,531 | 10,197,850 | 17,551,555 | | 147,955,457 |
| 1947 .... | 87,245,857 | 58,059,884 | 11,409,228 | 20,891,130 | | 177,606,099 |
| 1948 .... | 92,889,655 | 60,563,530 | 9,876,880 | 22,282,425 | | 185,612,490 |
| 1949 .... | 77,903,021 | 40,929,565 | 12,542,565 | 20,322,136 | | 151,697,287 |
| 1950 .... | 87,590,263 | 57,640,222 | 9,327,450 | 23,395,011 | | 177,952,946 |
| 1951 .... | 99,773,053 | 50,945,656 | 13,150,144 | 25,871,319 | (Figures | 189,740,172 |
| 1952 .... | 83,900,093 | 46,284,192 | 15,214,778 | 23,277,942 | not available | 168,677,005 |
| 1953 .... | 107,345,783 | 51,034,713 | 14,317,229 | 26,999,207 | prior to | 199,696,932 |
| 1954 .... | 68,088,941 | 46,367,167 | 11,866,241 | 24,975,440 | 1960) | 151,297,789 |
| 1955 .... | 99,870,369 | 53,378,385 | 10,787,786 | 29,722,293 | | 193,758,833 |
| 1956 .... | 89,819,440 | 57,374,685 | 14,319,650 | 30,753,412 | | 192,267,187 |
| 1957 .... | 97,752,273 | 56,779,772 | 11,234,810 | 30,439,375 | | 196,206,230 |
| 1958 .... | 61,361,977 | 44,949,995 | 12,625,829 | 22,496,239 | | 141,434,040 |
| 1959 .... | 57,624,819 | 47,228,449 | 13,609,452 | 26,159,660 | | 144,622,380 |
| 1960 .... | 81,841,819 | 46,701,235 | 14,134,959 | 27,179,458 | 14,295,077 | 184,152,548 |
| 1961 .... | 68,205,051 | 43,969,565 | 16,607,745 | 25,418,364 | 14,873,925 | 169,074,650 |
| 1962 .... | 70,655,570 | 46,184,285 | 15,918,950 | 24,730,834 | 13,892,289 | 171,382,468 |
| 1963 .... | 75,373,761 | 51,642,796 | 18,877,164 | 28,547,128 | 12,416,589 | 186,857,437 |
| 1964 .... | 87,489,166 | 52,142,742 | 21,637,255 | 30,771,477 | 10,789,936 | 202,830,576 |

IX-65. Terminal facilities at some Great Lakes ports provided by local interests include specialized equipment for transferring between ship and shore the bulk commodities which constitute the greater part of commerce on the Great Lakes. Storage facilities, including grain elevators, are available at a number of upper and lower Great Lakes ports.

IX-66. These bulk commodities are carried on vessels ranging from less than 400 feet to 730 feet in length, the largest of which have maximum permissible loadline drafts of up to 27 feet 4¼ inches. Some of these ships can load to maximum loadline capacity only when the lakes are at high levels. These ships have been built with sufficient capacity to take advantage of possible high lake stages and in reliance upon the channel deepening program substantially completed in July, 1962 and reflected on L.S. Ex. 721, and the current and projected deepening of the harbors.

IX-67. Historically, bulk cargo handling facilities in the Great Lakes have been developed primarily by private enterprise. In recent years, there has been an expansion of activity in port development by public enterprise with participation by the governments of states, counties, and cities.

Service complexes, including ship chandlers, stevedoring companies, steamship agencies, marine surveyors, freight forwarders, ship cleaners, ship repair craftsmen, customs brokers, and marine insurance agencies are available at Great Lakes ports. Many of these service industries have been expanded due to the advent of the St. Lawrence Seaway.

IX-68. The loading rate at modern docks for iron ore cargo is 3,000 to 5,000 tons per hour. The average stay in typical years of all vessels loading iron ore at the upper lake ports is about 6 hours, which includes time for all delays as well as loading time. The average stay of the vessels in port when unloading is about 9 hours. The aggregate capacity of all ore-unloading machines on the Great Lakes exceeds 50,000 tons per hour.

IX-69. Coal can be loaded on board Great Lakes freighters at the rate of about 3,000 tons per hour. The coal is unloaded either by the self-unloading equipment on the vessel or by traveling bridge cranes, which can unload from 150 to 650 tons per hour.

IX-70. In periods of low water declines of as little as one inch in water levels may have an adverse effect on cargo unloading operations at docks in some Lake Michigan ports and in such periods an increase of one inch might be beneficial. Self unloading vessels cannot get as close to shore at lower levels; consequently their booms do not reach as far inland. Shore based unloading equipment, such as traveling materials handling bridges, cannot function as efficiently if the vessel is not next to the dock wall.

Dock operators' costs for handling a vessel are relaively constant, while their charges are on a per ton basis. Consequently, if a vessel carries an additional 100 tons of cargo, the cost to the dock operator of physically handling this additional tonnage is negligible, and the cost per ton of handling the incremental cargo is distributed over the entire cargo. Therefore, if the dock operator unloads the same number of tons in a given season but from a greater number of ships, due to reduced loading per ship caused by a lowering of lake levels, the dock operator's costs are increased. These costs, in turn, may be passed on to the shippers, and the cost of lake transportation may thereby rise.

IX-71. The bulk freighters on the lakes generally engage in transporting iron ore and grain. The self-unloading vessels are generally engaged in transporting stone and coal. With their built-in conveyor systems, self-unloaders can unload at docks where no dockside unloading facilities are available. The expansion in United States self-unloader vessels since 1927 has increased the number of such ships from 21 with 155,300 gross tons carrying capacity to at least 53 vessels with per trip capacity of 523,800 gross tons during 1964.

b. *Iron Ore*

IX-72. The most significant part of the movement of iron ore on the Great Lakes originates from mines in Minnesota and is downbound from ports on Lake Superior. Such movement for the year 1958 before the opening of the Seaway, is graphically illustrated on L.S. Ex. 378B. Iron ore is often the principal item of commerce on the Great Lakes. Of all the ports on the Great Lakes, Lake Superior ports ship more ore than any others.

Of the 104,970,000 tons of iron ore shipped from harbors in the United States in 1957, largely to receiving ports in the United States, more than 80,000,000 tons were shipped from the Lake Superior district.

The Corps of Engineers estimated in 1958 that average annual shipments of foreign iron ore to United States Great Lakes ports through the St. Lawrence Seaway during the next 50 years would be about 41,000,000 tons. This traffic will be largely Labrador ore shipped from Seven Islands on the Gulf of the St. Lawrence.

c. *Coal and Coke*

IX-73. A large portion of the total movement of coal and coke is upbound through the Great Lakes, originating primarily from Lake Erie and Lake Michigan ports. The movement of coal in 1958 is shown on L.S. Ex. 378H.

d. *Grain*

IX-74. The movement of grain on the Great Lakes is generally downbound with large grain elevators available at a number of both upper and lower lake ports. The movement of grain in 1958 is shown on L.S. Exs. 378, 378A, 378C, 378D and 378G.

Bulk grain handlers operate public terminal warehouses for the storing and handling of grain and buy and sell grain and grain byproducts in domestic and foreign commerce.

Exported grain from Duluth-Superior is grown in the States of Minnesota, North and South Dakota, Montana, Iowa, and Nebraska. The grain is shipped primarily to ports

in Belgium, the Netherlands, the United Kingdom, Germany and Italy. Improvements have been made to dock loading facilities because grain quality is standardized by the United States Department of Agriculture; therefore, all ocean ports are able to offer the same quality grain for shipment. Consequently, port facilities and loading time are important to the shipper concerned with transportation and loading costs. Prior to the opening of the St. Lawrence Seaway, the direct shipment of grain for export from Duluth-Superior was not feasible. The grain was shipped by lake vessels to Lake Erie or Lake Ontario ports and then transshipped by canaller (14 feet draft vessels used on the St. Lawrence River prior to the opening of the St. Lawrence Seaway) to Montreal or by rail or barge line to United States ports on the Atlantic for reloading aboard ocean vessels.

Since the opening of the St. Lawrence Seaway, the port of Duluth-Superior has been loading grain for direct export shipment, thereby eliminating the added expense of handling costs in transshipment. The amount of grain that a vessel can load from Duluth-Superior depends upon the water levels in the connecting channels, and the draft limitations in the St. Lawrence Seaway and Welland Canal. If an ocean vessel can load to full capacity at Duluth-Superior, it can proceed directly to its foreign destination without stopping at an ocean port to take on top-off cargo to complete its loading. Top-off cargo refers to additional grain loaded on an ocean vessel to put her down to her normal draft. If the water levels in the connecting channels do not allow the ocean vessels to load to the maximum draft available in the Seaway, or if the ocean vessels can load to a greater draft than that permitted in the Seaway, then such vessels will stop at an ocean port to take on additional cargo. The ability to ship directly overseas without the necessity of adding top-off cargo relieves the shipper of the delay in taking on additional cargo, as well as the additional cost involved in handling and loading the vessel at the ocean port.

During 1959, the St. Lawrence Seaway's first operating season, 222 of the ocean vessels which called at the port of Duluth-Superior and 37 of the lake vessels carried a total of 86,390,000 bushels of grain and 16,260 tons of grain by-products for direct export or for transshipment at Canadian ports as top-off cargo on the larger ocean vessels unable to load to their full drafts because of the draft limitations of the St. Lawrence Seaway. This compares with 650,000 bushels shipped in direct export during 1958 on the 12 smaller ocean vessels that were able to navigate the 14 feet depth available in the St. Lawrence River prior to the construction of the St. Lawrence Seaway.

e. *Stone*

IX-75. The movement of stone commerce on the Great Lakes is generally downbound. Among the major stone shipping centers on the Great Lakes are Calcite, Port Inland, Drummond Island and Alpena, all of which are located in the upper parts of Lakes Michigan and Huron. The major stone receiving ports are in the vicinity of Detroit, Cleveland, Buffalo and Chicago. The movement of stone on the Great Lakes in 1958 is shown on L. S. Ex. 378E.

f. *Petroleum Products*

IX-76. Petroleum products include gasoline, kerosene, fuel oil and crude oil, all of which are shipped extensively over the Great Lakes from pipeline terminals such as Indiana Harbor, Indiana, and Toledo, Ohio.

4. *Controlling Levels*

IX-77. The Lake Carriers Association issues to vessel owners its recommendations on safe vessel drafts for the connecting channels. The owners in turn inform their operating personnel. During the 1958 navigation season, the Lake Carriers Association issued 17 notices to vessel owners recommending changes in safe drafts in the connecting channels. Of these 17 circulars, 13 recommended draft

changes of only one inch. During 1959, the Lake Carriers Association issued 72 recommendations relative to vessel drafts in the Great Lakes connecting channels. Of these 72 recommendations, 11 recommended draft changes of only one inch.

IX-78. Beginning in March 1963 the U.S. Lake Survey has reported in its semi-monthly bulletins during the navigation season the water depths currently available in the connecting channels, and future projected water depths in the channels.

IX-79. In determining the effect on navigation of any lowering of lake levels resulting from increased diversion at Chicago appropriate consideration must be given to several factors including the fluctuation of lake levels resulting from hydrologic phenomena, depths provided in channels and harbors, and the characteristics of the fleet.

IX-80. When the controlling lake level is below LWD during the navigation season safe draft in the connecting channels, as defined in Finding IX-1, is reduced, and, conversely, when the controlling lake level is above LWD during the navigation season the safe draft is increased.

IX-81. The monthly mean elevations of the surfaces of the lakes are the normal bases of studies to determine which lake is controlling with respect to depth available in the connecting channels. The 35-years period, 1922-1956, is considered by the Corps of Engineers to be representative of long-range variations in the levels of the Great Lakes because it includes both high and low stages. The levels experienced in this 35-years period, 1922-1956, are considered by the Corps of Engineers to be representative of the levels which will prevail in the future.

IX-82. Interlake and intralake shipping utilizes harbors which, in some instances, have lesser depths than those available in the connecting channels. For traffic such as this, the restriction on loading of vessels may be determined by the controlling depths in the harbors and not by

the depth in connecting channels. Some of the vessels engaged in this trade are required to load at reduced drafts because of limited depths available in these harbors.

IX-83. Dockside depths at many Great Lakes harbor facilities are substantially less than the depths available in the federally-maintained projects on which they are situated.

5. *Reduction in Carrying Capacity Which Would Result from Changed Diversions*

a. *Corps of Engineers Study*

IX-84. In 1957, the Corps of Engineers made an estimate of the reduction in the average annual carrying capacity over the next 50 years of the U.S. Great Lakes bulk cargo fleet if the diversion at Chicago were to be permanently increased by 1,000 cfs. The Corps estimated that the total U.S. Great Lakes bulk cargo commerce in 1985 which would be affected by such an increased diversion is 193,800,000 tons. This estimate is for United States commerce only, excluding coal commerce to Lake Superior harbors, coal commerce in Canadian vessels to Canadian harbors and commerce in petroleum carried in small vessels. These latter categories were estimated to amount to 46,200,000 tons. The Corps believed that such commerce would not be affected by the lowering due to such an additional Chicago diversion since at the time of its study this commerce did not fully utilize depths available in the Lake Erie or Superior harbors involved. However, in another study the Corps stated that as a result of the increasing competition by other sources of heat and energy, the Corps believed that coal would probably be transported more and more in the deeper draft vessels, because of the economies involved. The Corps also excluded St. Lawrence Seaway commerce.

IX-85. The Corps divided the bulk commerce affected by a lowering of levels due to the Chicago diversion into the following categories:

Category I—Commerce in iron ore, stone and grain utilizing the connecting channels and harbors deepened to provide a safe draft of 25.5 feet. Losses were computed whenever the levels would not permit loading to maximum permissible draft. Losses were computed for 1 inch reduction in draft when Lakes Michigan-Huron were deemed to be controlling and for a 5/8 inch reduction in draft when Lake Erie was deemed to be controlling.

In this category, the Corps assumed that vessels of Classes 6 and 7 would be used. For the mid-summer season the Class 7 vessels in existence at the time of the Corps' study had average maximum loadline drafts of 26.8 feet. A vessel with a draft of 26.8 feet draws 1.3 feet more than the designed channel safe draft of 25.5 feet. Therefore, the lake elevation which will affect the carrying capacity of the vessel is any elevation which is less than 1.3 feet above low water datum. For vessels transiting channels influenced by Lakes Michigan-Huron, any time the safe draft is below 26.8 feet, such vessels are subject to loss in carrying capacity. For each additional 1,000 cfs diverted by Chicago, the safe draft of such channel, to accommodate the Class 7 vessels sailing at average mid-summer loadline would have to be .08 feet higher. Therefore anytime the levels are less than 1.38 feet above LWD, vessels transiting the connecting channels influenced by Lakes Michigan-Huron will be subject to reduction in their carrying capacity.

Category II—Commerce in iron ore, limestone, coal and petroleum products for which harbors on Lake Erie or portions of such harbors with depths less than connecting channel depths would be controlling. For this category, it was estimated that bulk carriers of Classes 4, 5 and 6 and tankers of Classes 1 and 2 would be used and would be required to load 5/8 inch less than maximum permissible draft whenever the level of Lake Erie was below an elevation of two feet above its low water datum plane. Lake Erie was below such level 57 per cent of the time of the eight months navigation season in the period 1922-1956.

Category III—Intralake and interlake commerce involving movement of iron ore, limestone, coal and petroleum products on Lakes Michigan and Huron only. It was estimated that self-unloaders and bulk carriers of Class 5 and tankers of Classes 1 and 2 would be used for this traffic and would be required to load 1 inch less than maximum permissible draft whenever the level of the lakes was below an elevation of 2 feet above their low water datum plane. In the period 1922-1956, the lakes were below this level 70 per cent of the eight months navigation season.

Category IV—Commerce in coal and petroleum products originating on Lake Erie and destined to shallower draft harbors on Lakes Michigan-Huron, or traffic from such harbors to harbors on Lake Erie. It was estimated that self-unloaders and bulk carriers of Classes 2, 3 and 4 and tankers of Classes 1 and 2 would be used and that such ships would be required to load 1 inch less than maximum permissible draft when the levels of Lakes Michigan-Huron were below an elevation of 2 feet above their low water datum planes and were controlling, and $\frac{5}{8}$ inch less than maximum permissible draft when the level of Lake Erie was below an elevation of 2 feet above its low water datum plane and was controlling. The same percentages used in Categories II and III respectively were used here.

Therefore, the Corps' estimate in 1957, based on the future United States Great Lakes commerce and fleet as of 1985, the general 1957 pattern of traffic on the Great Lakes, expected waterway improvements in the connecting channels and harbors, and the natural variations in levels of the Great Lakes, was that the average annual carrying capacity of the United States Great Lakes bulk cargo fleet would be reduced by 300,000 tons, in the following categories:

| | | |
|---|---|---|
| I | 26,000 tons | (based on 5 mos. season) |
| II | 100,000 tons | (based on 8 mos. season) |
| III | 101,000 tons | (based on 8 mos. season) |
| IV | 71,000 tons | (based on 8 mos. season) |
| (say) | 300,000 tons | |

IX-86. The Corps raised this estimate by 10 per cent in 1959 because of more recent data available to it, to find that the average tonnage loss due to an additional diversion of 1,000 cfs would amount to 330,000 tons. The Corps also found that if the diversion were to be permanently increased by 1,800 cfs, the average estimated reduction in carrying capacity of the Great Lakes fleet would be 600,000 tons.

IX-87. The Corps assumed that the minimum level of 244 feet could be maintained on Lake Ontario during the navigation season even if there were a permanent increase in the Chicago diversion of 1,000 cfs.

IX-88. The Corps also assumed that there would be no loss in tonnage on the St. Lawrence River because of the ability to regulate the levels of Lake Ontario, which levels usually control levels in the upper St. Lawrence River.

IX-89. The Corps considered in 1957 that the monetary value of the economic loss in 1985 attributable to a permanently increased diversion of 1,000 cfs could reasonably be measured by the average cost of transportation of bulk commerce on the Great Lakes which it had then determined to be $0.80 per ton. At this average rate, based on a reduction in carrying capacity of 300,000 tons, the resulting annual economic loss was estimated to be $240,000 per 1,000 cfs of additional diversion.

IX-90. In 1959, the Corps reviewed the $0.80 per ton figure in the light of more recent information on costs of transportation as developed in connection with its Great Lakes harbor studies. These studies had shown that the actual carriers' cost per ton varied from $0.34 for short haul coal trips, to $1.80 per ton for grain from Duluth to Buffalo. The Corps estimated that the weighted average operating cost per ton was $1.10. Therefore, the annual economic loss in 1985 on 330,000 tons of commerce due to a permanent additional diversion of 1,000 cfs was estimated by the Corps to be $363,000; on 600,000 tons it was estimated by the Corps to be $660,000.

IX-91. In making these estimates, the Corps assumed that there were some times when there would be no loss due to an increased diversion at Chicago to commerce between ports in Lake Superior and ports in Lakes Michigan-Huron and Erie. This was due to the fact that the Corps believed that even if the diversion at Chicago were permanently increased by 1,000 cfs there would be times when the elevation of Lake Superior would be lower in relation to its LWD than would the elevation of Lakes Michigan-Huron and Erie, and thus restrict by at least one inch the depths in the connecting channels controlled by Lake Superior levels and Lake Superior harbors.

b. *General Stratton's Study*

IX-92. The Lake States by witness Stratton presented evidence to show that there were other methods than those the Corps used which could be utilized to arrive at an estimate of tonnage in 1985, and also to estimate the amount of tonnage that will be shut-out, i.e., cargo that cannot be carried because of a loss in vessel capacity due to a reduction in draft attributable to the Chicago diversion. In Stratton's forecast, several types of movements excluded by the Corps were included. These were:

(1) Iron ore shipped from eastern Canada to U.S.;

(2) receipts of foreign iron ore at U.S. ports;

(3) iron ore from Canadian lake ports to Canadian lake ports;

(4) coal traffic on Canadian vessels to Canadian ports;

(5) coal traffic moving upbound to Lake Superior ports on iron ore vessels;

(6) grain traffic between Canadian ports;

(7) grain movements from U.S. and Canadian lake ports directly overseas;

(8) petroleum traffic between Canadian ports;

(9) receipts and shipments of petroleum products at both U.S. and Canadian ports in small vessels. (No shut-out tonnage was calculated for this category.)

IX-93. Stratton's study, like those of the Corps, did not include any shut-out tonnage estimates for ships having deeper drafts than 26.8 feet.

Due to the inclusion of the categories referred to in Finding IX-92, plus higher estimates on the traffic studied by the Corps in Senate Document 28, L.S.Ex. 19H, based principally on later reports of the Corps, the 1985 commerce in bulk commodities on the lakes was estimated at 346,420,000 tons by Stratton.

IX-94. Stratton's method for computing shut-out tonnage involved the establishment of centroids for each commodity movement from all harbors in the lake of origination to all harbors in the lake of destination.

The centroid is the point at which all of the shipments or receipts in a commodity movement may be considered to be located. The location of the centroid is determined by computing for each lake, commodity and anticipated harbor depth the total ton-miles involved in a movement from the lake inlet or outlet to each harbor involved, or from harbor to harbor on the same lake for intralake commerce, and dividing the ton-miles so determined by the total tonnage under consideration.

The result is the distance of the centroid from the lake inlet or outlet, which is the weighted average distance of haul on the lake for which the computation is made.

When this was done, the size and composition of the 1985 operating Great Lakes fleet was determined.

The establishment of vessel utilization in 1985 involved the determination of the number of trips the vessels engaged in each particular commodity will be able to make each year, the monthly distribution of such trips, and the average carrying capacity of each vessel on each trip, as

controlled by the then prevailing lake level and the appropriate seasonal loadline.

In order to account for natural fluctuations, an analysis of the frequency with which each lake was at any particular level or stage for each month of the navigation season for the 35 years period, 1922-1956, was made. From this study, it was found that in a midsummer month, if an additional 1,000 cfs were permanently diverted at Chicago, the levels of Lakes Michigan-Huron would be below the point where Class 7 vessels could load to maximum capacity 34.7 percent of the time.

Similar calculations were made for the other lakes, except for Lake Superior since Stratton's conclusion was that Lake Superior levels would never control ship loading.

From these calculations it was possible to determine the average loss of vessel draft, should the diversion be permanently increased by 1,000 cfs, on each lake for the proportion of the time that the lake level was such that there would be a loss of capacity.

IX-95. The basic formula used by Stratton for computing the loss due to shut-out for a typical single vessel trip is $L = F \times D \times TPF$ where

$L$ = loss due to shut-out of tonnage expressed in short tons,

$F$ = frequency (expressed in percentage of time) that the vessel's carrying capacity would be affected by a change in diversion.

$D$ = change in lake levels expressed in feet or fractions of feet resulting from a specific diversion,

$TPF$ = tons per foot, which is the carrying capacity of the vessel in short tons per foot of immersion.

To establish total loss of commerce in one commodity, a further formula was used:

$L' = L \times VT$, where

$L'$ = total loss of tonnage in a given centroid to centroid movement for a given month.

$L = F \times D \times TPF$, and
VT = vessel trips.

IX-96. Using these formulae, the following losses in each commodity were determined by Stratton for an additional diversion of 1,000 cfs at Chicago:

| | *Tons* |
|---|---|
| Iron Ore | 104,000 |
| Limestone | 89,000 |
| Coal | 150,000 |
| Grain | 14,000 |
| Petroleum | 10,000 |
| Total | 367,000 |

For an additional Chicago diversion of 3,000 cfs, the losses attributable thereto are as follows:

| | *Tons* |
|---|---|
| Iron Ore | 386,000 |
| Limestone | 330,000 |
| Coal | 557,000 |
| Grain | 52,000 |
| Petroleum | 37,000 |
| Total | 1,362,000 |

For an additional Chicago diversion of 5,000 cfs, the losses attributable thereto are as follows:

| | *Tons* |
|---|---|
| Iron Ore | 802,000 |
| Limestone | 686,000 |
| Coal | 1,157,000 |
| Grain | (108,000) |
| Petroleum | 77,000 |
| Total | 2,830,000 |

For a reduction of 1,600 cfs in the present Chicago diversion or a return of 1,600 cfs of Chicago diversion to the lake, the gains attributable thereto by Stratton are as follows:

| | *Tons* |
|---|---|
| Iron Ore | 113,000 |
| Limestone | 97,000 |
| Coal | 164,000 |
| Grain | 15,000 |
| Petroleum | 12,000 |
| Total | 401,000 |

IX-97. At 1959 charter rates, the value of shut-out tonnage was computed by Stratton as follows:

| | 1,000 cfs Additional Diversion | 3,000 cfs Additional Diversion | 5,000 cfs Additional Diversion | 1,600 cfs Reduced Diversion |
|---|---|---|---|---|
| Iron Ore | $196,000 | $ 727,000 | $1,511,000 | $214,000 |
| Limestone | 102,000 | 378,000 | 786,000 | 111,000 |
| Coal | 169,000 | 627,000 | 1,303,000 | 184,000 |
| Grain | 20,000 | 74,000 | 154,000 | 22,000 |
| Petroleum | 9,000 | 33,000 | 69,000 | 10,000 |
| | $496,000 | $1,839,000 | $3,823,000 | $541,000 |

IX-98. Following are tabulations prepared by Stratton indicating the value of shut-out tonnage in 1985, without assuming any general inflation:

| | 1,000 cfs Additional Diversion | 3,000 cfs Additional Diversion | 5,000 cfs Additional Diversion | 1,600 cfs Reduced Diversion |
|---|---|---|---|---|
| Iron | $362,000 | $1,343,000 | $2,791,000 | $395,000 |
| Limestone | 134,000 | 497,000 | 1,033,000 | 146,000 |
| Coal | 203,000 | 753,000 | 1,565,000 | 221,000 |
| Grain | 26,000 | 96,000 | 200,000 | 28,000 |
| Petroleum | 11,000 | 41,000 | 85,000 | 12,000 |
| | $736,000 | $2,730,000 | $5,674,000 | $802,000 |

*c. Considerations Applicable to Both Studies*

IX-99. In both Stratton's study and those of the Corps of Engineers the estimate of loss which would be due to a permanent increase of 1,000 cfs in the Chicago diversion in 1985 is, in effect, an average of losses which would occur over a period of years, with the estimated 1985 commerce and fleet, and assuming the same frequency of controlling lake levels during such period as occurred during the years 1922 through 1956. In a given year of low levels of the lakes losses may be substantially in excess of those predicted.

IX-100. The differences in dollar value at 1959 rates of the losses in tonnage attributable to an additional 1,000 cfs diversion are explained by the fact that the Corps used carriers' cost figures while General Stratton used charter rates.

IX-101. It appears that neither the computations of Stratton nor those of the Corps took into account the facts stated in Findings IX-102 through IX-108.

6. *Manner and Extent of Loading Vessels*

IX-102. It is not uncommon for cargo vessels on the Great Lakes to load to drafts in excess of those legally prescribed.

IX-103. On many occasions the operators of Great Lakes vessels fail to utilize all of the water depth available to them.

IX-104. On many occasions Great Lakes vessels carry up to 400 tons less cargo when loaded to a given load line than they do on other trips when loaded to the same load line.

IX-105. On many occasions Great Lakes vessels cannot utilize all available water depth due to lack of sufficient cargo to be carried on the vessel.

IX-106. Some Great Lakes vessel operators advise the captains of their vessels concerning available safe depths of water in harbors. Sometimes these recommendations fail to take advantage of all available water.

IX-107. Great Lakes vessel operators sometimes disagree as to the safe draft to which their respective vessels can load when calling at given Great Lakes ports.

IX-108. From the evidence it appears that the demand for shipping space has never been sufficient to warrant the utilization of all Great Lakes cargo vessels.

7. *Significance of Shipping Rates*

IX-109. There is a direct and significant correlation between the cost of operating Great Lakes cargo vessels, such as the crews' wages and fuel expense, and the shipping rates charged for commodities hauled on such vessels.

IX-110. There is no significant correlation between available water depths and the shipping rates charged by owners of Great Lakes vessels.

IX-111. The freight rates charged by operators of Great Lakes bulk cargo vessels for hauling iron ore from upper lake ports to lower lake ports in the years 1938 to 1958 are reflected in Table 25, L. S. Ex. 391C.

8. *Coast Guard Control of St. Marys River Navigation*

IX-112. The United States Coast Guard Captain of the Port at Sault Ste. Marie, Michigan, is responsible for enforcing the navigation and anchorage regulations in the St. Marys River, and for supervision of the navigation of the St. Marys River. His jurisdiction extends from Point Iroquois to Point Detour, exclusive of the St. Marys Falls Canal which is under the jurisdiction of the Corps of Engineers.

IX-113. The navigation season for traffic between Lake Superior and the other lakes, begins with the opening of the locks at Sault Ste. Marie for navigation, and ends with the closing of these locks to navigation.

IX-114. The Coast Guard requires that the master of each vessel transiting the St. Marys River report the draft of his vessel. The Coast Guard does not otherwise check the draft of the vessels. The lockmaster of the St. Marys Falls Canal, an employee of the Corps of Engineers, visually notes the drafts of the vessels passing through the canal.

IX-115. The U. S. Coast Guard personnel at Sault Ste. Marie, Michigan, maintains logs reflecting the name of each vessel transiting the St. Marys River, the draft of each vessel transiting the river, as reported by the vessel's master, the hourly readings of water level gages at four lookout stations in the river downstream of the St. Marys Falls Canal, and the time each vessel transiting the river passes these four lookout stations.

IX-116. Coast Guard Lookout Stations in the St. Marys River, their numbers and locations are as follows:

Lookout Station Number One, situated on Neebish Island at Johnson's Point.

Lookout Station Number Two, situated on Neebish Island in the Middle Neebish Course. (This station was not manned in 1961.)

Lookout Station Number Three, located off Mission Point in the Little Rapids Cut.

Lookout Station Number Four, situated at the north end of the Rock Cut in the West Neebish Channel.

## X. Hydroelectric Power Generation on the Niagara and St. Lawrence Rivers

### A. General Considerations

X-1. In evaluating the effect of change of flow on hydroelectric production, it is necessary to consider energy, or work done, and power, or the rate of doing work. A watt is the expression of electrical power, and 746 watts (or 0.746 kilowatts) is equal to one horsepower. One horsepower is 550 foot pounds per second. One megawatt (mw) equals 1,000 kilowatts, or 1,000,000 watts.

X-2. At any water power site using fresh water, which weighs approximately 62.4 lbs. per cubic foot, the water used for power generation drops through the vertical distance available, and the force produced by gravity acting on that mass of water operates through a vertical distance, producing energy.

X-3. The economy factor at a given hydroelectric plant is a figure, based upon the vertical drop (or head) available and the plant efficiency, which expresses the relationship between power in kilowatts (kw) and flow through the turbines in cubic feet per second (cfs). The power produced at the generators by one cubic foot of water per second can be computed by the basic formula:

$$\frac{kw}{cfs} = \frac{h \times e \times e'}{11.8}$$

where: $h$ = net head
$e$ = turbine efficiency
$e'$ = generator efficiency

"Net head" is the gross head of a hydroelectric plant or the total fall of water from the water intake of the hydroelectric plant to its final water discharge outlet, minus the head loss in all water passages other than those which are integral parts of the turbine. Such head loss is produced because energy is taken from the water by friction and turbulence as the water flows through water passages such as tunnels, canals and pipes. If "e" is defined to include both turbine and conduit efficiency, then "h" would represent gross head.

X-4. The power output of generators is produced at a comparatively low electrical pressure, which is commonly called voltage, and before the power can be sent from the station to the load, its voltage must be increased. The increase in voltage is accomplished in transformers. In instances where power is sold at the high voltage side of the transformers, the formula for the economy factor is

$\frac{kw}{cfs} = \frac{h \times e \times e' \times e''}{11.8}$, where "e''" is the efficiency of the transformers.

X-5. The instantaneous power change at the generators by a change of flow through the turbines at a given hydroelectric plant assuming that there is sufficient turbine and generator capacity to utilize the change in flow, and that there is no change in head, may be computed by the basic formula:

$$kw = \frac{Q \times h \times e \times e'}{11.8}$$

where kw equals the change in power at the generators due to a change in flow and Q equals the change in flow in cfs. The product of this formula, multiplied by the time in hours during which the change is effective, gives the energy change in kilowatt hours (kwh).

X-6. An electric system must be capable of supplying on a dependable basis the energy (kwh) demand placed upon it, and must have the capacity for dependably supplying such energy at the time and rate (kw) required by the system.

X-7. The true measure of dependable capacity of a hydroelectric plant is its ability to render unnecessary the construction of equivalent dependable capacity elsewhere in the system.

X-8. The true measure of the economic value of power and energy produced at a hydroelectric plant is the cost of capacity and energy supplied at an alternative steam plant that would need to be constructed in the system under consideration if the hydroelectric plant were not built.

X-9. It is common practice to evaluate power and energy from a hydroelectric plant on the basis of costs of the most economical alternative source of supply, which, in the case of upstate New York, is from coal-fired steam plants.

X-10. In the application of the practice described in the preceding Finding, capacity is properly evaluated at the amount of the annual charges against the capital cost of the steam plant. Firm energy is properly evaluated at the amount of the savings in fuel that would be realized by operation of the hydroelectric plant rather than a steam plant, plus the incremental cost, if any, of operating the steam plant to produce additional required energy. Secondary energy is properly evaluated at the cost of fuel only from the alternative steam plant.

X-11. Primary energy is not defined in either the St. Lawrence or Niagara contracts hereinafter referred to in Finding X-104. It is defined in the Glossary of Important Power and Rate Terms, prepared under the supervision of the Federal Power Commission, as hydroelectric energy which is available from continuous power. Continuous power is defined in the same Glossary as hydroelectric power available from a plant on a continuous basis under the most adverse hydraulic conditions contemplated.

X-12. Economy energy is not defined or mentioned in the St. Lawrence or Niagara contracts hereinafter referred to in Finding X-104. Economy energy is available under pooling arrangements of New York State utilities, wherein it is sometimes defined as electric energy purchased and supplied on an hourly basis during periods (1) when a buyer desires, for economy purposes, to restrict the generation of energy from its own operating generating capacity, and/or to restrict the purchase of energy under firm contract from others, and to purchase instead the equivalent quantity of energy under a pooling arrangement, and (2) when a buyer's value for energy exceeds the seller's cost for energy.

X-13. Fuel costs at modern steam-electric generating plants in upstate New York are in the order of 3.1 mills per kwh. Steam-electric plant operating costs other than fuel are in the area of 0.8 mills per kwh.

X-14. Capital costs of constructing a modern steam electric generating plant in upstate New York are approximately $160 per kw of name plate capacity and annual fixed charges are 12.8 per cent of capital costs, or $20.48 per name plate kw. Due to reserve requirements for unit outages in steam electric generating plants, 1.13 kw of steam electric name plate capacity is required to yield one kw of dependable generating capacity, so that the annual fixed costs per kw of dependable capacity at such plant would be $23.14 per dependable kw.

X-15. Capital costs of constructing small increments of generating capacity in modern steam electric generating plants in upstate New York, such as the increment between a 500 mw unit and a 565 mw unit, are in the area of $125 per kw of name plate capacity.

X-16. The capacity of a plant, regardless of where the plant operates on the load curve, has the same economic value.

X-17. The term "load factor", as used in the electric power industry, is defined as the ratio of the average load over a designated period to the peak load occurring in that period.

X-18. The instructions for completion of Schedule 16 of Federal Power Commission Form 12 state: "The dependable capacity of system hydro plants, as defined for Schedule 16, relates to the capacity which under the most adverse flow conditions of record can be relied upon to carry system load, provide dependable reserve capacity, and meet firm power obligations, taking into account seasonal variations and other characteristics of the load to be supplied and of the firm power obligations. Some systems may be able to utilize off-peak energy from other systems so as to increase the dependable capacity of the reporting system hydro plants."

X-19. The dependable capacity of a hydroelectric project may be limited (a) by what would be saleable in the market area, or (b) by the machine capability of the

project, i.e. the maximum instantaneous output of the machinery installed if it had all the water available that the machines could use at full gate, and at the minimum head associated with flows accompanying such water availability; or (c) by the instantaneous capability of the plant with the minimum dependable flow available to it during the critical load period and the minimum head associated with such minimum dependable flow, taking into account all legal, physical and economic factors affecting or determining such minimum flow and head; or (d) the availability of dependable energy to meet system requirements accompanying a given capacity.

The critical load period described under (c) is the period when the demand placed upon the plant most nearly approaches the capability of the plant at the loads, flows and heads which may be anticipated during such period, taking into account the possible variation, with respect to time, in dependable capacity of other plants in the system. It is not necessarily the period of the annual peak load.

X-20. The dependable capacity of a system is usually measured by the peak demand rate in kilowatts which it can supply, provided the system also dependably supplies all demands other than the peak. There is, however, no requirement that the system be capable of operating at its peak demand rate for 100 percent of the time in order for its dependable capacity to equal its peak demand. Rather, since rate of demand fluctuates both on an hourly and a seasonal basis in a generally predictable manner, a system's dependable capacity is at least equal to its peak demand rate so long as it can dependably meet all fluctuating demands for energy at peak and non-peak rates as they occur. In order to do this, the system must have available to it dependable energy, in number of kilowatt hours, equal to the load factor during the critical load period times the required dependable capacity in kilowatts times the number of hours in such period.

X-21. In some circumstances a hydroelectric plant must be capable of generating energy during non-peak load

hours, if the full peak load hour capability of the plant is to be useful in the system as dependable capacity. As an illustration, one may assume an hypothetical plant which could generate at a rate of 1,000 mw during one peak hour, but could achieve this only by utilization of stored water in addition to current flow in the river during that hour. If the plant were part of a system having a 5,500 mw peak hour demand, only 4,500 mw of other generating capacity would be needed to meet the peak hour demand. However, if the system demand during non-peak hours were 5,000 mw, the hydroelectric plant could be considered to have 1,000 mw of dependable capacity only if it could also be depended upon to furnish energy at the rate of at least 500 mw during such non-peak hours, so that it, together with such 4,500 mw of other dependable generating capacity in the system, would be sufficient to meet non-peak hour demand. If, because of lack of sufficient dependable flows, the hydroelectric plant could not supply dependable energy at the rate of 500 mw during the off-peak hours while storing enough water to supply energy at the rate of 1,000 mw on the peak hour, the remainder of the system would have to contain more than 4,500 mw of dependable generating capacity. In this event, the dependable capacity of the hydroelectric plant would be no greater than the difference between the peak load of 5,500 mw and the other dependable capacity needed in the system, and would thus be some figure less than 1,000 mw.

In other circumstances, a hydroelectric plant need not be capable of generating energy during non-peak hours for the full peak load hour capability of the plant to be useful in the system as dependable capacity. Thus, in the foregoing illustration, if the load of the hypothetical system during off-peak hours is 4,500 mw, then the 1,000 mw hydro plant would provide 1,000 mw of dependable capacity during the peak hour and would not be required to generate at all during off-peak hours. To the extent that there is water available for generating during off-peak hours, the resulting energy merely results in a saving of fuel that would otherwise be used by other plants in the system.

X-22. In determining the dependable capacity of a hydroelectric plant and the dollar values of changes in flows available to it, it is necessary to consider the load curve of the system into which the plant feeds its power. A determination of dependable capacity involves consideration of the pattern of the load curve, magnitude of the load, generation and position on the load curve of other plants in the system, capacity and efficiency of the machinery in the power plant, head, magnitude and variability of the water supply, and storage capability.

X-23. In the delivery of power and energy, a differentiation must be made between contractual and operational requirements for such deliveries.

A project may have contracts with power purchasers whereby energy is required to be delivered at a specified load factor, i.e., that a given amount of energy must be delivered with a given amount of capacity. However, the project may be interconnected with other plants in its marketing area, so that they can be operationally coordinated and used simultaneously to serve the combined load of all of the plants in the most economical manner. In such cases power and energy can be purchased or exchanged by the plants involved, thus making it unnecessary to operate a given plant in the system at its contractual load factor.

X-24. There is a certain maximum discharge that can be obtained through any specific hydraulic turbine when it is operating under a particular head, with full gate opening. Unless an increase in head results, no additional water above that maximum discharge can be passed through the turbine, even though additional water is available. Thus a supply of additional water will not furnish additional power (kilowatts) if the turbine is already operating at full discharge capability. Also, the output of a unit may be restricted by the capability of the generator. And, in such a case, if the supply of water is sufficient to produce power equal to the generator capability, an additional water supply will not increase power generating capability even if the turbine would otherwise be capable of discharging

more water. Thus, if a unit, for any of the foregoing reasons, is already operating at maximum power generating capability on the peak hour of the load curve, the supply of additional water cannot be used at the peak hour and must be used off-peak if it is to be used at all.

X-25. In a system where installed hydro capacity is fixed, future load growth must be met by increases in thermal capacity. In such a system the economical position of the hydro plant will progressively be higher on the load curve as time goes on, with progressively smaller amounts of energy being required to support the dependable capacity of the hydro. There then must be a point in time as the load grows at which the available energy becomes adequate to support all of the hydro plant's capability and such capability becomes dependable capacity. If more hydroelectric energy is available, such energy will be generated in order to avoid waste, but since such energy is not needed operationally, its only economic value lies in the savings in fuel that will result from the temporary reduction of thermal plant output. This additional energy is thus only secondary energy and has an economic value equivalent to the cost of fuel.

X-26. As indicated in Finding X-3 the power (in kw) available from a hydroelectric project at any instant is equal to the product of the economy factor times the flow in cfs. However, if water is made available at a uniform rate of flow to a project involving reservoir storage capacity upstream of a power plant, it might be possible to develop a dependable capacity in kw which exceeds the product of such uniform flow times economy factor. To accomplish this, it is necessary that the project be able to store part of such flow during low-load hours and utilize such stored water during peak-load hours to supplement the uniform inflow then occurring. Whether such result could be achieved at a given plant would depend upon the availability of storage capability during the off-peak hours, the availability of load that could be served by the plant, the availability of generating capacity to utilize the increased

flows during the peak load hours, and the energy requirements established by the load curve under which the plant must operate.

B. POWER AUTHORITY OF THE STATE OF NEW YORK.

X-101. The Power Authority of the State of New York (herein sometimes referred to as the "Power Authority" or as "PASNY") was created by the State of New York as a corporate municipal instrumentality and political subdivision of the State, exercising governmental and public powers for the purpose, among other things, of developing the hydroelectric resources within the boundaries of the State of New York existing in the Niagara and St. Lawrence Rivers.

X-102. The Power Authority has financed its projects by the sale of revenue bonds to the general public or by notes that have been funded by such bonds, the bonds being a lien against all revenues of the Power Authority. The credit of the State is not pledged by the bonds and the projects financed by bonds are required to be self-supporting and self-liquidating, and, therefore, rates must be sufficient to pay operating expenses, bond interest, reserves, and amortization.

X-103. The Power Authority is required to operate without profit and is required by New York law to market power for the benefit of the people of the State as a whole, and particularly, to make power available to domestic and rural consumers at the lowest possible cost to them. The bond resolutions under which all of its bonds have been sold contain a rate covenant in which the Power Authority agrees that it will, if possible, establish operating procedures or maintain rates so that each year after 1961 the ratio between (a) net revenues and (b) the sum of interest paid on bonds and notes (except interest paid from the proceeds of their sale) and principal installments shall not be less than 1.40 to 1.0. The Power Authority has, in addition, agreed with one of its contractors, Aluminum Com-

pany of America, that its rates at the St. Lawrence project shall be limited to cost of operation and maintenance, bond interest, reserve funds and amortization.

X-104. The Power Authority has entered into contracts for terms expiring in 1985 or thereafter for the sale of St. Lawrence project power to the following:

| CONTRACT NUMBER | PURCHASER | FIRM POWER KW | INTERRUPTIBLE POWER KW |
|---|---|---|---|
| S–2 | State of Vermont | 100,000 | |
| S–4 | Plattsburgh Air Force Base | 10,000 | |
| S–3 | City of Plattsburgh, N. Y. | 30,000 | |
| S–9 | Village of Solvay, N. Y. | 12,000 | |
| S–8 | Village of Boonville, N. Y. | 3,800 | |
| S–6 | Niagara Mohawk Power Corp. | 115,000 | 21,000* |
| S–10 | Village of Rouses Point, N. Y. | 2,000 | |
| S–7 | New York State Electric & Gas Corp. | 20,000 | |
| S–12 | Village of Theresa, N. Y. | 600 | |
| S–13 | Village of Philadelphia, N. Y. | 800 | |
| S–16 | Village of Hamilton, N. Y. | 3,000 | |
| S–22 | Village of Sherburne, N. Y. | 3,000 | |
| S–14 | Village of Ilion, N. Y. | 8,000 | |
| S–15 | Village of Mohawk, N. Y. | 2,500 | |
| S–17 | Village of Skaneateles, N. Y. | 3,000 | |
| S–18 | Village of Frankfort, N. Y. | 2,500 | |
| S–19 | Delaware County Electric Cooperative | 4,000 | |
| S–20 | Oneida Madison Electric Cooperative | 1,300 | |
| S–21 | Otsego Electric Cooperative | 4,000 | |
| S–1 | Aluminum Co. of America | 174,000 | 65,000 |
| S–5 | Reynolds Metals Company | 200,000 | 39,000 |
| S–11 | General Motors Corporation | 12,000 | |
| | Total | 711,500 | 125,000 |

Contracts have been executed under which three utility companies, 22 municipal electric systems, two rural cooperatives and the State of Vermont have contracted for the purchase of power to be produced by the Niagara project as follows:

* Estimated. See Finding X-210.

| | FIRM POWER | | | | |
|---|---|---|---|---|---|
| nt -kw | Expansion Power (2)—kw | Withdrawable Pursuant to Public Law 85-159—kw | Non-Withdrawable Power—kw | Peaking Power (3)—kw | Total Power—kw |
| (4) | 212,250(5) | 197,000 | 250,000 | 108,000 | 1,212,250* |
| | 12,550(5) | 163,000 | 220,000 | 92,000 | 487,550* |
| | | 70,000 | 130,000 | | 200,000* |
| | | | 50,000 | | 50,000 |
| | | | 2,500 | | 2,500 |
| | | | 700 | | 700 |
| | | | 700 | | 700 |
| | | | 6,000 | | 6,000 |
| | | | 6,000 | | 6,000 |
| | | | 1,000 | | 1,000 |
| | | | 700 | | 700 |
| | | | 1,000 | | 1,000 |
| | | | 5,000 | | 5,000 |
| | | | 11,000 | | 11,000 |
| | | | 2,500 | | 2,500 |
| | | | 1,900 | | 1,900 |
| | | | 1,500 | | 1,500 |
| | | | 2,000 | | 2,000 |
| | | | 6,000 | | 6,000 |
| | | | 7,000 | | 7,000 |
| | | | 400 | | 400 |
| | | | 3,000 | | 3,000 |
| | | | 4,000 | | 4,000 |
| | | | 2,000 | | 2,000 |
| | | | 6,000 | | 6,000 |
| | | | 7,000 | | 7,000 |
| | | | 700 | | 700 |
| | | | 3,000 | | 3,000 |
| | 224,800(5) | 430,000 | 731,600 | 200,000 | 2,031,400 |

requirements which will ordinarily be available at a 12.5% monthly load factor.

(4) The provisions relating to replacement power may remain in effect, at Niagara Mohawk's option until January 1, 2006.

(5) Subject to increase or decrease as the Authority makes new allotments of expansion power or increases or decreases existing allotments.

(6) These contracts also provide for the sale of secondary power.

| Contract Number | Purchaser | Term | Replacement Power (1) — |
|---|---|---|---|
| NS–1 | Niagara Mohawk Power Corporation | Jan. 1, 1990 | 445,000 |
| NS–11 | New York State Electric & Gas Corp. | Jan. 1, 1990 | |
| NS–13 | Rochester Gas & Electric Corp. | Jan. 1, 1990 | |
| NS–20 | Public Service Board, State of Vermont | Dec. 31, 1979 | |
| NS–4 | Village of Akron | June 30, 1985 | |
| NS–3 | Village of Andover | June 30, 1985 | |
| NS–23 | Village of Angelica | June 30, 1985 | |
| NS–8 | Village of Arcade | June 30, 1985 | |
| NS–21 | Village of Bath | June 30, 1985 | |
| NS–10 | Village of Bergen | June 30, 1985 | |
| NS–27 | Village of Castile | June 30, 1985 | |
| NS–16 | Village of Churchville | June 30, 1985 | |
| NS–22 | Village of Endicott | June 30, 1985 | |
| NS–6 | Village of Fairport | June 30, 1985 | |
| NS–26 | Village of Groton | June 30, 1985 | |
| NS–7 | Village of Little Valley | June 30, 1985 | |
| NS–25 | Village of Marathon | June 30, 1985 | |
| NS–15 | Village of Mayville | June 30, 1985 | |
| NS–28 | Village of Penn Yan | June 30, 1985 | |
| NS–2 | City of Salamanca | June 30, 1985 | |
| NS–24 | Village of Silver Springs | June 30, 1985 | |
| NS–17 | Village of Spencerport | June 30, 1985 | |
| NS–9 | Village of Springville | June 30, 1985 | |
| NS–19 | Village of Watkins Glen | June 30, 1985 | |
| NS–5 | Village of Wellsville | June 30, 1985 | |
| NS–14 | Village of Westfield | June 30, 1985 | |
| NS–18 | Chautauqua-Cattaraugus Electric Cooperative | June 30, 1985 | |
| NS–12 | Steuben Rural Electric Cooperative | June 30, 1985 | |
| | | | 445,000 |

* Excluding Secondary Power: see note (6).

(1) Replacement power is Project firm power made available by the Authority to Niagara Mohawk Power Corporation pursuant to Public Law 85-159 to replace power formerly produced by Niagara Mohawk Power Corporation in its Adams and Schoellkopf plants.

(2) Expansion power is firm power supplied for resale to industrial consumers which the Authority designates for use in the expansion of their operations.

(3) Peaking power is power provided to meet peak load

X-105. The Power Authority's St. Lawrence and Niagara projects were planned, licensed, financed, designed and built in the light, inter alia, of diversions at Chicago being approximately 3,200 cfs.

X-106. The principal marketing area of the Power Authority's St. Lawrence and Niagara projects covers upstate New York and a large part of Vermont. The Power Authority has not sold power or energy generated at the St. Lawrence or Niagara projects to anyone other than the 22 contractors for St. Lawrence power and the 28 contractors for Niagara power listed in Finding X-104. The two projects are operated to provide only for the loads of those contractors.

C. ST. LAWRENCE PROJECT

X-201. Subsequent to the authorizations contained in Federal Power Commission License for Project No. 2000 and Executive Order No. 10500 [see Finding II-27], the Power Authority and The Hydro-Electric Power Commission of Ontario (hereinafter sometimes referred to as "Ontario Hydro" or "HEPCO") constructed certain works (hereinafter referred to as the "St. Lawrence project"), which works included certain channel improvements and enlargements, the Moses-Saunders Power Dam, the Long Sault Dam, the Iroquois Dam and dikes on both sides of the river.

X-202. The aforementioned works cost approximately $650,000,000, of which approximately half was paid for by the Power Authority out of the proceeds of revenue bonds and revenue during construction, with the balance being paid for by Ontario Hydro. The Power Authority issued three series of general revenue bonds in connection with the St. Lawrence project, Series A in the amount of $335,000,000; Series B (primarily for construction of a transmission line to Plattsburg, New York) in the amount of $7,500,000; and Series C (primarily for supplemental transmission facilities) in the amount of $6,800,000.

X-203. The generating facilities of the St. Lawrence project are located in the Moses-Saunders Dam. These consist of 32 propeller turbine-generators, of which 16 are owned respectively by the Power Authority and Ontario Hydro. Each turbine-generator has an installed rated capacity of 57,000 kw, and a maximum hydraulic capacity of not less than approximately 10,500 cfs at gross heads greater than 74.5 feet, and the combined capacity of the 16 Power Authority turbines under such conditions is not less than 168,000 cfs.

X-204. Outflow from Lake Ontario is regulated by the St. Lawrence project, although the Iroquois Dam constitutes a possible control point. The Iroquois Dam has been generally operated with open gates, due to the requests of both power and navigation interests, and the Moses-Saunders Dam is the control point for Lake Ontario and the St. Lawrence River upstream of that dam.

X-205. The Power Authority and Ontario Hydro, by agreement made prior to the construction of the St. Lawrence project, divide equally all flows available for power at the project, including those resulting from the Long Lake-Ogoki diversion, subject to a minor adjustment for a small difference in head between the Canadian and United States sides of the Moses-Saunders Dam, so that the energy potential available to each entity is equalized.

X-206. Under Plan of Regulation 1958-D, [see Finding II-32] maximum required flows at the St. Lawrence project never exceed 310,000 cfs. The Power Authority turbines could accommodate and utilize all flow available to the Power Authority under that plan or any plan pursuant to which maximum required flows would be increased by as much as 3,100 cfs.

X-207. During the navigation season, lockage water for the St. Lawrence Seaway locks bypasses the power dam and is lost for power purposes; it averaged 375 cfs during the period 1960-1964 and is expected ultimately to reach approximately 670 cfs during the eight-months navi-

gation season. Additional flows bypass the power dam through the intake works at the north end of a canal at Massena formerly used to supply water to a now-abandoned hydroelectric power station. Part of such water passes through a pumping station and pipe system supplying municipal water to the Village of Massena and domestic and process water to an industrial plant. An additional amount is discharged into the canal bed through sluiceways for public health purposes to prevent stagnant water from accumulating in the canal bed.

Additional flows also bypass the power dam to supply the municipal water requirements of the City of Cornwall, Ontario. The daily average magnitude of these three flows for the period 1960-1964 was as follows:

| | AVERAGE DAILY DIVERSIONS IN CFS | | |
|---|---|---|---|
| Month | Massena Canal | St. Lawrence Seaway | Cornwall Canal |
| January | 46 | 0 | 210 |
| February | 38 | 0 | 206 |
| March | 34 | 24 | 216 |
| April | 32 | 330 | 238 |
| May | 32 | 578 | 218 |
| June | 36 | 596 | 218 |
| July | 38 | 596 | 222 |
| August | 38 | 602 | 264 |
| September | 38 | 572 | 228 |
| October | 38 | 554 | 208 |
| November | 36 | 554 | 210 |
| December | 34 | 98 | 200 |
| Annual Average | 37 | 375 | 220 |

X-208. Water from the St. Lawrence River passing through the Massena Canal serves a population of 16,000 and associated industries. The water passing through the Cornwall Canal serves a population of 18,000 and associated industries. Based on an annual average flow of 37 cfs

through the Massena Canal, which prevailed in the period 1960-1964, this constitutes a flow at the rate of 2.3 cfs per 1,000 persons, or 1,490 gallons per day per capita. The flow through the Cornwall Canal in the period 1960-1964 was at the rate of 12.2 cfs per 1,000 persons, or 7,900 gallons per day per capita.

X-209. Assuming a diversion of 3,100 cfs for 3,550,000 persons at Chicago the rate of diversion is 0.87 cfs per 1,000 persons, or 565 gallons per day per capita.

X-210. As indicated in Finding X-104, the Power Authority has entered into 22 contracts with utilities, industries, and various public bodies which collectively result in the sale of all power and energy that is produced at the Power Authority's St. Lawrence plant. Each of the contracts provides for the sale of firm power and energy, three of the contracts provide for the sale of interruptible power and energy, and one contract provides for the sale of secondary energy.

The present contract rates are $1.00 per kw as a capacity charge for firm power, 2.67 mills per kwh for firm and interruptible energy, and 2.00 mills per kwh for secondary energy at the Power Authority switchyard.

The Power Authority has executed contracts having demands which total 711,500 kw of firm power. The total contract demand consists of 386,000 kw of firm power for industries, 135,000 kw to public utilities, and 190,500 kw to the State of Vermont, municipalities, and other public entities. In addition, 104,000 kw of interruptible power has been contracted for by industries. Niagara Mohawk Power Corporation ("Niagara Mohawk"), a utility, has contracted to take and pay for all interruptible energy not taken by the Authority itself, or by all other contractors for interruptible power, which, it has been estimated by the Authority, will at times reach 21,000 kw over and above the 104,000 kw mentioned above.

Firm power is defined as "power which is always available except when the operation of [the Power Au-

thority's] facilities is suspended, interrupted, interfered with or curtailed due to uncontrollable forces . . ." which uncontrollable forces are defined to include any cause beyond the control of the Power Authority, including but not limited to failure of facilities, flood, earthquake, storm, lightning, fire, epidemic, war, riot, civil disturbance, sabotage, and restraint by court or public authority, which by exercise of due diligence and foresight the Authority could not reasonably have been expected to avoid. In addition, two of the industrial contracts totalling 374,000 kw of firm power provide that if the Authority should reduce firm power and energy produced at the project by reason of the occurrence of extreme low water flow, the Authority's only obligation shall be to allocate the remaining firm power and energy as between the said industrial customers and all other customers pro rata in accordance with their then contract demands. Under the other contracts the Authority has the right to restrict the customer's taking of firm energy, whenever it determines that there is an insufficient supply available for sale, to an amount not to exceed that calculated by applying the customer's normal average load factor to the customer's contract demand. Niagara Mohawk has contracted to pay for all firm power not required by the Authority, Seaway, or other contractors, in addition to 115,000 kw of firm power which it has contracted for.

For firm power, four of the contracts with utilities and industries which total 509,000 kw or 72 percent of the total power sold, provide that the contractor pays each month the capacity charge applied to the full contract demand, irrespective of whether or not they take the power, or the capacity charge applied to the power actually taken, if the power taken is greater than the contract demand. In 18 other contracts, the contractor pays each month the capacity charge applied to the billing demand, i.e., the maximum power actually taken each month, subject to a minimum monthly charge for power and energy equal to $1 per kw of contract demand.

Under 19 of the contracts, totalling 325,500 kw of contract demand, or 46 percent of the total, the contractor is billed for energy associated with firm power on the basis of energy actually taken or on the basis of applying the contractor's load factor to the contract demand, whichever is greater. For one contract of 174,000 kw the contractor is billed for such energy on the basis of energy actually taken or on the basis of applying the Power Authority system load factor for firm power (exclusive of the firm power load of the contractor) to the contract demand, whichever is greater. For two contracts totaling 212,000 kw the contractor is billed for firm energy on the basis of energy actually taken.

Interruptible power is the first power generated in addition to firm power, and which is available continuously for substantial periods of time, but subject to interruption. There is no capacity charge for interruptible power, but overall the contractors for interruptible power are required to pay a minimum monthly charge of $1 per kw when interruptible is available. All interruptible energy is sold at present rates for 2.67 mills per kwh. Interruptible power has been sold to three contractors, and one of those three, Niagara Mohawk, is committed to take and pay for all interruptible energy not taken by the Authority itself or by all other contractors for interruptible power.

Secondary energy is energy over and above the firm and interruptible energy, which may be available from time to time for short periods of time. There is no capacity charge for secondary power. The present price at which the Authority sells secondary energy is 2.00 mills per kwh. Contracts for sale of secondary energy have been entered into with only one contractor, Niagara Mohawk, which is required to take and pay for it only if the cost of such energy is less than one-half the saving which the contractor could realize from the reduction of output from or shutting down of higher cost power sources made possible by the receipt of such energy.

The rates for power and energy supplied by the Power Authority's St. Lawrence project apply to transmission voltage at the Barnhart Island Switching Station. Where power and energy are delivered elsewhere, appropriate adjustments of meter readings are made to compensate for transmission and transformation losses between the Barnhart Island Switching Station and the point of delivery.

X-211. The contracts for the sale of power and energy to an agency of the State of Vermont, to certain New York municipalities and rural cooperatives, and to two New York State public utilities, Niagara Mohawk and New York State Electric & Gas Corporation contain provisions requiring resale for the benefit of the domestic and rural consumers in the project's market area.

X-212. While economy factor at a project varies with head and flow, the average economy factor at the St. Lawrence project to date has been approximately 5.95 kw per cfs at the generators.

X-213. The St. Lawrence project is interconnected with the Niagara project of the Power Authority by high voltage lines sufficient so that the operation of the two projects can be coordinated and may be used simultaneously to serve the load of one large system.

X-214. The Aluminum Company of America plant was located in Massena in the early 1900's because of available cheap hydroelectric power. The Reynolds Metals Company and General Motors Company plants were new plants built subsequent to construction of the project.

X-215. A change in inflow to Lake Ontario of as much as 1,000 cfs resulting from a change in diversion at Chicago or elsewhere would require development of a new plan of regulation for Lake Ontario, if the regulatory criteria [see Finding II-30] are to be met. Those criteria could be met by a new plan of regulation if the change of inflow involved a reduction of as much as 2,000 cfs.

X-216. Past revisions of the Lake Ontario regulation plans have been primarily for the improvement of navigation conditions in Montreal harbor. Such changes have raised the average level of Lake Ontario. The effect on power that might otherwise have been experienced from discharge changes under such revisions has been balanced by higher average lake levels that have been provided under successive plans of regulation.

X-217. Any new plan of regulation of Lake Ontario required to meet a future change in diversion would be formulated and adopted by the International Joint Commission in the light of conditions then existing and without the participation or approval of the States of New York and Illinois. Its provisions, therefore, cannot now be known or accurately predicted. Such a new plan required because of increased diversion from Lake Michigan could, but probably would not, result in higher average elevations of Lake Ontario while at the same time providing for the maintenance of undiminished minimum discharges in critical power and navigation periods. Conversely, under decreased diversion lower average elevations of Lake Ontario could, but probably would not, result from such a new plan. Whether, in either case, such a change in the average elevations of Lake Ontario would result would depend largely upon the amounts of minimum (and, in the case of decreased diversion, maximum) discharge from the lake which were provided for by the new regulation plan.

X-218. The change in dependable capacity of the St. Lawrence plant resulting from a change in the Chicago diversion would depend primarily upon whether, under the new plan of regulation which would then be required, the minimum required regulated outflows during critical load periods and the head provided during such critical load periods deviated from the flow and head during such critical load periods under the present plan of regulation. Since $kw = \frac{Q \times h \times e \times e'}{11.8}$ a decrease in such minimum flow

[Q] would decrease dependable capacity unless offset by a proportionate increase in head [h] during such period. [See Finding X-5]. Conversely, an increase in such minimum flow would increase dependable capacity unless there were a proportionate decrease in head.

D. NIAGARA PROJECT

X-301. In 1957, Congress, by Public Law 85-159, directed the Federal Power Commission to issue to the Power Authority a license for the construction and operation of a power project with capacity to utilize all of the United States' share of the water of the Niagara River permitted to be used for power purposes by international agreement. P. L. 85-159 also required that such license include the following conditions:

> "(1) In order to assure that at least 50 per centum of the project power shall be available for sale and distribution primarily for the benefit of the people as consumers, particularly domestic and rural consumers, to whom such power shall be made available at the lowest rates reasonably possible and in such manner as to encourage the widest possible use, the licensee in disposing of 50 per centum of the project power shall give preference and priority to public bodies and nonprofit cooperatives within economic transmission distance. In any case in which project power subject to the preference provisions of this paragraph is sold to utility companies organized and administered for profit, the licensee shall make flexible arrangements and contracts providing for the withdrawal upon reasonable notice and fair terms of enough power to meet the reasonably foreseeable needs of the preference customers.
>
> "(2) The licensee shall make a reasonable portion of the project power subject to the preference provisions of paragraph (1) available for use within reasonable economic transmission distance in neighbor-

ing States, but this paragraph shall not be construed to require more than 20 per centum of the project power subject to such preference provisions to be made available for use in such States. The licensee shall cooperate with the appropriate agencies in such States to insure compliance with this requirement. In the event of disagreement between the licensee and the power-marketing agencies of any of such States, the Federal Power Commission may, after public hearings, determine and fix the applicable portion of power to be made available and the terms applicable thereto: *Provided,* That if any such State shall have designated a bargaining agency for the procurement of such power on behalf of such State, the licensee shall deal only with such agency in that State. The arrangements made by the licensee for the sale of power to or in such States shall include observance of the preferences in paragraph (1) of this subsection.

"(3) The licensee shall contract, with the approval of the Governor of the State of New York, pursuant to the procedure established by New York law, to sell to the licensee of Federal Power Commission project 16 [Niagara Mohawk Power Corporation] for a period ending not later than the final maturity date of the bonds initially issued to finance the project works herein specifically authorized, four hundred and forty-five thousand kilowatts of the remaining project power, which is equivalent to the amount produced by project 16 prior to June 7, 1956, for resale generally to the industries which purchased power produced by project 16 prior to such date, or their successors, in order as nearly as possible to restore low power costs to such industries and for the same general purposes for which power from project 16 was utilized: *Provided,* That the licensee of project 16 consents to the surrender of its license at the completion of the construction of such project works upon terms agreed to by both licensees and approved by the Federal Power

Commission which shall include the following: (a) the licensee of project 16 shall waive and release any claim for compensation or damages from the Power Authority of the State of New York or from the State of New York, except just compensation for tangible property and rights-of-way actually taken, and (b) without limiting the generality of the foregoing, the licensee of project 16 shall waive all claims to compensation or damages based upon loss of or damage to riparian rights, diversionary rights, or other rights relating to the diversion or use of water, whether founded on legislative grant or otherwise.

"(4) The licensee shall, if available on reasonable terms and conditions, acquire by purchase or other agreement, the ownership or use of, or if unable to do so, construct such transmission lines as may be necessary to make the power and energy generated at the project available in wholesale quantities for sale on fair and reasonable terms and conditions to privately owned companies, to the preference customers enumerated in paragraph (1) of this subsection, and to the neighboring States in accordance with paragraph (2) of this subsection.

"(5) In the event project power is sold to any purchaser for resale, contracts for such sale shall include adequate provisions for establishing resale rates, to be approved by the licensee, consistent with paragraphs (1) and (3) of this subsection.

"(6) The licensee, in cooperation with the appropriate agency of the State of New York which is concerned with the development of parks in such State, may construct a scenic drive and park on the American side of the Niagara River, near the Niagara Falls, pursuant to a plan the general outlines of which shall be approved by the Federal Power Commission; and the cost of such drive and park shall be considered a part

of the cost of the power project and part of the licensee's net investment in said project: *Provided,* That the maximum part of the cost of such drive and park to be borne by the power project and to be considered a part of the licensee's net investment shall not exceed $15,000,000.

"(7) The licensee shall pay to the United States and include in its net investment in the project herein authorized the United States share of the cost of the construction of the remedial works, including engineering and economic investigations, undertaken in accordance with article II of the treaty between the United States of America and Canada concerning uses of the waters of the Niagara River signed February 27, 1950, whenever such remedial works are constructed." [71 Stat. 401-402]

X-302. On January 30, 1958, the Federal Power Commission issued a license to the Power Authority for the Niagara project, project No. 2216, containing the conditions required by Public Law 85-159.

X-303. To a substantial extent, the availability of low cost power is essential to the economy of the Niagara Frontier. Electrometallurgical and electrochemical industries came to Niagara Falls in the 1890's and shortly thereafter, because cheap hydroelectric power was available, and power is a very important item in their cost of production, amounting in many cases to about 15 percent of the total cost of production or doing business.

X-304. The Niagara Project was substantially completed in 1963 with 13 units at Lewiston and 12 at Tuscarora, as provided in the license application and the Federal Power Commission license, at an estimated cost of $737,000,000, including $8,834,556 paid to the United States for the United States' share of the cost of construction of the remedial works. The total cost is still estimated due to the pendency of certain condemnation pro-

ceedings. The estimated sum of $737,000,000 includes the following:

| | |
|---|---|
| Scenic drive and park on the American side of the Niagara River | $15,000,000.00 |
| Remedial works in Niagara River | 8,834,556.57 |
| Niagara overlook building and reception center (including parking lot) | 5,547,659.51 |
| Contribution to the City of Niagara Falls and other local governments | 3,620,251.62 |
| Tuscarora Park | 304,569.35 |
| Temporary facilities for visitors | 586,176.00 |
| | $33,893,213.05 |

X-305. A schematic drawing of the Power Authority Niagara project (L. S. Ex. 138) is included in the Appendix to this Report for general descriptive purposes only. The principal features of the Niagara project are two plants which have been designated for the purposes of this hearing as the Lewiston generating plant and the Tuscarora pumped storage plant, both located downstream of the falls and lower rapids. The Lewiston plant is the main power plant, containing 13 Francis-type turbines and generators having a name plate rating of 150 megawatts (mw) each, or a combined name plate rating of 1,950 mw. The Tuscarora plant contains 12 combination pump-turbine units which can operate either as pumps, to pump water into an artificial reservoir containing 60,000 acre feet of capacity, or as generators. The Tuscarora units as generators have a rated capacity of 20 mw each, or a combined rated capacity of 240 mw.

X-306. Water from the Niagara River is delivered to the Lewiston and Tuscarora plants through twin reinforced concrete conduits, running from an intake structure located about 3½ miles above the falls for a distance of four miles to the forebay of the Lewiston plant.

The gates in the conduits at the intake works and at the forebay are used only for emergencies, to completely shut off the flow of water. Hour by hour regulation of the amount of water taken from the river is accomplished by the turbine wicket gates of the Lewiston Power Plant units operated in conjunction with the Tuscarora units. From the forebay, the water may either be pumped into the Tuscarora reservoir immediately above the Lewiston forebay or may flow directly through the Lewiston units to generate power, or part may flow each way. Water pumped into the Tuscarora reservoir is ultimately released and passes through the Tuscarora units, acting as generators, which discharge it into the Lewiston forebay, from which point it normally passes through the Lewiston units to generate power and is discharged into the lower Niagara River.

X-307. The primary function of the Tuscarora plant is to store flows available at night and weekends in excess of that required to meet demand and release it during the peak-load hours.

X-308. The United States' share of the flow available for power during low flow periods in the Niagara River is not sufficient fully to utilize the machine capability of the Lewiston units, unless additional flows are available from storage. There is no seasonal storage capacity in the Niagara project; storage capacity is limited basically to storage of night-time flows, during which hours power demand is reduced (and, in the tourist season, during which hours greater flows are available for power,) and weekend flows, when power demand is reduced. Substantial quantities of water available to the Power Authority under treaty provisions are not utilized for power and energy generation.

X-309. The Power Authority excluded the monthly mean flows which prevailed in the drought years 1934, 1935 and 1936 in computing the dependable capacity which would be available from the Niagara project.

X-310. As stated in Finding X-104, the Power Authority has entered into 28 contracts which collectively result in

the sale of 2,031,400 kw of power and associated energy produced at the Power Authority's Niagara Plant. The Power Authority has stated that this represents the complete sale of Niagara power now available.

The contracts provide for three separate categories of power and energy, which are firm power, peaking power and secondary energy. Firm power is defined as that which is always available except when it is interrupted by uncontrollable forces. In the contracts with utilities, firm power is further divided into non-withdrawable firm, withdrawable firm, replacement, and expansion power. Non-withdrawable power is for the benefit of rural and domestic customers of the contractor, which the contractor will have for the duration of the agreement. Withdrawable firm power is sold to three investor-owned utilities subject to withdrawal for potential preference customers, including municipalities, cooperatives and other public entities, and pending such withdrawal is sold for the benefit of rural and domestic customers. Replacement power is non-withdrawable, and is sold to one utility, Niagara Mohawk, for replacement of the output of hydroelectric plants previously operated in the Niagara area, whose water supply was transferred to the Power Authority. Expansion power is sold to two utilities for resale by the contractor to industrial customers as specified by the Power Authority.

Peaking power is power available to meet customers' peak load requirements, which, unless otherwise agreed, shall be available at a 12.5 percent monthly load factor.

Secondary energy is energy not associated with firm or peaking power which the Power Authority determines to be available for sale from time to time.

X-311. The contracts include sales of power and energy to the State of Vermont, to certain New York municipalities and rural cooperatives, and to the New York State public utilities, Niagara Mohawk, New York State Electric & Gas Corporation, and Rochester Gas and Electric Corporation, all of which contracts contain provisions requiring resale for the benefit of the rural and domestic

consumers in the project's market area. The contracts with the utilities contain provisions for withdrawal by the Power Authority of power and energy necessary for compliance with the conditions of Public Law 85-159.

The total contract demand under the 28 contracts is as follows:

| | |
|---|---|
| Non-withdrawable firm | 600,000 kw |
| Withdrawable firm | 430,000 kw |
| Replacement | 445,000 kw |
| Expansion | 224,800 kw |
| Peaking | 200,000 kw |
| Subtotal, to Investor-Owned Utilities: | 1,899,800 kw |
| Firm Power to Public Entities: | 131,600 kw |
| Total Sold | 2,031,400 kw |

The present contract rates are $1.00 per kw for capacity associated with firm power and peaking power, 2.67 mills per kwh for firm and peaking energy, and 2.00 mills per kwh for secondary energy. Replacement and expansion power and energy are charged for at firm rates. There is no capacity charge for secondary energy.

The utility contracts and the contract with Vermont provide that for firm and peaking power (exclusive of expansion power), which total 1,725,000 kw or 86 percent of the total power sold, the contractors will pay each month the capacity charge applied to the full contract demand, irrespective of whether or not they take such power, or the capacity charge applied to the power actually taken, if greater than the contract demand. The capacity charge for expansion power sold to utilities and for firm power sold to municipalities and cooperatives is applied to the billing demand, i.e., the maximum power actually taken during the month.

The contractor is billed for energy associated with replacement power on the basis of energy actually taken or

on the basis of applying a 95 percent load factor to the contract demand for replacement power, whichever is greater. For all other types of energy associated with firm power the contractor is billed on the basis of energy actually taken or on the basis of applying the contractor's load factor to the contract demand, whichever is greater. For energy associated with peaking power, the contractor is billed for net energy actually delivered, taking into account any such energy which the contractor may return in kind during the term of the contract.

Contracts for sale of secondary energy have been entered into with only the three utility contractors, Niagara Mohawk, New York State Electric & Gas Corporation, and Rochester Gas and Electric Corporation.

The utilities are required to take and pay for secondary energy only if the potential saving to the contractor, if any, is at least 0.5 mills per kwh, or if operating conditions on the contractor's system permit acceptance of such secondary energy.

The rates for power and energy supplied by the Power Authority's Niagara project apply to transmission voltage at the Niagara Switching Station. Where power and energy is delivered elsewhere, appropriate adjustments of meter readings are made to compensate for transmission and transformation losses between the Niagara Switching Station and the point of delivery.

X-312. The Power Authority's Niagara contracts with Niagara Mohawk, New York State Electric and Gas Corporation and Rochester Gas and Electric Corporation provide that those contractors will supply energy, to the extent that, in its determination, the contractor can make such energy available without jeopardy to its own loads, to other Power Authority contractors in the event that the Power Authority is unable to do so at the producer's cost of production plus 15 percent. On the basis of a fuel cost of 3.18 mills per kwh, and other costs of 5 percent of 3.18 mills per kwh, the cost of energy so purchased by the Power Authority would be 3.84 mills per kwh. The Power Authority

in turn would collect from the contractors taking such energy 2.67 mills per kwh, so that the net cost to the Power Authority of such purchased energy would be 1.17 mills per kwh. If the exchange were based on the fuel cost of 2.50 mills per kwh, the Power Authority would purchase energy for 3.02 mills per kwh and sell it for 2.67 mills per kwh, or a net cost of only 0.35 mills per kwh.

X-313. Three municipalities within the Niagara River drainage basin take their water supply from the Niagara River. They are Buffalo, New York; Niagara Falls, New York, and Niagara Falls, Ontario. All of them return their water to the Niagara River.

X-314. Buffalo, New York, takes its domestic water supply from the Niagara River and, when used, returns it to the river. Since the water is taken above the shoal at the head of the Niagara River and returned below that shoal, it has some slight lowering effect on Lake Erie. Since the water is returned above the power intake, it does not diminish the amount of water available for power, except to the extent that some part of the water may be consumed.

X-315. Niagara Falls, New York, takes its domestic water supply from the Niagara River upstream of the intake for the Power Authority's Niagara project, and discharges its waste water to the Niagara River below the falls and above the Lewiston plant. The amount of water taken by Niagara Falls, New York, reduces the amount of water available for the generation of hydroelectric energy at the Niagara Falls power plants.

X-316. There are three municipalities located outside of the Niagara River drainage basin which take water from the Niagara River above the Niagara power project for domestic purposes and return it to Lake Ontario. They are Lockport, New York, and St. Catharines and Thorold, Ontario. The two Canadian cities have populations of 83,941 and 8,000, respectively.

X-317. Lockport, New York, whose 1961 population was 26,370, takes its domestic water supply from the Niagara River by means of a crib at North Tonawanda, New York. The water is pumped 13 miles to Lockport. The City of Lockport discharges its waste water into Eighteen Mile Creek which in turn discharges into Lake Ontario east of the Niagara River. The water taken by Lockport is not available for generating hydroelectric power at the Niagara Falls power plants.

X-318. The average weekday use of domestic water in Lockport, New York, is 11.5 million gallons per day (MGD), with daily peaks of 15 MGD and hourly peaks of 18 MGD. Lockport's use of water from the Niagara River is pursuant to a permit issued by the State of New York, Department of Conservation, Water Resources Commission. The permit recites that the present supply of water to Lockport is apparently only an intermediate step, and will provide adequate quantities of water only until 1967.

X-319. The Black Rock Canal in Buffalo, New York, extends four miles along the east side of the Niagara River from Lake Erie to the deeper section of the Niagara River below the rapids.

X-320. The New York State Barge Canal, the main branch of which is called the Erie Canal, extends across New York State from the Niagara River to the Hudson River, and has several branches. Water passes from the Niagara River through the canal to Lake Ontario, bypassing Niagara Falls, and so reducing the amount of water available for power.

X-321. The water in the New York State Barge Canal which bypasses Niagara Falls enters Lake Ontario by four routes. The first of these routes is at Lockport, New York, where water is spilled from the canal into Eighteen Mile Creek which flows into Lake Ontario. This spillage at Lockport is 125 cfs from May to October, inclusive, and 75 cfs from November to April, inclusive.

X-322. Part of the water spilled from the New York State Barge Canal into Eighteen Mile Creek is passed through the Hydraulic Race plant which has 46 feet of head. The water utilized is water which was necessary for navigational purposes at a point in the canal, but has become surplus at the point of spillage.

X-323. Water which is spilled from the New York State Barge Canal into Eighteen Mile Creek is utilized to dilute effluent from the City of Lockport's sewage treatment plant. The State of New York, Department of Public Works, Division of Canals and Waterways issued a permit, Ill. Ex. 539, to the City of Lockport to divert water from the New York State Barge Canal to Eighteen Mile Creek for sanitary or domestic purposes in diluting the effluent to be discharged into Eighteen Mile Creek from the City of Lockport, New York, sewage treatment plant. The permit provides that the City of Lockport shall pay the State of New York a monthly permit fee which is the average cfs spilled from the New York State Barge Canal into Eighteen Mile Creek during the month at the rate of forty cents per cfs.

X-324. The project to install capacity in Lockport, New York, to take an additional supply of water originating in the Niagara River was found by the New York Water Resources Commission on June 6, 1961 to have no adverse effect on the water supply interests of any other municipality or civil division of the State of New York.

X-325. The average monthly diversions from the Niagara River to the New York State Barge Canal for the period 1945 through 1964, expressed in cfs, were as follows:

| YEAR | JAN. | FEB. | MAR. | APR. | MAY | JUNE | JULY | AUG. | SEPT. | OCT. | NOV. | DEC. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1945 | 700 | 575 | 50 | 1075 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 850 |
| 1946 | 700 | 600 | 0 | 700 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 700 |
| 1947 | 700 | 600 | 75 | 750 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 800 |
| 1948 | 700 | 550 | 0 | 700 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 225 |
| 1949 | 325 | 700 | 100 | 700 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 700 |
| 1950 | 700 | 700 | 350 | 300 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 800 |
| 1951 | 0 | 575 | 700 | 950 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 700 |
| 1952 | 50 | 450 | 700 | 950 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 750 |
| 1953 | 700 | 50 | 450 | 950 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 750 |
| 1954 | 700 | 50 | 250 | 950 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 700 |
| 1955 | 250 | 700 | 700 | 950 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 300 |
| 1956 | 0 | 0 | 250 | 750 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1050 | 450 |
| 1957 | 0 | 0 | 0 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 350 |
| 1958 | 0 | 0 | 0 | 360 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 750 |
| 1959 | 0 | 0 | 0 | 450 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 590 |
| 1960 | 0 | 0 | 0 | 230 | 1060 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 410 |
| 1961 | 0 | 0 | 0 | 440 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 290 |
| 1962 | 0 | 0 | 0 | 900 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 300 |
| 1963 | 0 | 0 | 0 | 830 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 330 |
| 1964 | 0 | 0 | 0 | 800 | 1200 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 200 |

X-326. At Medina, New York 225 cfs of water which was necessary for operation of the New York State Barge Canal at certain points, but which at Medina had become surplus, is spilled into Oak Orchard Creek. This water is utilized to generate hydroelectric power at the four hydroelectric power stations, Oak Orchard, Canal, Glenwood, and Waterport. These stations develop a total head of 195 feet. The water spilled at Medina develops power through a total of 241 feet of head between the Niagara River and Lake Ontario including that of the Hydraulic Race plant at Lockport.

X-327. Approximately 375 cfs of water which was necessary for the operation of the New York State Barge Canal but has become surplus at Rochester, is spilled into the Genessee River at that point and is passed through three hydroelectric plants with a total head of 244 feet. Adding the 46-foot head of the Hydraulic Race plant to the total head of the three plants at Rochester means the water spilled from the Barge Canal into the Genessee River is used through a total of 290 feet of head between the Niagara River and Lake Ontario.

X-328. Water diverted from the Niagara River by the New York State Barge Canal, and not spilled at Lockport, Medina or Rochester, New York, passes eastward through Macedon, New York and then into Lake Ontario by the Oswego River, except for an indeterminable amount which is diverted at various places on the New York State Barge Canal and utilized for irrigation purposes.

X-329. During the period 1960 through 1964, inclusive, 197,563 tons of commerce, on an annual average, moved over those portions of the New York State Barge Canal which are supplied with water from the Niagara River. The average diversion from the Niagara River into the Canal during this period was 721 cfs.

E. NEW YORK STATE ELECTRIC UTILITY COMPANIES.

X-401. The major New York State electric utility companies are Niagara Mohawk, Rochester Gas & Electric Company, New York State Electric & Gas Co., which, together with the Power Authority and certain smaller utilities, are referred to as the Upstate New York Systems; and Central Hudson Gas & Electric Corporation, Orange and Rockland Utilities, Inc., Consolidated Edison Company of New York, Inc., (Con Edison) and Long Island Lighting Co., which, together, are referred to as the Southeast New York Systems.

The seven New York utilities mentioned above have formed a group known as "Empire State Utilities Power Resources Associates," to facilitate coordination of operations so as to make maximum utilization of existing power resources and to plan system additions on the most economic basis for the New York State utility system as a whole. Several contracts have been entered into providing for interchange of power and energy among various of these utilities.

The Power Authority is not a member of the Empire State Utilities Power Resources Associates and is a party only to the contracts listed in Finding X-104.

The existing agreements between the members of the Power Resources Associates provide for setting up interconnections, sharing of reserves, supply of economy energy to reduce operating costs, and the framework under which the sale of specified amounts of assured capacity for temporary periods can be arranged readily under supplemental agreements. However, each utility is responsibile for providing for its own load and decides for itself what capacity and energy to buy and sell. The sale of specific amounts of dependable capacity is outside of and supplemental to the general pooling agreements.

X-402. The transmission of firm power and energy on a permanent basis between southeast New York State and upstate New York would not be economical.

X-403. A 345-kilovolt (kv) transmission line extends easterly from the Niagara generating station of the Power Authority to Albany, where it connects with a 345-kv double-circuit line running southerly from Albany to Consolidated Edison's Dunwoodie Substation in Yonkers, New York.

X-404. From the vicinity of Utica, New York, a 230-kv line runs to the Power Authority plant at Massena and to Plattsburgh, New York, from which there is a 115-kv submarine cable connection across Lake Champlain with Vermont Electric Power Co.

X-405. There is a 230-kv line between Niagara Mohawk's Dunkirk Substation and the Erie Substation of Pennsylvania Electric Company in Pennsylvania; a 230-kv interconnection from the Hillside Substation of New York State Electric & Gas Corporation to Pennsylvania Electric Company's East Towanda Substation; two 115-kv connections from Niagara Mohawk at Hoosick and Whitehall, New York to the Vermont Electric Power Company, Inc.; and, in addition, there are other 115-kv and lower capacity inter-connections to other states.

X-406. A 345-kv circuit of 300-megavolt ampere initial capacity has been constructed which connects Connecticut Light & Power Company's Southington Substation with Con Edison's Pleasant Valley Substation near Poughkeepsie, New York, where connection is also made to the 345-kv line between Con Edison and the Upstate New York Systems, and a 138-kv line of 300-megavolt amperes initial capacity connecting Con Edison with Public Service Electric and Gas Company in New Jersey. Con Edison has also indicated it would connect to one of two 500-kv lines, to be built by a group of Pennsylvania, New Jersey, and Maryland companies, which, together, are known as Pennsylvania-New Jersey-Maryland Interconnection (PJM System).

X-407. Con Edison has been granted a license by the Federal Power Commission for Project No. 2338, a pumped

storage plant on the Hudson River at Cornwall, New York. The plant, as now conceived, would consist of eight Francis type reversible hydraulic pump-turbines connected to generator-motors with a combined name plate capacity of 1,800,000 kw and a maximum capability of 2,000,000 kw. The plant would operate from a high-head reservoir having no significant natural inflow, and generation would be confined to the outflow of water previously pumped into the reservoir through the pump-turbines. On December 29, 1965 the United States Court of Appeals for the Second Circuit set aside the Commission's order granting the license. [354 F. 2d 608, cert. den. 384 U. S. 941]

X-408. The Cornwall pumped storage plant, if ultimately authorized, essentially would make off-peak electric energy available during on-peak hours and its basic purpose would be to supply capacity at a cost below that for which a thermal plant could be built in the Southeast New York area. Such a plant could not be operated other than as a peaking plant, since it would be necessary to utilize off-peak periods to pump water into the reservoir.

X-409. The dependable capacity of the Niagara and St. Lawrence projects of the Power Authority will be fully absorbed by the upstate New York market by approximately 1967.

F. CANADIAN POWER PROJECTS.

X-501. In the Soulanges section of the St. Lawrence River in Canada the two existing hydroelectric plants, Beauharnois and Cedars, are operated by the Hydro Electric Power Commission of the Province of Quebec. Enlargement of the Beauharnois plant was completed in 1961 and plans have been considered for developing the power potential of Lachine Rapids and downstream thereof at 35 foot average net head.

X-502. The following Canadian hydroelectric plants utilize Lake Erie outflows: the Toronto Power, Ontario

Power, Canadian Niagara (Rankine), DeCew, Welland Canal and Sir Adam Beck (No. 1 and No. 2) plants.

G. Effect of Changed Diversions.

1. *General Effect.*

X-601. A change in diversion at Chicago would not be reflected fully in the flows available to the Power Authority's Niagara and St. Lawrence power projects until about 15 years after the change was made. Approximately 19 per cent of the change would be reflected in one year, approximately 40 per cent in two years, over 50 per cent in three years and over 75 per cent in five years.

X-602. The alternative cost of thermal energy generation that might be required as a result of a change in diversion at Chicago must be evaluated on the basis of the oldest generating units in the system at the time the loss is fully effective, since those units would otherwise be on a standby basis.

X-603. When evaluating the capital cost of thermal capacity alternative to hydro under reduced flow conditions, it is necessary to consider the cost of units not yet ordered, since the alternative capacity would not be installed until the effect of a change in diversion was at least partially effective at the Power Authority plants.

Turbines and generators decrease in cost per installed kilowatt as unit size increases, and the trend has been progressively toward larger units.

A decrease in flows available to the Power Authority up to 1,600 cfs would probably not call for a complete new unit, because such a change would result in a change in generating capacity of not more than 65 megawatts, even under the most prejudicial circumstances.

X-604. To determine whether a change in diversion at Chicago would result in a change in the Power Authority's dependable capacity, it is necessary to consider the load curve of the system to which the Power Authority supplies power. [See Finding X-22]

X-605. The gain or loss in revenues or economic values resulting from changes in diversion at Chicago would be smaller before the full effect of the change was realized.

X-606. Present diversions at Chicago do not jeopardize the amortization of the St. Lawrence or Niagara projects.

2. *Niagara Project.*

X-607. There are no specific provisions at the Power Authority's Niagara project for additional units to be installed but space is available for their future installation.

X-608. The capability of the Power Authority's Niagara project depends upon a number of factors. These include (a) the discharge of the Niagara River, (b) the time of the year (whether the tourist or non-tourist season), (c) the number of units available, (d) the amount of flow available from storage in the Grass Island pool, and (e) tailwater conditions in the lower Niagara River.

X-609. Dependable capacity at the Power Authority's Niagara project is in the order of 1,985 mw. The firm and peaking power contracted for by the project should not exceed its dependable capacity, except by a small percentage which is permissible because of a small diversity in load between contractors. On this basis, the total contracted firm and peaking power of 2,031.4 mw is consistent with an estimate of present dependable capacity of 1,985 mw.

X-610. The average economy factor of the Niagara project is approximately 23.2 kw per cfs.

X-611. The daily load curve pattern which the Niagara plant is required to meet permits it to store in the Tuscarora reservoir a sufficient portion of night time flows to operate at 70 per cent load factor. Storage capacity and pumping capabilities are sufficient to permit such operation, i.e., to store a portion of a uniform 24-hours flow during off-peak hours for use, in addition to the uniform flow, during peak-load hours.

X-612. Thermal capacity will grow with load in the Power Authority's marketing area since practically all the

potential hydropower in the area has been developed. Under such circumstances, the Power Authority's Niagara project will probably operate higher and higher on the load curve as time goes on, and at some point in time additional water may have no capacity value, representing only secondary energy.

X-613. An increase in Chicago's diversion would cause a reduction in energy produced at the Power Authority's Niagara project, since most of the increment of water that would be available if an increase in diversion had not been made could be utilized for energy production during off-peak load periods. A decrease in diversion would increase energy proportionately.

X-614. Purchases of energy by the Power Authority may be required to deliver energy at the current contractual load factor, even with existing diversions at Chicago, although such energy will not be required operationally on the system. Such purchases would have to be increased if diversions were increased at Chicago, and would be decreased if diversions were decreased.

X-615. A 1,000 cfs increase in flows available for power at the Niagara project, resulting from a decrease in diversion, would produce a substantial increase in available energy, the amount of which cannot be predicted with certainty but would probably be in the order of 200,000,000 kwh per year. Conversely, a 1,000 cfs decrease in flows available for power at the Niagara project, resulting from an increase in diversion, would probably produce a loss of available energy in the order of 200,000,000 kwh per year.

X-616. A 1,000 cfs increase in flows available for power to the Niagara project resulting from a decrease in diversion would produce a revenue gain for the Power Authority the amount of which cannot be predicted with certainty, largely because the future position of the Niagara project on the load curve of its marketing area cannot now be known, but which gain would probably be in the order of $940,000 per year in the next few years. A 1,000 cfs de-

crease in flows available for power resulting from an increase in diversion would probably produce a like loss in revenue at that project.

X-617. A 1,000 cfs increase in flows available for power at the Niagara project resulting from a decrease in diversion would result in a gain in power produced at such project the amount of which cannot be predicted with certainty, largely for the reason indicated in Finding X-616, but which would probably have an economic value to the State of New York in the order of $1,480,000 per year. A 1,000 cfs decrease in flows available for power would probably result in a loss in power produced at such project having an economic value to the State of New York of a similar amount.

3. *St. Lawrence Project*

X-618. To analyze accurately the effect of a change in Chicago diversion on the economy factor, the dependable capacity and the resultant energy production at the Power Authority's St. Lawrence project, it would be necessary to consider regulation of Lake Ontario under existing diversion conditions and under conditions with a change in diversion. This would require a study of lake regulation under both conditions, including a determination of the economy factor as it varies for each month with changes in discharge and head. However, as indicated in Finding X-217, such a study is not feasible because the provisions of the lake regulation to be adopted following a future change in diversion cannot now be known or accurately predicted.

X-619. A 1,000 cfs increase in flows resulting from a decrease in diversion, if actually made available for power at the Power Authority's St. Lawrence project by a new plan of Lake Ontario regulation and if no change in average levels of Lake Ontario resulted, would probably produce an increase in annual revenue at present Power Authority rates of approximately $85,000 in capacity revenue and $140,000 in energy revenue, a total possible revenue gain of

approximately $225,000 per year. A 1,000 cfs decrease in flows actually made available for power resulting from an increase in diversion would probably produce a like loss in revenue at that project.

X-620. A 1,000 cfs increase in flows resulting from a decrease in diversion, if actually made available for power at the Power Authority's St. Lawrence project by a new plan of Lake Ontario regulation and if no change in average levels of Lake Ontario ensued, would probably result in a gain in power produced at that project having an economic value to the State of New York of approximately $380,000 per year. A 1,000 cfs decrease in flows actually made available for power resulting from an increase in diversion and if no change in average levels of Lake Ontario ensued, would probably result in a loss in power produced at such project having an economic value to the State of New York of a similar amount.

X-621. If, in case of a 1,000 cfs increase in flows resulting from a decrease in diversion, lower average levels of Lake Ontario should result from a new plan of lake regulation, with a consequent decrease in head of water at the St. Lawrence project, the capacity revenue to the Power Authority and the economic value to the State of New York of power produced, would be less than are stated in Findings X-619 and X-620, respectively. Conversely, if, in case of a 1,000 cfs decrease in flows resulting from an increase in diversion, higher average lake levels should result from a new plan of lake regulation, with a consequent increase in head, the capacity revenue to the Power Authority and the economic value to the State of New York of power produced would be more than are indicated in the last sentences of Findings X-619 and X-620, respectively. However, as stated in Finding X-217, it is improbable that such changes in average lake levels would result from a new plan of lake regulation.

4. *Summary*

X-622. The Chicago diversion, if it be assumed to be 3,200 cfs, and if it be further assumed that one-half of the

diverted flow would otherwise have been available for power at the Power Authority's plants, presently results in a loss of power production at the Power Authority's plants having a value at present Power Authority rates in the order of $1,850,000 per year, but having an economic value to the State of New York in the order of $2,975,000 per year. In addition it results in a substantial loss of power and energy at the Canadian plants on the St. Lawrence River and those utilizing the outflows of Lake Erie.

Each reduction of 1,000 cfs in such diversion, if no change in the regulated average levels of Lake Ontario ensued and if one-half of the additional flow resulting from the reduced diversion were made available for power at the Power Authority's projects, would ultimately result in an increase in power production at the Power Authority's plants which would probably produce in the order of $587,500 per year at present rates and which would probably have an economic value to the State of New York in the order of $930,000 per year. Likewise each such reduction would result in increased production at the Canadian plants referred to above.

Each increase of 1,000 cfs in such diversion, if no change in the regulated average levels of Lake Ontario ensued and if one-half of the reduced flow resulting from such increased diversion were withdrawn from the Power Authority's projects, would probably produce a loss of revenue and of economic value of similar amounts.

## XI. Interests of Municipalities and Industries Located on the Great Lakes

### A. Municipalities of Michigan

XI-1. According to the official 1960 Census, Michigan has a population of 7,823,194. Fifty percent of the total population of Michigan is served by water systems depending for their supplies on Lakes Michigan and Huron, the St. Clair River, Lake St. Clair, the Detroit River, and Lake Erie.

Most of the upstate municipal water supply systems in Michigan have intake cribs in the lake or river from which the water is taken which with their associated conduit lines, shore wells and pumping equipment operate more efficiently and economically when water levels are higher and less efficiently and economically when they are lower. The same is true of the intake structures, connecting tunnels and pumping equipment of the City of Detroit and of Wayne County.

The City of Detroit is now constructing a water supply system which will draw water from Lake Huron. The capacity of this system, as planned, is 800 MGD or 1,250 cfs. If the City of Detroit withdraws 800 MGD from Lake Huron and returns the unconsumed portion thereof to the Great Lakes system at Zug Island the net effect would be to reduce the levels of the St. Clair River, Lake St. Clair and Lakes Michigan-Huron by some amount not precisely determinable from the evidence, but in no event more than 1.2 inches.

The daily per capita water use in the following Michigan cities during 1955 was: Flint, 236 gallons per capita per day (gpcd); Albion, 255 gpcd; Highland Park, 269 gpcd; and Jackson, 230 gpcd.

B. Public Utilities of Michigan

XI-2. The Consumers Power Company has operations in 64 of the 68 lower peninsula counties of Michigan and furnishes electric and natural gas services in an area of 26,899 square miles. Some of the company's plants are located on the inland waterways, but most of these are older, less efficient and smaller than the modern plants. All of the plants built since 1940 and those being built or planned are located on the Great Lakes or connected waterways.

It is important for modern electric generating plants in Michigan to be located on the Great Lakes shores or connecting waterways, in order that large quantities of

cooling water and water transported coal may be available to them.

Plants of the Consumers Power Company on Lakes Michigan and Huron would be adversely affected by a permanent reduction in lake levels in a substantial amount.

XI-3. The Detroit Edison Company is the eighth largest public utility in the United States and supplies electricity, central heating and steam for industrial use in 7,600 square miles of territory in southeastern Michigan.

All of the company's power is generated in coal burning thermal plants. Two, the Marysville and St. Clair plants, are on the St. Clair River; four—Conners Creek, Delray, River Rouge and Trenton channel plants—are on the Detroit River, and the company had sites at Harbor Beach on Lake Huron and at Monroe on Lake Erie where generating stations were to be constructed.

The Detroit Edison Company's Enrico Fermi Atomic Power Plant, situated on Lake Erie, near Monroe, has been completed and has been operating at reduced power of one megawatt since 1960. The Atomic Energy Commission conducted a hearing on August 30, 1965 at Detroit, Michigan, to consider the issuance of an amendment to the plant's provisional operating license (No. DPR-9), which amendment, if issued, would extend the expiration date of the license, and authorize operations at power not to exceed 200 megawatts.

The Detroit Edison generating plants are located on the Great Lakes because of the availability of large quantities of water for cooling purposes and of waterborne coal. A permanent lowering of the water levels of the lakes and rivers on which these plants are located would tend to have a detrimental effect upon their operation. Such a permanent lowering, if in a substantial amount, would tend to increase the transportation cost of waterborne coal, increase the cost of pumping condenser cooling water, uncover some circulating water pump suctions, necessitate deeper excavations and structures to accommodate future plant water supply,

and decrease the stability of plant and plant structures located on the lake and river banks.

In the event that lake levels were permanently increased some corresponding benefits might well accrue to the Detroit Edison Company.

XI-4. The Amherstburg channel was completed to a depth of 27′ LWD at the end of the 1959 season. In 1960 Detroit Edison dredged alongside the face of its St. Clair power plant dock to an 18′ depth LWD and tapering to a depth of 26′ LWD 15′ out from the dock face. During the 1960 season, 2,025,000 tons of coal were shipped to the St. Clair plant at a vessel rate reduction of 3½¢ per ton, realizing a transportation saving of over $70,000 on these 1960 coal deliveries based on an increase in the dredged depth of 4 feet.

## C. Industries

### 1. *Iron Ore Industry of Minnesota*

XI-5. The Lake Superior district is the greatest iron ore producing district in the United States. Iron ore is the most valuable mineral resource in Minnesota and iron ore mining and processing is one of the most important industries of the State. Large amounts of money (approximately $600,000,000 to date) and much effort have been and are being directed toward the development of the large deposits of low grade oxidized ores and the taconites.

The processing and beneficiation of iron ore is becoming more important to Minnesota's economy, especially as the higher grade, direct-shipping domestic iron ores are depleted and as the competition from foreign iron ores, shipped through the St. Lawrence Seaway, increases. Prior to the opening of the St. Lawrence Seaway, Minnesota iron ore shipped on the Great Lakes had a transportation cost advantage over foreign iron ore, which had to be transshipped by rail from ocean ports to steel producing centers

of the United States. Rail freight rates on foreign iron ore from United States ocean ports to steel producing districts in 1958 ranged from $3.51 per gross ton to $6.29 per gross ton (2,240 lbs.), while lake freight rates from upper Great Lakes ports to steel producing districts ranged from $1.48 to $2.28 per gross ton which latter rates include an unloading charge of 28¢ per ton. The Seaway now provides an all water route for shipping foreign iron ore. Increases in foreign iron ore shipments to the United States which have occurred yearly are expected to continue to increase. At the same time, the cost of producing iron ore in Minnesota has steadily increased.

Taconite beneficiation plants are the newest development in iron ore processing in Minnesota. Demands of the steel industry for a better quality, more uniform furnace feed have increased the need for processing and beneficiation of iron ore. Modern beneficiation processes produce a high grade iron ore from low grade ores. Conservative estimates indicate that there are 5 billion tons of magnetic taconite in Minnesota which can be mined by open pit methods without any substantial amount of rock stripping. Over 80 active iron ore beneficiation plants are located in Minnesota and in the last decade taconite beneficiation plants were and are being built in Minnesota. These taconite beneficiation plants process ore containing about 25 per cent iron and 35 per cent silica into a uniform size and quality pellet containing about 63 per cent iron and not more than 8 per cent silica.

Reserve Mining Company, one of Minnesota's large commercial taconite processing companies, made an initial investment in its taconite facility and harbor totaling approximately $190,000,000 and the subsequent expansion of this facility cost the company approximately $125,000,000. This plant will produce approximately 9,000,000 tons of pellets annually. To facilitate the shipping of these pellets, a private harbor was constructed at Silver Bay with depths of 30 feet at the face of the dock. A similar installation has been made at Hoyt Lakes by the Erie Mining Company.

Taconite pellets processed at Hoyt Lakes are shipped from the newly constructed port facilities at Taconite harbor which have depths of 30 feet at the face of the dock.

All iron ore produced in Minnesota is dependent upon low cost water transportation to reach the steel producing centers of the United States. Employment opportunities and the economic prosperity of northeastern Minnesota are in turn dependent upon the development and expansion of iron ore mining and processing. Therefore, any increase in the cost of shipping iron ore resulting from a reduction of levels in the lower Great Lakes and connecting channels is disadvantageous to Minnesota iron ore producers and hinders their efforts to compete with foreign ores.

2. *Chemical Industry of Michigan*

XI-6. The Pennsalt Chemicals Corporation, which engages in manufacture of industrial chemicals, has a plant located on the west bank of the Detroit River. The plant has 66 buildings on 85 acres of land. In 1960 the company employed about 1,000 people and gross sales were $14,250,000. Permanent lowering of the level of the Detroit River might require receipt of coal for the plant in boats of shallower draft or might require that the self-unloading boats stand so far offshore as not to be able conveniently to reach the entire area used for storage of coal.

XI-7. Wyandotte Chemicals Corporation is engaged in the manufacture, sale and distribution of basic alkali chemicals, and other inorganic and organic chemicals, specialized cleaning and sanitizing products. In 1960 total sales approximated $98,000,000. The principal offices and manufacturing business are in Wyandotte where there are two plants on the Detroit River. The company also owns and operates a salt brine field at the juncture of the Detroit River and the Trenton channel at the head of Grosse Ile, producing 750,000 tons of salt a year. In the vicinity of Wyandotte, the company owns and occupies six miles of shoreline or harbor line on Detroit River waters. The Com-

pany also owns Fighting Island on the Canadian side of the river, which is operated as a waste materials settling and collecting area. The gross book value of the company's plants in 1961 was $125,000,000 and it employed 4,000 people.

Any permanent lowering of the Detroit River water levels in a substantial amount might curtail the amount of raw and finished materials that could be delivered to and from the plants via water as a result of decreased draft and carrying capacity of the company's vessels and outside carriers. Providing of additional depth by dredging alongside the docks might weaken the stability of dock structures and endanger plant installations on the immediate edge of the docks.

XI-8. The Dow Chemical Company manufactures industrial and agricultural chemicals, plastics materials, and magnesium metal and magnesium products. Net sales for the fiscal year ending May 31, 1960 were $781,000,000. Michigan plants are located in Midland, Ludington and Bay City. Two of these plants are located on navigable water and all of them use water transportation for raw materials and products.

In 1961 a project had been approved by the Federal government for deepening the entrance channel to the Saginaw River and up the river. In connection with this project, Dow and two lake carriers advanced a total of $218,000 to repair two railroad bridges in Bay City; Dow's contribution was $25,000. In addition, Dow expected to spend about $26,000 to extend the additional depth from the channel in the river to its docks.

In 1961 the Corps of Engineers was engaged in a study of improving the channel of the Tittabawassee River to provide a navigable waterway from Saginaw Bay to Midland.

A permanent lowering of the water levels in the harbor at Ludington and in the Saginaw River in a substantial amount might have an adverse effect on Dow's water trans-

portation costs, on its cost of obtaining cooling water for its operations, and on the cost of maintaining its docks.

3. *Cement Industry of Michigan*

XI-9. The Huron Portland Cement Company plant at Alpena manufactures portland cement and masonry cement. The manufacturing facility is located on the shore of Thunder Bay in Lake Huron and is capable of annual production of 12,000,000 barrels of cement. Huron has other plants located in Michigan, Minnesota, Wisconsin and New York. All of these distributing plants receive the greatest majority of their cement or clinker via water transportation from Alpena.

At each location where Huron has a distributing plant, it has constructed or leased dock facilities to handle its incoming vessels, storage silos and equipment for loading of package or bulk cement into cars or trucks for delivery to customers.

XI-10. The Peerless Cement Company operates three cement plants in Michigan. The Port Huron plant is located on the St. Clair River below its junction with Lake Huron. The Jefferson Avenue plant is located on the Old Rouge Channel opposite Zug Island in the city limits of Detroit. The Brennan Avenue plant is within one-half mile of the Jefferson Avenue facility on the Rouge River.

These plants have a combined capacity of 6,500,000 barrels of cement annually. They receive stone and coal via self-unloading lake carriers. Under full operation these plants receive stone totaling 1,345,000 tons and coal totaling 255,000 tons annually. The stone is quarried at Calcite, Michigan, and shipped to Peerless plants at Port Huron and Detroit.

XI-11. Penn-Dixie Corporation owns and operates a cement plant on Little Traverse Bay of Lake Michigan in Petoskey which has an annual capacity of 2,700,000 barrels. In an average operating year, the plant uses

about 145,000 tons of coal, which is transported to its dock by water from rail terminals in south Chicago.

4. *Paper Industry of Michigan*

XI-12. The American Can Company has paper plants located at Menominee and Green Bay which constitute the major portion of its Northern Paper Products, Marathon Division. These plants in 1961 employed a combined total of 1,822 persons and had a combined annual payroll of $10,000,000. They receive woodpulp from the Marathon, Ontario, pulp mill via a company-owned motor ship, the D.C. Everest. Coal, limestone and sulphur are received at these plants via bulk lake carriers.

5. *Shipbuilding Industry of Michigan*

XI-13. The Defoe Shipbuilding Company has a shipyard located at Bay City on the Saginaw River which flows into Lake Huron. This company since 1905 has designed and constructed a variety of lake and ocean vessels, beginning with small pleasure and commercial craft, and expanding to the point where it now contracts for construction of specialized types of ships for the U.S. Navy and Coast Guard.

If the levels of Lakes Michigan and Huron were to be permanently raised, such higher levels would benefit this company by decreasing the amount of dredging necessary at its dock face and increasing the cushion of safety in the launching of its boats and their navigation to Lake Huron.

6. *Steel Industry of Michigan*

XI-14. McLouth Steel Corporation owns and operates steel plants located at Detroit, Trenton and Gibraltar, Michigan. In 1959 production was 2,040,000 ingot tons. This corporation is a producer of hot and cold rolled carbon and stainless steels. The corporation owns a dock on the Trenton channel of the Detroit River where it receives iron ore and limestone by water transportation. In 1960 McLouth received 2,400,000 gross tons of iron ore and 500,000 tons of limestone over this dock.

XI-15. Great Lakes Steel Corporation is a completely integrated steel company producing pig iron from ore in its own blast furnaces and steel in its open hearth furnaces from the blast furnace pig iron production and scrap. Plants in the Detroit area are the Blast Furnace and Coke Oven Divisions located on Zug Island in the City of River Rouge with main steel producing plants in the cities of River Rouge and Ecorse.

Materials used in the manufacture of pig iron are ore, limestone and coal. The availability of water transportation for these raw materials was one of the major reasons for the selection of the site of the plants of Great Lakes Steel Corporation.

Large quantities of water are required in the production of steel from raw materials. Most of this water is used as a cooling medium for the blast furnaces, open hearth furnaces, steel heating furnaces and condensers and is returned to the river with a slight rise in temperature. Two pumping stations and intakes at the Blast Furnace Division of Great Lakes Steel on Zug Island pump 120,000,000 gallons of water per day under full plant operation. One pumping station and intake at the main steel plant at Ecorse pumps 110,000,000 gallons per day, making a total of 230,000,000 gallons per day.

A substantial drop in the river level under low water conditions might adversely affect the pumping operations of the company.

### 7. *Mining Industry of Michigan*

XI-16. The State of Michigan in 1960 produced minerals worth over $400,000,000. There are large proven reserves of metallic and non-metallic minerals in Michigan. The continued profitable exploitation of all Michigan minerals depends to some extent upon the availability of cheap transportation by water.

8. *Automobile Industry of Michigan*

XI-17. The Ford Motor Company is a manufacturer of passenger automobiles, trucks, tractors and related parts and accessories. Its steel operations in Michigan include three blast furnaces, coke ovens, ten open hearth furnaces and a rolling mill, all operated on the Rouge River in Dearborn. In addition there is a large coal-burning powerhouse serving all of Ford's plants in the Rouge area. It is one of the many Michigan industries having its own intake and pumps 500 MGD of Great Lakes water for use in its plants.

Ford Motor Company owns a fleet of five vessels operated as an adjunct to its steel operations. They are the Henry Ford II, the Benson Ford, the William Clay Ford, the Ernest R. Breech, and the Robert S. McNamara, all engaged principally in carrying iron ore from Lake Superior ports to Ford's steel mill, and also carrying coal and limestone to the Ford plants in Dearborn.

The limiting depth of water, so far as Ford's Rouge operations are concerned, is the depth of the Rouge River and at Ford's docks.

It is the practice to load the Henry Ford II and the Benson Ford to maximum capacities, at drafts of 22′ 3″ and 22′, respectively, pushing these ships through the mud bottom of the Rouge River. The Ernest R. Breech has a maximum draft of 24′ 10½″ and the Robert S. McNamara 20′ 5″. The William Clay Ford, which has a maximum draft of 25′, is loaded to a draft of only 23′ since deeper loading may cause the ship to become stranded.

Ford Motor Company has a slip on the Rouge River which is 250 feet wide and 3,000 feet long. On the east side of this slip there is an ore dock 500 feet wide and 2,600 feet long. This dock is built of reinforced concrete and is supported on timber piling 40 feet in length under the bins and 60 feet in length under the walls.

These piles are below the water level but are driven into a very plastic blue clay which has a shear value of only 100 pounds per square foot. Any lowering of the water

reduces the resisting force of the water against the side of the dock and also reduces the load of the water on the bottom of the slip which is resisting an upheaval of the soft clay under the slip bottom. The 1,500,000 tons of material stored in the ore bins create a surcharge load on the plastic clay underlying these bins and a lateral force on the dock wall.

Ford has not dredged the Rouge River to a greater depth because the support of river banks, dock structures and buildings developed by the soil mass along the river would be decreased beyond acceptable limits and their stability jeopardized by dredging. When the channel is deepened, there are dimensional changes in supporting elements in the soil mass which are of significant magnitude. The cost of changing various structures along the Rouge River to give them sufficient stability to permit deepening the river would possibly amount to millions of dollars.

9. *Instability of Industrial Docks; Rouge River*

XI-18. In the construction and use of docks, facilities for mass storage and industrial buildings along navigable waterways in the Great Lakes, consideration must be given to the geological origin of soil deposits in these areas. The controlling factor is the lacustrine clay varying in depth from 75 to 150 feet, deposited as a sediment along the borders of postglacial lakes. These lakes, now the Great Lakes, once much larger, have shrunk to their present size, leaving these depths of sedimentary clay of varying consistency. Under favorable drainage conditions, the surface strata may have decreased in moisture content due to evaporation, but at greater depths moisture contents of this clay have changed little, and they are soft to plastic in consistency and of low shearing resistance.

In many places the loading or pressure differential on the underlying clay mass with respect to the channels, due to the difference in weight between soil and water, exceeds the static resistance of the clay. These areas are subsiding slowly and there is lateral movement or displacement to-

ward the channel going on without any superimposed load on the bank. Nevertheless the demand of industry to use these areas for docking facilities and mass storage is imperative and the development of this potential has resulted in a design and construction procedure somewhat unusual in engineering practice.

There are no safety factors possible comparable to those used in other fields of structural engineering. Docks for mass storage are designed at overload ratios of 2 to 3, the usual limit being 2.5, and these designs are normally based on a low water datum established by the Corps of Engineers. The overload ratio is defined as the ratio of applied stress to the yield value or limit of static resistance. In the design of docks and mass storage facilities, stress due to applied loads is usually well beyond the elastic limit and progressive or continuing displacement is an accepted fact, with rates of movement from a fraction of an inch to several inches per five years.

Overload ratios above 3.5 are liable to result in sudden mass movement and embankment failure. An overload ratio of 4.0 is theoretically the failure point. The problem of calculating mass stability becomes a statistical evaluation of the probability of failure which must include the potential ranges of experimental errors in measuring the controlling factors. These errors may be a temporary increase in the overload ratio due to abnormally low water levels, overloading of the dock due to poor operating control, abnormal variation in soil resistance, or experimental errors in test procedure, design miscalculations, and variations in controlling depth of dredging. Any one or a combination of several of these factors could put a given dock structure in the failure zone, as demonstrated by actual experiences in the River Rouge area.

The River Rouge valley is an area where conditions of soil instability are more critical than those found in the Great Lakes area as a whole. It is low-lying and poorly drained, and the underlying clay is so soft that it approaches the lower limit of reliable shear testing. In some

places it may be described as being of toothpaste consistency.

In general, the loading condition with the presently maintained dredged depths in the River Rouge channel is such that the overload ratio is close to the upper limit possible without any superimposed load. In the lower reaches of the river, where docking facilities are in greatest demand, the existing overload ratios range from 2 to 2.5 and sometimes higher. There have been rather frequent embankment failures in this area.

As above indicated, the preferred design limit for mass storage docks has been an overload ratio of 2.5 based on LWD. Water levels lowered to less than LWD move the existing design limits to a higher overload ratio so that reduction in amount of mass storage becomes necessary to maintain the margin of safety.

The amount by which the load-carrying capacity of the soil would be reduced if the level of the adjoining water were reduced one inch is so slight that it could not be determined by computations utilized in normal engineering practice.

## XII. Recreational Interests of Plaintiff States

### A. State of New York

XII-1. The State of New York for many years has fostered the development of many of its natural resources which can be devoted to public recreational use. The Division of State Parks of the State of New York has the primary function of creating and operating outdoor recreational facilities for the public. The Division of Fish and Game of the New York Conservation Department maintains fish hatcheries and game farms and acquires and manages property such as streams, lakes, forest and upland areas for fishing and hunting purposes.

XII-2. It has been estimated that park use in general in the entire State of New York has increased at the

rate of eight percent a year since World War II, and annual attendance at the State parks is presently in excess of 30,000,000 persons. Revenues average $3,000,000 per year. The annual operating budget of the Division of State Parks has been increasing and is now more than $12,000,000, and the State has made capital outlays in the range of $3,000,000 to $6,000,000 per year for park development in some years.

XII-3. The development of the Great Lakes shoreline by New York for park purposes began in 1925 and now comprises some 8,571 acres of park land along 29.4 miles of shore front. A New York witness estimated that $7,500,000 has been expended for land acquisition and development of parks along the shores of Lake Ontario and Lake Erie in New York State. The Niagara Frontier State Park Commission has eight State parks under its jurisdiction on the Great Lakes, and the Thousand Islands State Park Commission has 14 such parks. Total attendance at the park areas along the Great Lakes shorelines was over 2,000,000 in 1959, approximately twice the attendance recorded in 1948.

XII-4. In addition to expenditures directly by the State of New York to foster the park program along the Great Lakes shoreline, Power Authority of the State of New York has expended money for recreational purposes in connection with its St. Lawrence project, which includes the St. Lawrence State Park, which has been turned over to the Thousand Islands State Park Commission.

This park includes a 1,200-feet bathing beach and a parking space for 600 cars.

The amount expended by the Power Authority for recreational purposes in connection with the St. Lawrence project is in excess of $2,800,000.

XII-5. Recreational expenditures by the Power Authority also include the Coles Creek campsite near Waddington, New York, which has available 44 trailer sites and 66 tent sites, which area the Power Authority has graded,

landscaped and provided with street lighting, toilets and a small beach; a wildlife refuge at Wilson Hill seven miles west of Massena, consisting of approximately 2,765 acres, of which 1,750 are covered by water and which the New York Conservation Department has stocked with large-mouth black bass and pan fish; and the Coles Creek Marina near Waddington, New York.

XII-6. At Niagara Falls, Power Authority has spent money on improvements directly related to preservation and enhancement of the world-known scenic beauty of the falls and the accommodation of tourists. These improvements include the Tuscarora Park, to which, although it is now under the jurisdiction of the New York State Department of Parks, the Power Authority contributed an overlook building and reception center, including parking lots, and a scenic drive and park on the American side of the Niagara River.

The amount expended by the Power Authority for improvements directly related to the preservation of the scenic beauty of the falls is in excess of $25,000,000, exclusive of the cost of the remedial works in the Niagara River. The amount contributed to the Tuscarora Park by the Power Authority was about $300,000; while the Park itself cost approximately $2,100,000.

The scenic drive and park on the American side of the river cost approximately $15,000,000. About 3,000,000 people annually visit the falls.

XII-7. The Thousand Islands region has long been recognized as one of great natural beauty and offers as well opportunities for fishing, pleasure boating, duck shooting and other hunting and provides a study area for those interested in fish and wildlife. Although most of the islands are privately owned, the general public may avail itself of the natural facilities and enjoy the beauties of the landscape through the medium of the State parks. In 1959 attendance at the State parks in this area approximated 700,000 per-

sons. The trend of attendance is increasing, and the State Park Commission is engaged in an expansion program for the acquisition of more land and the further development of park facilities.

XII-8. Tourists patronizing parks in the Thousand Islands region primarily use small boats of the outboard class ranging from 12 to 20 feet in length and small cruisers of 20 to 40 feet in length. Present facilities will accommodate at one time about 600 boats of the outboard class and provide anchorage for about 50 small cruisers. The main boating activity is to fish in the waters around the many islands and to take excursions by boat to view the great scenic spectacles that the islands possess. The channels traversed by tourists in small boats include shallow passages, some of which are narrow, and include shoals.

Some of these shallow passages in the area of the Thousand Islands are not more than two or three feet in depth and some of the shoals are uncharted, thereby constituting hazards to inexperienced navigators during periods of low water.

When low water levels prevail in Lake Ontario, boating in the Thousand Islands area is impaired and any further lowering* in levels would augment such damage, by causing more shoal waters, making some areas inaccessible and other areas hazardous for navigation. Conversely, any rise in levels will improve conditions by making more areas available for navigation.

XII-9. Some New York communities at the eastern end of Lake Ontario and in the vicinity of the Thousand

* In this connection it must be remembered, however, that the level of Lake Ontario is regulated under international agreement by the International Joint Commission. Accordingly, unless the criteria agreed upon by the United States and Canada for such regulation (see Finding II-30) are changed or regulation itself is abandoned, the levels of Lake Ontario will not go below 244.0 in the spring, summer and autumn and even in the winter extremes of low stage will be reduced.

Islands are largely dependent upon the tourist trade and commercial activity related thereto. Industry in that area is on the wane. The most dollar volume of business in such communities is thus derived from the influx of tourists during the summer months. During the winter months, many commercial establishments, such as inns, hotels, motels, and restaurants, are either closed or operated at sharply reduced rates of activity.

Because of low water conditions during 1959-60 in the Thousand Islands area, many docks and slips were rendered useless; at others extensive dredging had to be undertaken, and new docks had to be constructed to replace those which the low levels had rendered unusable. Extensive reconstruction, including rock blasting, had to be undertaken at some of the shorefront facilities because of the low levels. In some cases, the low levels forced shorefront facility owners out of business. The muddy water resulting from shallow depths damages boat engines.

The low water levels, in addition to decreasing the value of commercial property, have also caused damage to private residences, with a resulting decrease in property values.

The effect of low water levels on the tourist trade is of vital concern to the entire community. Any further lowering* of levels from those experienced in 1959-60 will greatly curtail the commercial boating establishments in this area, since all of them are operating on a marginal basis. This will be economically disastrous to the area which is heavily dependent on tourism. Experience in the past has shown that low water levels have a marked deleterious effect upon the tourist and associated trades, due to the increased hazards to small boat navigation and the concomitant inaccessibility of certain areas.

XII-10. The marshlands abutting Lake Ontario and the St. Lawrence River provide nesting or feeding grounds for ducks and other types of waterfowl, such as Canada

* See footnote to Finding XII-8.

geese, rails, gallinules and coots. Biologists estimate that approximately 25,000 ducks are reared annually in these marshes. The area is used by hunters and also those interested in the preservation and study of fish, game and other wildlife. There are approximately 50,000 acres of marshlands along the New York shore of Lake Ontario that provide nesting and feeding grounds and natural habitat for game birds and such wild animals as muskrats and mink. Fish, such as walleyed pike, northern pike, yellow perch, bullheads, large-mouth bass, small-mouth bass, sunfish, smelt, white bass, suckers, carp and minnow, inhabiting Lake Ontario migrate to the bays and use the marshland areas for spawning, rearing their young and feeding.

XII-11. In the counties bordering on the Great Lakes or the Niagara and St. Lawrence Rivers, 26,916 combination fishing and hunting licenses were issued, and 47,037 fishing licenses were sold during the license years 1958-59. Sixty-seven fishermen were licensed for commercial operation on Lake Ontario, and the recorded catch was 261,073 pounds of fish. Duck stamp sales records for the years 1956 and 1957 indicated 24,498 sold. A New York witness estimated that annual expenditures by sportsmen are around $169,365,000 for fishing and around $54,512,000 for hunting, and that the annual average personal expenditure of such sportsmen is around $125. Seven marshes in Cuyahoga County, New York, comprising about 498 acres, produce an average annual muskrat harvest of four pelts per acre, and eight registered marshes in Oswego County, encompassing some 532 acres, average approximately 1,960 muskrats per year. It is estimated that the Lake Ontario marshlands as a whole produce annually 100,000 muskrats as the trappers' harvest. Some fish, game and other wildlife depend upon marshland plant life to provide food and shelter. Historically, shallow waters at lake and river edges have risen and fallen and have thus created more or less saturated soil on which marsh vegetation is grown, upon which marsh birds and mammals feed and in which they seek shelter.

XII-12. Some shallow water areas are referred to as the "feather edge". In the feather edge areas the depth of water may run from six inches to the point of saturated soil.

The type of plant life referred to in Finding XII-11 is dependent on frequent submersion of the soil. Continued growth and health of such marsh vegetation in the feather edge is essential to marsh-loving birds and mammals for their food, shelter and breeding habitat. In addition, the shallow waters of the feather edge produce an abundance of frogs and invertebrates which are important as food to birds, mammals and fish feeding in these areas.

The New York marshlands occur on those segments of the lake shore known as the lake plains, where the lands bordering the lake are characterized by long, gentle gradients to the lake's edge. Due to the very slight gradient a permanent decrease* in the average range of elevations of Lake Ontario by as little as one inch would tend to dry up this feather edge area and thereby alter the character of the plant life providing feed and shelter for the inhabitants and impair the value to marsh inhabitants. A permanent increase in the range of lake levels, because of the gentle gradient of the plain, would correspondingly increase the area of the feather edge, providing greater water plant growth and greater usefulness for marshland inhabitants. The welfare of the thousands of migratory waterfowl utilizing the marshlands affects the Canadian provinces and many states to the south of New York, as far as Florida.

A permanent increase in the range of elevations of Lake Ontario of two inches or more would provide additional spawning and feeding areas for fish, and a permanent decrease* would reduce such areas.

The Canadian shore of Lake Erie is similar to the New York shore of Lake Ontario in that there are extensive marshlands which provide the same benefits for fish and wildlife as the New York feather edge.

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* See footnote to Finding XII-8.

XII-13. Along the shores of Lake Erie and particularly in the area of Buffalo and the Niagara River, recreation activities such as boating, fishing, swimming and other aquatic sports are enjoyed.

It is estimated that over 1,000,000 people annually use the facilities at Beaver Island and Evangola State Parks in the Niagara Falls area. At Beaver Island State Park there are beach and picnic facilities which can handle up to 30,000 people at one time. During the summertime 50 to 60 boats are often tied up near the beach. Evangola State Park has facilities to handle up to 20,000 people. At Grand Island a boat basin has been constructed which can hold 160 to 200 boats.

The amount spent and being spent by New York State for these parks through 1959 was about $3,800,000. The State was also contemplating at that time spending an additional $800,000 for the development of a site at Four Mile Creek on Lake Ontario for small boating and camping.

Low water levels at these parks, such as those that prevailed in 1959, impair the use of the boating, fishing and bathing facilities at these parks. Any additional lowering* will reduce or eliminate the shallow water boating and fishing areas preferred by the public. Conversely, the raising of water levels will materially improve the beach and anchorage facilities at the same parks.

XII-14. Pleasure boating has been increasing rapidly each year. The type of boat in use varies from luxury yachts to small outboards which are brought to the water by automobile. There are houseboats which can be moved from anchorage to anchorage and serve as a summer residence for the owners. There are also large numbers of fishing boats and speedboats of many types, from the high-speed inboard motor cruisers down to the simple, low-power outboards. Watercraft use includes everything from long-range cruising, racing, water skiing and other aquatic

* See footnote to Finding XII-8.

sports, to fishing and the simple low-speed transportation for picnicking or other family purposes.

XII-15. There are some eight yacht clubs, 18 marinas and two small boating facilities in the Buffalo-Niagara River area, as well as four boat liveries, at some of which docking or mooring facilities are available. In addition, certain private estates bordering on the lake and river are equipped with docking facilities. The membership of the yacht clubs ranges from 150 to 500 members. A New York witness, fleet captain of the Buffalo Launch Club, reports that club's investment in plant and buildings at approximately $175,000. The total investment in marinas in the area is estimated by a New York witness to be in the order of $2,700,000. Employment at the yacht clubs is estimated by the same witness as between 40 and 50 persons and at the marinas some 250 persons, at an estimated average wage of approximately $100 per week. Investment in the assorted businesses that are dependent upon the yachtsman trade, such as restaurants, motels and lodging houses, varies, according to the estimate of the New York witness, from luxury establishments, valued at approximately $175,000, down to the simpler facilities. These businesses also provide employment for the adjacent communities and account for expenditure of money. The boatyard industry and actual sales of craft of all kinds are also dependent upon recreational use of the waters. The volume of business depends upon weather, economic and water conditions and, a New York witness estimated, might range from $450,000 in a good year to $75,000 in a poor year. There are 36 boat and motor dealers in the Buffalo-Niagara Falls area that are members of the Marine Trade Association.

On the Niagara River and Lake Erie there are nearly 10,000 inboard boats registered. The number of outboards is unknown but it is estimated to be considerably in excess of that figure.

Pleasure boating activity on Lake Erie and the Niagara River is affected to a very great extent by water levels.

Most of this activity centers around the Niagara River. According to insurance underwriters' statistics in the area, as testified to by Lake States' witness McGroder, motorboat accidents during the past few years of low water increased some 70 percent. These accidents have generally occurred when boatmen who have successfully navigated specific areas during periods of high water levels, not aware that such areas are no longer safe for navigation, have cracked up their boats on rocks and shoals. These accidents have occurred at Horsehoe Reef and Strawberry Island in the Niagara River, Beaver Island Park near Grand Island, Crescent Beach on the Canadian shore of Lake Erie, and in the Waverly Shoal area in Lake Erie. Any further lowering of levels would probably increase these hazards to boatmen.

XII-16. Pleasure boating and the other aquatic recreation activities available in the Buffalo-Niagara Falls area serve as an inducement to business concerns to locate nearby or to continue to maintain establishments previously located.

XII-17. While the topography of the New York shore of Lake Erie is such that the area is already well developed by industry and there are few swamplands which are essential to waterfowl propagation and form a natural habitat, the Canadian shore is flat ground sloping gently to the lake, where seepage creeps up creating swamps and marshes that provide an excellent feeding ground and habitat for wild birds. At least fifteen clubs or sporting groups own or lease shooting property in and around Turkey Point, Long Point and Port Rowan, Ontario. The hunters enjoying these facilities are predominantly United States citizens from the Buffalo area and their guests. On an annual basis it is estimated that some 300 people use the Ontario marsh preserves for hunting during the season. The land on which these shooting clubs and preserves are located is valued at an average of $100 per acre, which indicates a total valuation of roughly $2,000,000, not including the clubhouses, storage

facilities and other equipment estimated at an investment of at least $150,000. The shooting preserves provide almost the only employment that many of the local residents can obtain during the fall season. The employment cycle begins in late March with the trapping of muskrats. The trapping privileges are leased by the marsh owners to persons acting as caretakers and guides. During the summer months the residents serve as fishing guides, and after Labor Day they obtain employment in the marshes, preparing them for the coming hunting season. From the first week in October until the middle of December there is employment by the hunters. The maintenance of these shooting preserves, therefore, provides employment for at least sixty families nine months of the year and also affects shopkeepers selling supplies and small country hotels for those hunters not accommodated by the clubs.

XII-18. At Buckhorn Island State Park (located at the north end of Grand Island), where the State owns some 896 acres of shoreline and woods, there are extensive inland bays and marshlands which provide natural habitats for fish and wildlife. Permanent reduction of the water level below historic levels would dry up some of these areas. The northern end of this park, an area called Burnt Ship Creek, where levels are influenced by those of the Niagara River, is an excellent spot for fish propagation and provides a haven for wild fowl as well. Such a permanent loss in water elevation might eliminate the wildlife sanctuary that the Burnt Ship Creek area provides. This would entail a serious loss to the recreational use of the whole Niagara frontier because the marshes surrounding Burnt Ship Creek are the only grounds of this type along the river or the lake in the Niagara area on the American side.

Because of the very shallow depths in the creek, even a slight lowering of the Niagara River level has a noticeable effect upon depths in the creek and upon the marsh area. Conversely, any increase in the levels improves the area for fish and wildlife purposes, since there is ample area on either side of the creek which could, by increased

flooding, provide the marine vegetation and marshlands necessary for fish and wildlife purposes. There are also many creeks which empty into both Lakes Erie and Ontario. Sandbars exist at the mouths of almost all of these, so that a lowering of lake levels would leave the pools upstream from the mouths isolated, creating stagnancy and pollution. Fish would be trapped in the pools, which would end their migration and propagation.

Low water is also making the small boat harbor maintained by the Port Authority of the City of Buffalo for small boat owners unsatisfactory for boating activities due to the fouling of propellers on dense weed growth. Any further lowering of levels would aggravate these conditions, and, conversely, any increase in levels would aid the small pleasure craft operators and the various facilities used by them.

B. State of Pennsylvania

XII-19. The western portion of Erie harbor is primarily used for recreational and tourist activities. The peninsula, about 6¼ miles in length and 3,200 acres in area, contains the Presque Isle State Park and public and private recreational and tourist facilities and attractions, including a marina, boating, mooring and docking facilities. In 1960, an estimated 3,000,000 people, and as many as 62,000 in a single day, visited Presque Isle State Park.

XII-20. The Commonwealth of Pennsylvania expended over $6,000,000 between 1955 and 1960 for the protection and the development of Presque Isle State Park and to build up the shore lines of the peninsula. In addition, money from private and city sources has been expended to protect and develop this area. Future programs and plans call for the expenditure of millions of dollars annually to further develop the area.

XII-21. There is no doubt that dredging of Presque Isle Bay would, to some degree, be destructive to fish and aquatic life, and it would be difficult to determine the extent of loss.

The Pennsylvania Fish Commission recommends that dredging be carried on in the fall months to keep to a minimum the interference with the spawning of fish.

XII-22. Presque Isle State Park has the only large public beach in the area and draws people from Ohio, Pennsylvania, and New York, for whom private investors have provided adequate rail, bus, air and motor transportation in addition to numerous hotels and summer cottages.

XII-23. The contribution of Presque Isle State Park to the economy of the area has been estimated by the Erie Chamber of Commerce to be $35,000,000 annually and is anticipated to rise to $60,000,000 within the next ten years.

XII-24. The Commonwealth of Pennsylvania cooperated in the development and improvement of five miles of beach frontage in Presque Isle State Park and has (a) improved highway access to the park by 2.5 miles of new roads; (b) built three new beach pavilions with bathrooms and parking areas; and (c) installed new water and power lines. These expenditures from 1956 to 1959 totaled $1,429,000.

XII-25. The net movement of beach material is due to wave action and littoral currents from prevailing westwardly winds.

C. State of Michigan

XII-26. Out of a total area of land and water of 96,720 square miles, within the boundaries of the State of Michigan there are, when the lakes are at their high water mark, 39,698 square miles of Great Lakes water.

XII-27. Marshes constitute the feeding and breeding grounds of many kinds of fish, amphibians, reptiles, birds, mammals, and a great many life forms that make up the food chain for the higher animals. All 26 species of waterfowl common to Michigan utilize the Great Lakes system.

The open waters have particularly heavy use by diving ducks during migration periods, but the wetland meadows, shallow waters and shoreline are feeding areas for all species and provide the best hunting grounds. The vegetation which grows in the shallows is necessary for waterfowl as protective cover and for hunters as concealment. Migratory waterfowl passing through and using these marshes for resting and feeding have exceeded well over 1,000,000 in recent years. Surveys show that more than 27 percent of Michigan duck hunters' efforts are expended here, and that 35 percent of total state duck kills occurred in counties bordering these waters. The Great Lakes marsh areas are also used extensively for such pursuits as hunting of game animals, trapping, and study and observation of animal and plant life.

The Michigan Department of Conservation has engaged in a land acquisition program to save remaining natural marshes from exploitation and to develop and improve these areas. The State-owned Pointe Mouillee marsh located at the mouth of the Detroit River contains 2,608 acres. Lake St. Clair is an important waterfowl concentration area, the Michigan portion of which contains 11,350 acres. In the Saginaw Bay area there are over 133 miles of shoreline, including islands, which contain some 415,395 acres of habitat valuable for waterfowl. The Michigan Department of Conservation has included large segments of this shoreline in its acquisition projects to provide for public fishing and hunting.

Surveys indicate that a rise or fall of Lake Erie levels of six inches would affect an area 1,050 feet in width over a reach of 3.9 miles along Lake Erie shores in the vicinity of Pointe Mouillee, and could be expected to affect 500 acres of marsh. In the Saginaw Bay area, Lake Huron levels in the range of elevation 580 to 581 would flood these inland marshes to varying extents, and a reduction of six inches would change these lake plain marshes from ponds and fringe marshes to dry bogs. Lake Huron levels also control the levels inland in the Shiawassee River State

Game area. Weirs have been constructed to maintain certain levels of water in this area, and any substantial lowering of the levels of Saginaw Bay in Lake Huron would affect the operation of these weirs and the pumps that have been installed to transfer water behind the weirs. The water levels of Lakes Michigan, Huron and Erie thus influence thousands of acres of shoreline marsh areas important to wildlife.

XII-28. Prior to the depredations of the sea lamprey the waters of the Great Lakes supported an extensive fishery exploited commercially. Steps are now under way to control the lampreys and thereby to restore the lake fisheries.

XII-29. The tourist business adds substantially to the economy of the State of Michigan. This business is closely geared to the State's water resources. The use of these water resources has stimulated extensive resort development along Michigan's Great Lakes shoreline. The volume of Michigan's tourist activity is, however, dependent upon a number of factors. Water pollution is a factor which may adversely affect the tourist business.

Moreover, the recurrent periods of low water in the Great Lakes produce conditions which detract from the scenic beauty and usefulness of these shores for private property owners and the general public. A permanent lowering of water levels of six inches or more would, during periods of low water, perceptibly add to these conditions.

XII-30. Michigan ranks second in the nation in its total fleet of recreational water craft. Of a total of about 550,000 such craft, approximately 390,000 are operated at one time or another on the Great Lakes and waters connecting thereto.

XII-31. Since 1947 the Michigan State Waterways Commission has been engaged in the promotion and construction of a marine highway along the shores of the Great Lakes bordering Michigan. The basic purpose of this marine

highway is to provide a refuge harbor every 30 miles along the entire shoreline of the State to assure that no recreational watercraft will ever be more than 15 miles from a haven of refuge in time of storm or distress, and also to provide suitable transient facilities for traveling boatmen in existing harbors. The marine highway program is financed from a combination of Federal, State and local funds. A permanent lowering of the levels of the lakes of six inches or more would tend to affect these harbors of refuge adversely. On the other hand high water levels such as those experienced in 1952 have caused considerable damage to yacht clubs and marina facilities situated on the Great Lakes.

XII-32. The U. S. Coast Guard requests small craft on the Great Lakes to operate outside the channels dredged for big boats by the Federal government. Water depths of less than 10 feet restrict a certain number of recreational craft; and as the depths decrease, more and more such craft are restricted. Water less than three feet in depth would be available only for outboard craft moving at slow speeds. There are a great many areas on the Great Lakes, particularly the bays, inlets and harbors, where the prevailing depths are such that slow speed and considerable caution are required.

Variations in the water levels of the Great Lakes can endanger pleasure craft by causing confusion and uncertainty as to the existence of shoal areas, lessened channel depths and other marine hazards.

XII-33. The City of Detroit maintains public parks along its river frontage. The design and operation of many of the recreational facilities in these riverfront parks are directly related to the level of the river, the annual variation in which averages 1.5 feet. The City of Grosse Point Park maintains a public park on the shore of Lake St. Clair with a marina the operation of which is directly affected by the lake levels. The Cities of Escanaba, Menominee and Charlevoix each maintain public parks on the shores of Lake

Michigan. These parks include bathing beaches and marinas which are directly affected by lake levels. The permanent lowering of the water levels by six inches or more would adversely affect many of these facilities. There is no evidence, however, that it has not been possible to accommodate these facilities to the substantial monthly, annual, and long range fluctuations of lake levels which have taken place in the past.

In 1960, out of a total of 61 state parks in Michigan, 27 were located on the Great Lakes. Michigan has also retained in state ownership some 126 shoreline miles of state forest lands primarily for outdoor recreational purposes.

The waterfront recreational facilities built and maintained by the City of Detroit along the Detroit River were designed to function at 573 feet above mean tide New York. The average recorded elevation of the Detroit River has never been below 573 in the summer months, and Detroit has no record that it has ever been below 573 on any day during the summer.

XII-34. There is no evidence of any action taken or contemplated to be taken by the defendants that would result in a permanent reduction in lake levels of as much as six inches.

D. State of Wisconsin

XII-35. Approximately 12,000 Wisconsin pleasure boat owners navigate their boats on Lake Michigan. Over 1,000 pleasure craft are moored in yacht basins in Wisconsin Lake Michigan harbors during the summer.

## XIII. Recreational Facilities at Chicago

XIII-1. The Chicago Park District, created in 1933, is responsible for the development, operation and maintenance of parks, beaches, harbors and other public recreational facilities within the corporate limits of Chicago. Chicago has about 30 miles of shoreline on the lake, some 24 miles of which is publicly owned. Virtually all publicly owned lake

frontage, with the exception of six small sites devoted to military installations, is developed for public recreational uses and is dependent upon Lake Michigan and its shoreline for its principal scenic and aesthetic features.

XIII-2. Among the lakefront recreational facilities operated and maintained by the Chicago Park District are 14 major and 14 secondary or "street end" beaches. The beaches occupy 6.7 miles or 28 percent of the total publicly owned lake frontage. Seven boat harbors provide mooring space for 1,881 craft. In addition to the seven harbors operated and maintained by the Park District, the U.S. Coast Guard manages the Grant Park harbor which has accommodations for 500 craft.

XIII-3. Total attendance at Chicago's lakefront beaches was 9,880,000 in 1964; the day of peak attendance in that year was August 2d, when 528,000 people used these beaches. The Park District's 1965 budget allocated $894,607 for the operation and maintenance of the lakefront beaches, a portion of which is used to pay the salaries of persons employed in providing lifeguard and related services at these beaches.

XIII-4. In 1964 all of the 2,104 mooring facilities in the Park District's lakefront harbors were occupied, and 2,652 permits were issued to boat owners for the utilization of lakefront boat launching ramps. The Park District's 1965 budget allocated $183,078 for operating and maintenance expenses at the lakefront harbors.

XIII-5. An officer of the Park District testifying on behalf of Illinois estimated that the replacement cost, at 1962 construction cost levels, of Chicago's lakefront bathing beaches was about $20,000,000. The same witness estimated that the above cost accounts for about one-fourth of the total investment in publicly owned lakefront property.

XIII-6. If the defendants were to return sewage effluent to Lake Michigan in the manner and amounts suggested by plaintiffs, the quality of the water in the Park District's harbors and adjacent to their lakefront beaches might be

impaired, and their value for recreation might be substantially reduced. If such impairment of water quality occurred, the value of Chicago's water-oriented recreational facilities would be substantially depreciated.

## XIV. Water Quality at Great Lakes Beaches

### A. Milwaukee Beaches

XIV-1. Beaches within the breakwater at Milwaukee, Wisconsin are at times closed to bathers because of pollution of the waters of the harbor by sewage effluent and storm water carrying raw sewage.

### B. Monroe, Michigan, Beaches

XIV-2. The waters of Lake Erie along Sterling State Park near the City of Monroe, Michigan, are so polluted as to be unsafe for bathing.

### C. Ohio Beaches

XIV-3. The beaches of the City of Toledo, Ohio, situated on Lake Erie have been so polluted as to be unsafe for swimming since 1955.

XIV-4. The water at Cleveland and Huntington Park Beaches in Ohio has, for more than ten years, been so polluted by sewage and sewage treatment plant effluent as to make it unsafe for swimming.

### D. Chicago Beaches

XIV-5. Throughout the swimming season the Chicago Park District takes water quality samples on an average of two or three times a week at each of some 35 or 40 sampling points situated on the Park District's 28 beaches fronting on Lake Michigan. The water samples are tested, among other things, for the most probable number (MPN) of coliforms and streptococci or enterococci.

XIV-6. Judged on the basis of standards set forth by the Michigan Stream Control Commission, and adopted

by the Great Lakes Board of Engineers, for evaluating water quality on the basis of the coliform organisms contained in 100 ml samples, the water at the Chicago Park District's Lake Michigan beaches during the period 1950 through 1962 was generally acceptable for bathing purposes.

XIV-7. Analysis of the 4,471 Lake Michigan beach water samples taken by the Chicago Park District during the period 1950 through 1962 and based upon the standards of the Illinois laboratory routine which takes into consideration the enterococcus concentrations in the water as well as the coliform concentrations, more severe standards than those of the Michigan Stream Control Commission, indicates that 91.3 percent of the samples reflect water acceptable for bathing purposes.

XIV-8. If defendants were to discharge sewage effluent into Lake Michigan in the manner and amount suggested by plaintiffs the lakefront beaches in Chicago might become as contaminated as the beaches at Milwaukee, Wisconsin; Monroe, Michigan, and Toledo, Cleveland and Huntington Park, Ohio.

## XV. Findings in No. 11, Original

### A. Elmhurst — Villa Park — Lombard Water Commission Project

XV-1. The City of Elmhurst, the Village of Villa Park and the Village of Lombard are located in DuPage County, west of Chicago. Elmhurst, the easternmost of the municipalities, has its eastern boundary 14 miles due west of Lake Michigan and immediately west of the Cook-DuPage County line. Villa Park adjoins Elmhurst to the west, and Lombard lies immediately west of Villa Park. Their location is shown on Ill. Ex. 7, which is included in the Appendix to this Report. The water supply for these communities has been procured from local wells.

XV-2. The municipalities of Elmhurst, Villa Park and Lombard, hereafter "sponsor municipalities," in September 1955, formed the Elmhurst-Villa Park-Lombard Water Commission, hereafter the "Water Commission" or the "Commission," a municipal corporation with authority from the State of Illinois to acquire water supply, treatment and pumping facilities. The effort to form the Water Commission began in 1953, when the City of Elmhurst first took steps to alleviate a water shortage which had existed for several years. The City's first steps were in the direction of more advantageous use of its existing supply, and included installation of additional storage tanks for use during peak supply periods, drilling additional wells and the like. In 1955 the sponsor municipalities asked the Illinois Legislature to pass legislation enabling them to join in a project to go to Lake Michigan for a permanent source of water supply. Such legislation was passed in that year.* In 1956 consulting engineers were employed to consider the possibility of a Lake Michigan water supply. Prior to their employment, the City of Elmhurst had approached the City of Chicago to inquire into the possibility of obtaining water from it and had been told, generally, that enlargement of Chicago's mains to carry water in excess of Chicago's current needs to a point near Elmhurst would be extremely expensive and that the City of Chicago could not commit itself to carry out such a project. The Water Commission's consulting engineers reported that it was, in their opinion, physically and financially feasible to obtain a supply of water from Lake Michigan for the use of the Water Commission.

XV-3. The Water Commission thereafter entered into 50-years contracts to supply water to each of the sponsor municipalities and 40-years contracts to supply water to the villages of Addison and Bensenville, which are located just north of Elmhurst and Villa Park. Water sup-

* Illinois Revised Statutes 1957, Chapter 24, §§81-1 to 81-8, Laws 1955.

ply contracts were also entered into with the Elk Grove Sewer and Water Company, Inc., serving Elk Grove Village, for a 30-years period and the General Electric Company, which owned a large industrial site adjacent to Elk Grove Village, contracted for a 40-years supply. Elk Grove Village is located some eight miles north of Villa Park in Cook County. The General Electric Company later determined not to build a facility at its industrial site, and no water using facility has been constructed there. These contract purchasers, both municipal and corporate, other than the sponsor municipalities, are hereafter termed "contract customers".

XV-4. The contracts with these sponsor municipalities and contract customers provide that the Commission will supply the buyers' requirements for water during the contract period, subject to a maximum limit on the amount required to be supplied in any one day to each sponsor municipality or contract customer in the aggregate amount of 32.20 million gallons per day (MGD), which is equivalent to 49.8 cubic feet per second (cfs).

XV-5. The Water Commission proposed to build a facility to bring water from Lake Michigan to each of its sponsor municipalities and contract customers. The proposed facility consisted of a lake intake located 3,900 feet off the shore of Lake Michigan with its base 25.5 feet below the low water datum plane for Lake Michigan. This lake intake would be connected to a raw water pumping station, located at the northern boundary of the Village of Glencoe, Illinois, on the shore of Lake Michigan. The pumping station was to be located on property purchased from the Lake Shore Country Club. An agreement for the purchase of that property was executed and a special use permit from the Village of Glencoe allowing the construction of the pumping station was obtained. Both the Country Club and the Village of Glencoe reserved the right to purchase untreated water from the Commission up to a limit of 0.5 MGD (0.77 cfs) and 12 MGD (18.6 cfs), respectively. Both

presently use Lake Michigan water for their domestic purposes.

XV-6. The untreated water would be pumped westward on a right-of-way along a state highway and then approximately 14 miles southwest, along a 20-foot easement granted along its right-of-way by the Chicago and Northwestern Railway Company, to a filtration plant. The Commission proposed to build a 42-inches transmission main, a capacity sufficient to supply 57.8 MGD (89 cfs) which was estimated by the Commission's consulting engineers to be the year 2000 maximum day demand of the Commission's sponsor municipalities and contract customers.

XV-7. The filtration plant, to be located slightly east of Elk Grove Village, was to have a nominal capacity of 32.3 MGD, which the Commission's consulting engineers considered adequate to provide for the estimated maximum daily water demand in the year 1970. The Commission proposed to build filtered water transmission mains from the filtration plant to existing reservoirs in Elmhurst, Villa Park and Lombard. All other customers of the Commission would be obligated to construct their own feeder mains to the main filtered water main operated by the Commission. The contract under which the site for the filter plant was to be acquired gave the sellers the right to purchase filtered water from the Commission in an amount up to 0.5 MGD (0.77 cfs).

XV-8. The Department of Public Works and Buildings and the Department of Public Health of the State of Illinois have approved the proposed Lake Michigan intake, intake pipeline and pumping station. A permit for the construction of the intake and the intake pipeline was issued by the Corps of Engineers on August 20, 1958. The estimated construction time for the entire project is 2½ years.

XV-9. The estimated total construction cost for the project was $18,750,000. Revenue bonds in that amount

were authorized and issued by the Commission, but their sale to investment bankers who had agreed to their purchase has been stopped as a result of a protest lodged by the States of Michigan, Ohio and Pennsylvania against the building of the proposed facility. It was following that protest that the State of Illinois commenced its action [No. 11, Original] against the States of Michigan, Ohio, Pennsylvania, Minnesota, New York and Wisconsin for a declaratory judgment.

XV-10. The Illinois statute under which the Commission was created, Illinois Revised Statutes 1957, Chapter 24, §§81-1 to 81-8, Laws 1955, p. 1214, contained no limitation on the quantity, location or customers to whom the Commission may sell water. The Commission has acquired a right-of-way entitling it to install two 72-inch water mains. The Commission has not considered installing more than a single 42-inch main. Two 72-inch mains could pass 400 cfs.

XV-11. The project would have an intake capacity of 62-65 cfs, which would have to be ultimately enlarged if permissible demands under all Commission contracts were honored, as would the transmission mains. Intake, pumping and transmission facilities were designed to meet maximum daily demands only until 1980. The Commission's engineers estimate that the capacity of the transmission main could be increased to meet the expected maximum daily demand up to the year 2000 by the construction of a booster pumping station on the transmission main, and the addition of another raw water pump.

XV-12. The sponsor municipalities and contract customers are not within the Great Lakes watershed. Effluent from the sponsor municipalities and the contract customers is all discharged into the Mississippi River watershed. Return of Commission area sewage effluent to Lake Michigan could be effected at a cost which was estimated at 13.24¢ per thousand gallons. Waukegan and some other communities in Illinois north of Chicago which use Lake Michigan water return their effluent to Lake Michigan.

XV-13. The Water Commission's sponsor municipalities and contract customers are largely residential communities. Water usage in these municipalities, as between purely domestic pumpage and commercial or industrial uses, is, approximately, as follows:

| | Domestic Residential | Domestic Industrial or Commercial | Industrial Process |
|---|---|---|---|
| Elmhurst | 93% | 7% | 0% |
| Villa Park | 95% | 4.5% | 0.5% |
| Lombard | 95% | 5% | 0% |
| Addison | 96% | 3.5% | 0.5% |
| Bensenville | 96% | 4% | 0% |
| Elk Grove Village | 85% | 6% | 9% |

XV-14. The present water supply for each of the Water Commission's sponsor municipalities and contract customers comes entirely from ground water sources. The number and type of active wells serving each community is as follows (excluding two privately-owned wells located in Villa Park):

| | Sandstone | Limestone |
|---|---|---|
| Elmhurst | 6 | 1 |
| Villa Park | 3 | 2 |
| Lombard | 2 | 2 |
| Addison | none | 4 |
| Bensenville | 3 | none |
| Elk Grove Village | 2 | none |

XV-15. The population of the municipalities to be served by the Water Commission in 1960 was:

| | |
|---|---|
| Elmhurst | 36,991 |
| Villa Park | 20,391 |
| Lombard | 22,561 |
| Addison | 6,730 |
| Bensenville | 10,233 |
| Elk Grove Village | 6,608 |
| | 103,514 |

XV-16. The aggregate projected population of these communities for the year 1970 is about 160,000 persons and for the year 1980 is about 215,000 persons.

XV-17. Immediately adjacent to Elk Grove Village is an industrial area known as Centex Industrial Park. Industrial customers located in the park are supplied with water by the Elk Grove Sewer and Water Company. Of the 16 firms located in the industrial park in October of 1959, seven were warehouses and two used water for industrial processing purposes.

XV-18. The Village of Lombard in December 1958 annexed an area of 180 acres to be developed for an industrial park, zoned it for manufacturing and agreed, for a $50,000 payment, to extend water and sewer service to the area. The Village appointed an Industrial Commission to oversee the development of the industrial park so as, inter alia, to prevent large water users from locating there. The zoning of the area prior to annexation permitted more intensive development and a greater variety of uses than was permitted by the 1958 zoning in effect after annexation.

XV-19. The average daily water consumption of the population proposed to be served by the Water Commission is projected as about 106 gallons per capita per day in 1970 and about 107 gallons per capita per day in 1980.

XV-20. Consumption of water in the Commission's sponsor municipalities and contract customers in 1960 aggregated 8.8 MGD (13.6 cfs).

XV-21. The projected water consumption in the Water Commission's sponsor municipalities and contract customers in 1970 is approximately 17 MGD (26.3 cfs) and in 1980 is approximately 23 MGD (35.6 cfs).

B. Sources of Existing Ground Water Supply in Northeastern Illinois

XV-22. For the purpose of these Findings as to ground water supplies, the "Chicago Region" refers to the Counties of Lake, McHenry, Kane, DuPage, Cook, Kendall, and the northern portions of Grundy and Will Counties and is shown on Ill. Ex. 8, which is included in the Appendix to this Report. Its north-south dimension is 84 miles, while from east to west it extends about 55 miles. The Region is geologically and hydrologically interrelated and mutually affected by natural recharge from rainfall, by underground movement of waters, by pumping and removal of water, and by interference of pumping centers.

XV-23. The ground water resources of the Chicago Region are developed from four aquifers or water-bearing zones: (1) at the surface are scattered sand and gravel deposits within the glacial drift; (2) below these are the the shallow dolomite formations or limestone-like sedimentary rocks; (3) below these is the Cambrian-Ordovician Aquifer of which the Ironton-Galesville and Glenwood-St. Peter Sandstones are the most productive formations; and (4) the deep (1,800 feet or lower) Mt. Simon Aquifer, consisting of the sandstone of the Mt. Simon and lower Eau Claire formations.

XV-24. The glacial drift material which is at the surface is made up in the main of unsorted rock debris, called till, which was deposited directly by the glaciers. Most of this material is fine-grained clay and silt mixed with boulders which permits little movement of ground water. In some areas sorted sand and gravel called outwash was deposited by melt-waters of the glacier ice, and these are the main source of ground water from the glacial drift.

XV-25. Sediments laid down in lakes and ponds of the ice age are not favorable as ground water sources since the fine-grain sediments permit little movement through the material or into wells. The glacial drift varies in thick-

ness from a foot or less to more than 400 feet, the thicker deposits occurring in the northwest part of the area and in the now-buried valleys that had been cut in the rock surface prior to the glaciers.

XV-26. Beneath the glacial deposits lie bedrock formations of Silurian dolomite which range from zero to 450 feet in thickness, but are typically about 200 feet thick. These formations are connected hydrologically with the glacial drift above. In places the dolomite contains ground water in crevices and solution channels which yield considerable quantities of water. In other locations the dolomite is massive and tight, and wells drilled into it are dry holes. Cracks and solution channels, where they exist, do not extend under the entire region, but tend to be in a discontinuous and unpredictable pattern, although some areas are known to be more favorable for drilling than others.

XV-27. Beneath the Silurian dolomite in the eastern two-thirds of the Chicago Region is the Maquoketa Formation of tight shale. This formation is in itself not a source of water, but it has great importance in confining and limiting the vertical movement of water in the formations above and below. Below the Maquoketa Formation is the Cambrian-Ordovician Aquifer which consists of a number of formations which are under artesian pressure. These formations extend from the Galena-Platteville down to and including the Ironton-Galesville, all of which act hydraulically as one aquifer, and with an over-all thickness of about 1,100 feet. Within this aquifer the Ironton-Galesville Sandstone is the most consistently permeable and productive formation, producing about 80 percent of the Cambrian-Ordovician production, with the Glenwood-St. Peter being of second importance, producing approximately 15 percent.

XV-28. The Cambrian-Ordovician Aquifer is confined below by the impermeable beds of the middle and

upper Eau Claire Formation. The lower sandstones of the Eau Claire along with the Mt. Simon Sandstones make up the lowermost, or Mt. Simon, Aquifer. This aquifer is of less importance than the Cambrian-Ordovician because it is less consistently permeable and it contains highly mineralized water in many areas.

XV-29. Below the Mt. Simon Sandstones are the Precambrian crystalline rocks such as granite which form an impermeable basement at depths of from 3,000 to 5,000 feet below the surface. These rocks are not a source of water.

XV-30. The sand and gravel deposits of the glacial drift as well as the Silurian Dolomite Aquifer are recharged naturally from rainfall which falls locally.

XV-31. Wells drilled into the shallow dolomite formation may yield considerable quantities of water although in some places the dolomite is tight and wells drilled into it are dry holes. It is possible to drill a comparatively dry shallow well even though reasonable production is available close by.

XV-32. Shallow limestone wells have been considered as a possible source of future supply for the area to be served by the Water Commission but cannot of themselves supply the water needs of the area to be served by the Commission. Limestone wells are drilled into the dolomite formation and water is found in cracks, crevices and caverns which may exist in that formation. Generally favorable areas for the drilling of limestone wells can be found in south and southwest DuPage County.

XV-33. The deep Cambrian-Ordovician Aquifer is recharged in the extreme western part of the Chicago Region where the impermeable Maquoketa Formation is not present. There the infiltration from rainfall drains through the glacial drift and then through crevices in the intervening dolomites to reach the deep sandstones.

XV-34. Water then moves laterally at about 50-75 feet per year along the deep formations which slope gently to the southeast at a rate of about 10 feet to the mile.

XV-35. The amount of water transmitted from recharge areas in the western part of the region toward the southeast depends on the slope of the hydraulic gradient from the recharge areas to the areas in which wells are being pumped. An increase in the slope of the hydraulic gradient increases the amount of recharge transmitted.

C. Capacity of the Deep Sandstone Aquifers

XV-36. Waters in the deep Cambrian-Ordovician and Mt. Simon Aquifers are confined and under artesian pressure. When tapped by a well, water rises above the formation as a result of this pressure. The first deep well drilled at Chicago in 1864 flowed at a rate of about 200,000 gallons per day (gpd) with a head of 80 feet above the land surface.

XV-37. "Static water level" is the water level in a well which is not being pumped and which is located beyond the cone of influence of any well that is being pumped.

XV-38. "Nonpumping water level" is the level at which the water stands in a well not influenced by pumping in the immediate vicinity of the well.

XV-39. "Pumping level" is the level to which the water surface declines in a well which is being pumped. The decline is typically 100 feet below the static water level. Water levels will also be lowered by pumping at other wells (interference), depending on the nearness and amount of such other pumping. Static, nonpumping and pumping water levels are frequently expressed in terms of feet below the surface of the ground.

XV-40. Pumpage from the deep aquifers since 1864 has created depressions in the artesian pressure around individual wells and groups of wells. The artesian pressure

declined at an increasing rate throughout most of the period. In a considerable area of Cook and in portions of DuPage and Will Counties, the decline in artesian pressure has been in excess of 500 feet. These are average declines in nonpumping levels, not directly affected by the drawdown of a pump.

XV-41. The average rate of decline of static water levels in the Chicago Region from 1924 to 1957 was seven feet per year.

XV-42. The average static water level at Elmhurst in 1960 was projected at 568 feet below the surface of the ground.

XV-43. Predictions of future static water levels in the deep sandstone wells have been made through the use of a mathematical model of the hydrologic system. The Cambrian-Ordovician Aquifer in the Chicago Region has been analyzed by the use of a multiple image-well theory and the non-equilibrium formula. Results of past pumpage calculated through use of this model have been in reasonable accord with measured static water level declines in the area. The accuracy of the projections made through use of the model is about plus or minus 15 per cent.

XV-44. The Cambrian-Ordovician Aquifer under natural conditions, prior to development of wells, was in approximate dynamic equilibrium in which discharge balanced recharge. The small amount of water that entered the aquifer in recharge areas was discharged naturally by leakage through the confining bed (Maquoketa Formation) in the parts of the aquifer under artesian conditions and by leakage into the Illinois River.

XV-45. The withdrawal of water by wells disturbs the natural equilibrium. Cones of depression, with centers at the pumped wells, spread out in all directions and water is taken from storage within the aquifer as water levels are lowered in the areas under the influence of pumping. The cones overlap and continue to grow until: (1) the low-

ering of water levels results in increased recharge to, or decreased natural discharge from, the aquifer or a combination of these, and (2) hydraulic gradients are established from the recharge or natural discharge area to the pumped wells sufficient to bring from the area the amounts of water pumped. The natural discharge cannot be decreased, nor the recharge increased, unless the hydraulic gradients are changed in areas of discharge and recharge. The dimensions of the cones of depression depend largely upon the hydraulic properties of the aquifer (coefficients of transmissibility and storage), the location and character of geohydrologic boundaries, and the rates of pumping.

XV-46. Considerable time elapses before a cone of depression stabilizes, water is no longer taken from storage, and a new state of approximate equilibrium is established. The time required to reach approximate equilibrium can be computed. Computations made assuming distances of 47 miles (the average distance from Chicago [Loop] to recharge areas) from a pumped well to a source of recharge and ten miles from a pumped well to an observation point, indicate that time in the magnitude of 180 years would elapse before the cone stabilized at the observation point.

XV-47. The nonpumping water level in Elmhurst Well Number 1 dropped 120 feet during the decade 1930-1940, even though the pumpage for the area as a whole was 3 MGD less in 1940 than it was in 1930. The nonpumping water level in Elmhurst Well Number 4, during the same period, dropped 100 feet.

XV-48. Well Number 1 has been taken out of service because it was subject to severe interference from nearby Well Number 2. Well Number 4 was originally drilled to a depth of 2,219 feet in 1927 and thereby extended into the Mt. Simon Aquifer. For a period of 20 years considerable effort was expended to develop and improve the well to usable quality, before it finally became necessary to seal

the lower 700 feet with concrete to prevent entrance of salt water. It appears that Wells Numbers 1 and 4 cannot be considered typical of deep wells in the area.

The pumping water level in Elmhurst Well Number 4 declined 74 feet in one 11 months period. Declines in nonpumping water levels as great as 40 feet in one year have occurred. The measured water levels, while the individual wells were not being pumped, in Elmhurst Wells Numbers 3 and 4 during the late summer of 1959 were, respectively, 594 and 584 feet below the surface. The measured water levels in Elmhurst Well Number 5 and Villa Park Well Number 2, in each case while pumping, during the same period were, respectively, 710 and 644 feet below the surface. The nonpumping water level in Elmhurst Well Number 1 had declined, by 1958, at an average rate of approximately 14 feet per year since 1924, approximately 13 feet per year since 1936, approximately 17 feet per year since 1947 and approximately 25 feet per year since 1951. Between 1955 and 1958, it declined about 84 feet.

XV-49. Design of a dependable well water supply for a municipality requires consideration of the deepest pumping depths which may occur in particular wells, as well as the average depths projected for the municipality. Wells drilled to the Ironton-Galesville Aquifer must be cased (i.e., lined) from the St. Peter Sandstones to the top of the Galesville Sandstone in order to prevent the well walls from collapsing. The casing restricts the well diameter and with it, the size of the pump which can be installed in the well. In the case of a line shaft pump the withdrawal of the pump bowl for maintenance requires removal of the several hundred feet of shaft which connect it to the surface. As pumping depths increase, the amount and difficulty of maintenance also increases. The pumps in use in the area proposed to be served by the Water Commission are line shaft pumps having a motor at the surface connected by a shaft to the pump bowls, which are set below the pumping water level. If line shaft pumps are used the existence of great ground to water depths necessitates the

use of pumps having extremely long and heavy shafts and of large motors to raise the water to the surface. In a submersible pump, the pump motor is located below the pump itself, instead of at the surface, thus dispensing with the need for long and heavy drive shafts. The technology and capacity of such pumps have been increasing, but there is no evidence of the use of any presently available submersible pump at depths in excess of 1,000 feet.

XV-50. The "maximum sustained yield" of the deep sandstone aquifers is that pumpage which, if pumpage were ideally distributed throughout the Chicago Region, could be pumped indefinitely. The "practical sustained yield" is less than the maximum sustained yield and takes into account the fact that distribution of pumpage is not ideal; the "practical sustained yield" is the amount of water that can be pumped indefinitely if the static water level is stabilized 100 feet above the Ironton-Galesville Aquifer. Lowering of static water levels to this point will increase the slope or hydraulic gradient to an extent which more than offsets the reduced co-efficient of transmissibility of the aquifer, and hence increases the ability of the aquifer to transfer water from the recharge area. Below such point, the dewatering of the aquifer will reduce the transmissibility to an extent which would not be compensated for by the increase in slope, and hence a static water level 100 feet above the Ironton-Galesville Aquifer would be the optimum point or maximum production point. At static water levels below the maximum production point, recharge would not be sufficient to maintain the practical sustained yield. This level at Elmhurst would be approximately 460 feet below sea level, or approximately 1,150 feet below ground level.

XV-51. The practical sustained yield of the deep sandstone aquifers is 46 MGD. The practical sustained yield from deep wells could be increased somewhat by decentralizing pumping and by shifting centers of pumpage to the west.

XV-52. Each of the deep wells passes through the limestone aquifers which lie above the deep sandstones and water withdrawn from these wells is, as a result, taken, in part from those upper aquifers and, in part, from the deep sandstones. When the total pumpage from these wells is 81 MGD, the amount of water being taken from the deep sandstone aquifers is 46 MGD. If static water levels fell below the maximum production point, the yield of the deep aquifers in subsequent years would be reduced to less than the practical sustained yield of 46 MGD. Allowing the static water level to decline below the level 100 feet above the top of the Ironton-Galesville Aquifer will result in compaction within the aquifer and may result in its permanent damage as a recharge aquifer.

XV-53. Pumpage from deep wells in the Chicago Region is concentrated in six population or "pumping" centers: Aurora, Elgin, Des Plaines, Elmhurst, Joliet and Chicago. The changes in deep well pumpage at these pumping centers and for the Region as a whole have been:

PUMPAGE (MGD)

| Center | 1930 | 1940 | 1950 | 1959 | 1964 |
|---|---|---|---|---|---|
| Aurora | 7.5 | 8.15 | 12 | 15.1 | 18.545 |
| Elgin | 2.5 | 6.25 | 8 | 7.5 | 8.435 |
| Des Plaines | 2 | 1.7 | 4 | 10.9 | 17.713 |
| Elmhurst | 3 | 2.3 | 5 | 10.7 | 14.079 |
| Joliet | 8 | 7 | 12.5 | 18.9 | 23.013 |
| Chicago | 27 | 21.6 | 27 | 24.9 | 27.780 |
| Total | 50 | 47 | 68.5 | 88.0 | 109.565 |

XV-54. The 1964 rate of pumpage for the Chicago Region of 109.565 MGD includes 62.452 MGD of water from the deep sandstones, and is in excess of the practical sustained yield.

XV-55. Abandonment by the Commission area of deep wells as a source of supply will not prevent deep well pumpage in the Chicago Region from exceeding the practical sustained yield by the time the proposed pipe-

line could be built. Illinois has no regulatory statute governing location or spacing of wells, or pumping from wells nor any laws requiring return of clean water, drainage or condensing water to the aquifers, or any restriction requiring air conditioning cooling water to be recirculated, although some municipal ordinances do impose such a restriction.

XV-56. If the Commission's sponsor municipalities and contract customers should meet all their water needs from well water sources, including new deep wells which may be necessary, static water levels in the area are not projected to reach the level 100 feet above the top of the Ironton-Galesville Aquifer which would result in the practical sustained yield until at least 1970. While declining static levels in deep wells will require the replacement of certain existing equipment, consisting of straight shaft pumps with submersible pumps of lesser capacity, a program of such replacement together with development of new wells will meet Commission area water demand until at least 1970. If the Commission area joined with other areas in a larger scale project, to obtain a supplemental source of supply, it would result in a lower cost of water than would the presently proposed Commission project.

XV-57. So long as the static water level is not allowed to decline below the level 100 feet above the top of the Ironton-Galesville Aquifer, pumpage in excess of the practical sustained yield will result in a greater ultimate withdrawal from the aquifer, by accelerating the date at which maximum transmissibility will be achieved.

XV-58. The Chicago pumping center, the most easterly of the deep-well pumping centers, pumped 27.780 MGD from deep wells in 1964, compared to 14.079 MGD in the Commission area, and cessation of pumping at the Chicago center would leave a larger margin between total pumpage and practical sustained yield than would cessation of pumpage from the Commission area. The Chicago pumping center is closest to Lake Michigan of any of the centers.

XV-59. The population and per capita use and therefore the water requirements of the Chicago Region, exclusive of the City of Chicago, have been projected at a figure higher in each year than in the preceding year. Unless some present users of deep sandstone wells abandon that source, total pumpage from deep wells will increase each year above the 1964 pumpage of 109.565 MGD. Future pumpage for the Region as a whole was projected in L.S.Ex. 30 as increasing at least 1 MGD per year. Increasing deep well pumpage at such a rate will result in total pumpage in the year 1970 in excess of 115 MGD.

## D. Miscellaneous Findings

### 1. *Area River Flows*

XV-60. The Water Commission's sponsor municipalities and contract customers are located almost entirely in that part of the Des Plaines River and Salt Creek watersheds south of the Lake County line and west of the east line of DuPage County extended north which is delineated on Ill. Ex. 654, included in the Appendix to this Report, as Special Study Area 4. Flow of the Des Plaines River fluctuates over a wide range, and during a low year average daily flow for a six months period at the Riverside Gauging Station (slightly south of Elmhurst) was approximately 29 percent of 1980 projected water consumption in the Water Commission's sponsor municipalities and contract customers. No gaging stations are maintained on the DuPage River or Salt Creek, but their observed dependable flow is even smaller than that of the Des Plaines River. Both streams receive substantial sewage inflows. The Fox River, during a 54 days period of the lowest flow on record, had daily flows at Algonquin insufficient to meet projected 1980 water consumption in the Water Commission's sponsor municipalities and contract customers, and is subject to unavoidable and increasing pollution by communities in Illinois and Wisconsin.

2. *Effect of Commission Project on Lake Levels*

XV-61. Assuming that existing stage discharge formulae were applicable, if the proposed diversion of water from Lake Michigan by the Water Commission had begun on January 1, 1963, the lowering effect on Lakes Michigan-Huron in the year 2000 of the maximum water requirements projected by the Water Commission's consulting engineers to the year 2000 would be not more than 0.043 (1/23) inch. No levels gage, however, could accurately register a variation this minute.

XV-62. The estimated amount of the proposed taking by the Water Commission is less than the amount of water which bypasses the Power Authority's Niagara Falls power structure as a result of the taking by the City of Niagara Falls, New York, for domestic purposes. It is also less than the amount of water which bypasses the Power Authority's St. Lawrence River power structure as a result of the taking by the Village of Massena and an industrial plant for domestic and processing purposes.

3. *Other Proposed Water Projects*

XV-63. A water commission has been formed by the municipalities of Des Plaines, Arlington Heights and Mt. Prospect for the purpose of securing an additional supply of water for those communities. That Commission's consulting engineers have recommended to it that the additional supply be taken from Lake Michigan.

The Lake County, Illinois, Water Commission has also manifested a desire to secure water from Lake Michigan which would be diverted into the Mississippi Basin.

# Discussion

## I. Introductory Statement

The facts which bear upon the many issues raised by the parties in these cases cover a very wide range. It is inevitable that some or all of the parties will disagree with the view which I take that some of these issues are not actually involved in the decision of these cases and they may wish to present a different view to the Court. For this reason I have included in the foregoing findings of fact my findings with respect to substantially all of the facts which each party has alleged to be relevant and material. This I have done without passing upon the actual relevance or materiality of the findings in order that the parties might have as complete a factual background as possible against which to present their contentions both to me and to the Court. Needless to say I am disregarding those of the findings which after my full study of the cases I regard as irrelevant or immaterial to the issues which I deem necessary to be considered and which I am about to discuss.

As I have indicated in the preliminary statement [p. 13], the Lake States in their amended application for the reopening and modification of the decree of April 21, 1930 asked this Court to require the defendants to return the treated effluent emanating from their sewage and industrial treatment facilities to Lake Michigan from which it originally comes in the form of domestic pumpage or to take other measures which would either reduce the direct diversion or limit or restrict the domestic pumpage to the end that the total amount of diversion of water from Lake Michigan at Chicago would be reduced or restricted. They did not then ask that this Court prohibit all diversion from the lake, both of the treated effluent derived from the domestic pumpage and of the water directly diverted by the Sanitary District into the Sanitary and Ship Canal. They have, however, in their briefs and oral argument before me

taken the position that the entire diversion of approximately 3,200 cfs, consisting of 1,500 cfs of direct diversion and domestic pumpage of about 1,700 cfs, is unlawful and should be prohibited unless fully compensated for. The defendants and the United States, on the other hand, urge not only that the entire diversion of approximately 3,200 cfs is lawful but also that it has been authorized by the Congress for use in the navigation of the Illinois waterway and its reduction by this Court is thereby precluded. It thus becomes necessary at the outset to consider the power of the Congress in this regard, and whether the Congressional power has, in fact, been exercised.

## II. Congressional Authorization of the Diversion

### A. Extent of the Congressional Power

There can be no doubt of the plenary power of the Congress under the commerce clause of the Constitution to regulate the navigable waters of the United States. This includes the power not only to improve waterways for the purposes of navigation but also to authorize and control the diversion of water from one navigable waterway to another, Wisconsin v. Duluth, 1878, 96 U.S. 379, or even from one watershed to another, Wisconsin v. Illinois, 1933, 289 U.S. 395, 403, and to authorize its use for navigational purposes. Indeed, this Court has heretofore fully recognized the existence of this paramount power with respect to the diversion here in question. Sanitary District v. United States, 1925, 266 U.S. 405. In the opinion which this Court filed in these very cases in 1930, Mr. Justice Holmes said [281 U.S. 179, 198-199]: "All action of the parties and the Court in this case will be subject, of course, to any order that Congress may make in pursuance of its constitutional powers . . ."

Moreover, the exercise of this Congressional power is not limited to the direct needs of navigation, that is, merely to the improvement of waterways for the operation of

vessels, but is as broad as the needs of commerce. Thus, the power extends to the use of water of a navigable stream for the production of hydroelectric power, United States v. Appalachian Power Co., 1940, 311 U.S. 377, 426-427; F.P.C. v. Union Electric Co., 1965, 381 U.S. 90, and to the protection of navigable waters against pollution. Scow No. 36, 1 Cir. 1906, 144 F. 932; La Merced, 9 Cir. 1936, 84 F. 2d 444; United States v. Ballard Oil Co. of Hartford, 2 Cir. 1952, 195 F. 2d 369. Indeed, with respect to protection of the Nation's waterways from pollution the Congress by section 1(a) of the Federal Water Pollution Control Act, as amended by the Water Quality Act of 1965, P. L. 89-234, 33 U.S.C.A. §466(a), has declared its policy "to enhance the quality and value of our water resources and to establish a national policy for the prevention, control, and abatement of water pollution", and in furtherance of that policy has provided by section 10(a) of the Act, as amended, 33 U.S.C.A. §466g(a), that "The pollution of interstate or navigable waters . . . which endangers the health or welfare of any persons, shall be subject to abatement", if other action fails, by suit at the instance of the Secretary of Health, Education and Welfare.

It is equally well settled that when the Congress has exercised its power with respect to matters relating to navigable waters its action is conclusive. Wisconsin v. Duluth, 1878, 96 U.S. 379; United States v. Chandler-Dunbar Co., 1913, 229 U.S. 53, 64; United States v. Appalachian Power Co., 1940, 311 U.S. 377, 426-427; Oklahoma v. Atkinson Co., 1941, 313 U.S. 508, 527; United States v. Twin City Power Co., 1956, 350 U.S. 222, 224.

Although the ownership of the soil under and adjacent to a navigable river or lake may be vested in the State within the boundaries of which it lies, or in individuals claiming under the laws of that State, the river or lake itself is always subject to regulation and control by the United States for the purposes of commerce and navigation. Gibson v. United States, 1897, 166 U.S. 269, 272; United States v. Appalachian Power Co., 1940, 311 U.S. 377, 423-424;

United States v. Chicago, M., St. P. & P. R. Co., 1941, 312 U.S. 592. Accordingly, a riparian owner upon such a river or lake does not suffer a legally recognized injury when Congress, pursuant to its superior powers under the Constitution, acts to utilize or divert its flow for the purposes of commerce. United States v. Chandler-Dunbar Co., 1913, 229 U.S. 53, 66, 69, 76; United States v. Appalachian Power Co., 1940, 311 U.S. 377, 423-424, 427; United States v. Willow River Power Co., 1945, 324 U.S. 499, 502-503; United States v. Twin City Power Co., 1956, 350 U.S. 222; United States v. Grand River Dam Authority, 1960, 363 U.S. 229, 231-232.

B. Exercise of the Congressional Power

I turn then to the question whether the Congress has exercised its power by authorizing the diversion of water from Lake Michigan for use in the navigation of the Illinois waterway.

The decree of this Court limiting the diversion (after December 31, 1938) to an annual average of 1,500 cfs directly from the lake, in addition to domestic pumpage, was entered on April 21, 1930 [281 U.S. 696]. On July 3, 1930 the Congress enacted the River and Harbor Act of 1930. So far as here pertinent the Act provided:

> "That the following works of improvement are hereby adopted and authorized, to be prosecuted under the direction of the Secretary of War and supervision of the Chief of Engineers, in accordance with the plans recommended in the reports hereinafter designated.
>
> * * * * *
>
> "Illinois River, Illinois, in accordance with the report of the Chief of Engineers, submitted in Senate Document Numbered 126, Seventy-first Congress, second session, and subject to the conditions set forth in his report in said document, but the said project shall

be so constructed as to require the smallest flow of water with which said project can be practically accomplished, in the development of a commercially useful waterway: *Provided*, That there is hereby authorized to be appropriated for this project a sum not to exceed $7,500,000: *Provided further*, That the water authorized at Lockport, Illinois, by the decree of the Supreme Court of the United States, rendered April 21, 1930, . . . is hereby authorized to be used for the navigation of said waterway: *Provided further*, That as soon as practicable after the Illinois waterway shall have been completed in accordance with this Act, the Secretary of War shall cause a study of the amount of water that will be required as an annual average flow to meet the needs of a commercially useful waterway as defined in said Senate document, and shall, on or before January 31, 1938, report to the Congress the results of such study with his recommendations as to the minimum amount of such flow that will be required annually to meet the needs of such waterway and that will not substantially injure the existing navigation on the Great Lakes to the end that Congress may take such action as it may deem advisable." [46 Stat. 918, 929]

Generally, when the Congress has appropriated funds for a special project relating to navigation and has placed its management in the hands of officers of the federal government it may fairly be concluded, in the absence of an expressed intent to the contrary, that the Congress, for the public good, has adopted it and taken it over as a federal project. Wisconsin v. Duluth, 1878, 96 U.S. 379, 386-387. One of the purposes of the Act of 1930 was to take over and complete as a federal project the waterway which the State of Illinois had begun but had not yet completed from the southwestern end of the Sanitary and Ship Canal at Lockport to Utica on the Illinois River where the then existing federal waterway in the lower Illinois River began. Thus a commercially useful waterway connecting the Great Lakes

with the Mississippi River system would be provided.* The Lake States do not dispute this but they argue that the Act did not authorize the diversion of water from Lake Michigan. I cannot agree.

When H.R. 11781, which became the River and Harbor Act of 1930, was introduced in the 71st Congress on April 21, 1930, the very day on which this Court entered its decree, the bill provided, inter alia, "That nothing in this Act shall be construed as authorizing any diversion of water from Lake Michigan but the whole question of diversion from Lake Michigan shall remain and be unaffected hereby, as if this Act had not passed". This was substantially similar to the provision contained in the River and Harbor Act of 1927, 44 Stat. 1010, 1013, by which the Congress had provided for the improvement of the channel in the lower Illinois River and had declared that "nothing in this Act shall be construed as authorizing any diversion of water from Lake Michigan". This Court held that the quoted provision of the Act of 1927 fully supported the conclusion of Special Master Hughes that Congress had not at that time expressly authorized the diversion from Lake Michigan, even though it had considered the advisability of the pro-

* The Illinois waterway, as developed and enlarged pursuant to the Act of 1930 and subsequent legislation, includes the Sanitary and Ship Canal from Lake Michigan at Chicago to Lockport, Illinois, where the canal joins the Des Plaines River. It then follows the Des Plaines River to its junction with the Kankakee River, the two rivers forming the Illinois River at that point. The waterway then follows the Illinois River to Grafton, Illinois, where that river flows into the Mississippi River. The Illinois waterway thus provides the connection for navigation between the Great Lakes and the Mississippi River system. [Findings VIII-17, VIII-18] In addition to serving Chicago, it also serves nearby industrial areas in Indiana and important manufacturing cities along its route. Commerce on the waterway during the period 1955 through 1964 averaged approximately 28,300,000 tons per year, the principal commodities transported being coal, petroleum products, sand, gravel, stone, grain, sulphur, iron and steel products. [Finding VIII-19] The waterway also furnishes transportation for pleasure craft between Lake Michigan and the Illinois River. [VIII-30]

posed waterway and had called for surveys, plans and estimates. [278 U.S. 367, 416]

The provision of H.R. 11781 which I have quoted was in the bill as it was passed by the House of Representatives, and it would have left the matter of the diversion of water from Lake Michigan wholly to the Court. But it will be observed that the Act of 1930, as enacted, does not contain this provision but expressly states that "the water authorized at Lockport, Illinois, by the decree of the Supreme Court of the United States . . . is hereby authorized to be used for the navigation of" the Illinois waterway. As we have seen, this particular language was not in the bill when it passed the House, nor was it in the amended bill reported by the Senate Committee on Commerce. On the contrary, it was the subject of an amendment offered on the floor of the Senate by Senator Blaine of Wisconsin which was adopted by the Senate and agreed to by the House of Representatives after conference. [Finding VIII-10]

The version proposed by the Senate Committee on Commerce would have vested in the Secretary of War, under the supervision of the Chief of Engineers, control of the amount of the diversion of water from Lake Michigan to meet the needs of the Illinois waterway. [Finding VIII-7] It was this unlimited open-ended authority which the proponents of the Blaine amendment opposed, as indicated by the Senate debates, and which the Blaine amendment replaced with an authorization by the Congress itself of the specific amount of water to be diverted for the use of the waterway, namely, that authorized at Lockport by the decree of this Court. [Findings VIII-8 to VIII-10] It will thus be seen that the Congress took affirmative action to delete the provision that the Act should not authorize any diversion of water from Lake Michigan and to substitute therefor a clear authorization for the use for the navigation of the Illinois waterway of the water which this Court had then authorized to be diverted from Lake Michigan.

In my opinion, the quoted language of the Act of 1930 was a definite exercise of the Congressional power to pro-

vide the water necessary to maintain a navigable waterway, the Illinois waterway, and to determine the source from which that water should come, by diversion from Lake Michigan as previously authorized by this Court. This Court observed in the opinion handed down in these cases on May 22, 1933, 289 U.S. 395, 403-404, that, while the Congress had "adopted the amount fixed in the decree as the limit of permitted withdrawal" it had expressly withheld further action until there was opportunity to consider the results of the study which the Secretary of War was required to make. The Congress, as we shall see, received reports of this and later studies but did not by any subsequent legislation revoke the authorization contained in the River and Harbor Act of 1930, or modify it except to make more definite the maximum amount of the domestic pumpage which, together with the direct diversion of 1,500 cfs, was intended to be allotted to the waterway for purposes of navigation. The Act of 1930 accordingly remains at the present time the controlling expression of Congressional action in this matter. To repeat the language of Mr. Justice Holmes, it is exactly what this Court had in mind when in its opinion filed in 1930 [281 U.S. 179, 198-199], it was said: "All action of the parties and the Court in this case will be subject, of course, to any order that Congress may make in pursuance of its constitutional powers." I conclude that the Act of 1930, to the extent of the diversion which it committed to the Illinois waterway, is a complete refutation of the contention of the Lake States that Congress has not authorized the diversion from Lake Michigan.

### C. Amount of the Congressionally Authorized Diversion

It remains, however, to consider in this regard whether the Congress has placed any maximum limit upon the diversion which it thus authorized for the use of the waterway. It will be recalled in this connection that this Court in its opinion of April 14, 1930 in these cases indicated that

the authority to withdraw domestic pumpage from the lake and to divert its effluent into the Sanitary and Ship Canal was not to be understood to be without limit in amount. For in that opinion Mr. Justice Holmes said [281 U.S. 179, at p. 200] "If the amount withdrawn should be excessive, it will be open to complaint." Thus the Congress in authorizing the use for the Illinois waterway of the water authorized to be diverted from Lake Michigan by the decree of this Court must have known that the portion of it which involved domestic pumpage was not subject to unlimited or unreasonable future increase.

In the debates in the Senate upon the Blaine amendment, which as we have seen became the pertinent provision of the 1930 Act, it was repeatedly stated that the actual amount of the domestic pumpage authorized by the decree of this Court to be discharged into the Sanitary and Ship Canal was then 1,700 cfs. The reports of Special Master Hughes and the present findings show that the pumpage rose from 1,395 cfs in 1926 [First Report, pp. 22-23] to 1,565 cfs in 1928 [Report on Re-Reference, p. 104] and 1,700 cfs in 1930 [Finding IV-37], an increase of, roughly, 100 cfs per year. It was believed by the members of the Congress participating in the debates on the Blaine amendment in 1930 that this annual increase of 100 cfs of domestic pumpage would continue in the future, and that the pumpage might, therefore, reach 2,500 cfs by 1938, when the ultimate reduction in the direct diversion to 1,500 cfs, under the decree of this Court, was to take place. This annual increase did not, in fact, materialize, as I shall point out later. The figure of 1,700 cfs was repeatedly referred to in the debates as being the amount of domestic pumpage which the Blaine amendment would make available for the waterway. [Findings VIII-8 to VIII-10; 72 Cong. Rec. 10996-11094, 11168-11187, 11631-11635]

Moreover the 1930 Act also provided, as we have seen, that the Illinois River project should be "so constructed as to require the smallest flow of water with which said project can be practically accomplished, in the development of a

commercially useful waterway" and that the Secretary of War should cause a study and report to be made to the Congress by January 31, 1938 of the amount of water that would be required to meet the needs of such a commercially useful waterway and "not substantially injure the existing navigation on the Great Lakes." It may fairly be inferred from these provisions that the Congress, having for the time being authorized for the navigation of the Illinois waterway the water which this Court had authorized to be diverted from the lake, nonetheless wished to keep the diversion within as narrow limits as practicable. The Congress accordingly directed the study and report in order to be in a position to review its action and, if found appropriate, to modify in the future the amount of lake water which it had authorized to be diverted for the navigation of the newly improved and enlarged waterway.

The study thus directed was made by the Corps of Engineers and a report upon it by Major General E. M. Markham, the Chief of Engineers, was submitted to the Congress by the Secretary of War under date of December 7, 1933 and was printed as House Document 184, 73d Congress. Relevant excerpts from that document are included in Findings VIII-11 and VIII-12. Briefly summarized, the report stated that the domestic pumpage was, and "for some years to come" would be, about 1,700 cfs, bringing the total supply from the drainage canal into the Illinois waterway at Lockport to an annual average of 3,200 cfs after 1938. It was stated that this supply would not be uniform throughout the year but that a reliable flow of about 2,400 cfs could be expected, which would be ample to meet all requirements of lockage, seepage, leakage and evaporation on the waterway. The report also determined that the diversion estimated at an annual average of 3,200 cfs was the minimum "required to meet the needs of a commercially useful waterway in the Illinois River" and would "not substantially injure the existing navigation on the Great Lakes." Whether this flow would afford suitable sanitary conditions on the waterway could only be determined, the

report said, after the sewage purification plants at Chicago had been completed and placed in operation. In concluding his report General Markham stated that until the need was established for a greater diversion than that then provided by law, he saw no reason for a modification of the existing legislation and he, therefore, recommended that no change be made for the time being in the water authorized to be used for the navigation of the Illinois waterway under the provisions of the Act of 1930.

It thus appears that the domestic pumpage with which the Congress was then dealing amounted to about 1,700 cfs and, contrary to the predictions made in 1930 in the debates on the Blaine amendment, was not expected to rise above that figure for some years to come. The forecast made in House Document 184 in this regard was remarkably accurate, for the average amount of domestic pumpage for the entire period of 35 years from 1930 through 1964 was less than 1,700 cfs, in fact only 1,676 cfs. [Finding IV-37] The Congress gave consideration to the report of the Chief of Engineers which was embodied in House Document 184, and on August 30, 1935 enacted the River and Harbor Act of 1935, 49 Stat. 1028. That Act adopted and authorized the prosecution of the Illinois waterway project as recommended in House Document 184 in accordance with the plans and subject to the conditions set forth in that document. [Finding VIII-13]

Under date of September 3, 1958 the Secretary of the Army transmitted to Congress a report on the Illinois waterway by Major General E. C. Itschner, Chief of Engineers, which was printed as House Document 31, 86th Congress, pertinent excerpts from which are set out in Finding VIII-14. The report proposed the construction of duplicate locks on the waterway and estimated that the average annual flow needed to provide the water requirements for the modified waterway would be about 1,826 cfs when the contemplated traffic developed. Reporting that the annual domestic pumpage had averaged 1,686 cfs during the preceding 10 years, the report stated that "the presently

authorized diversion of 1,500 cubic feet per second, in addition to the domestic pumpage, would provide an adequate water supply for operation of the duplicate lock system." Although the sewage treatment works of the Sanitary District had then been in complete operation for many years, the report does not refer to the sanitary conditions in the waterway or suggest any need for increasing the diversion by reason thereof. Nor was there any recommendation that the amount of water authorized by law to be diverted from Lake Michigan could safely be decreased. Thereafter on October 23, 1962 the Congress enacted the River and Harbor Act of 1962, 76 Stat. 1173, by which House Document 31 was specifically approved and the project which it recommended was adopted and its prosecution authorized. [Finding VIII-15]

By referring to House Document 184 in the 1935 Act and adopting the proposals it contained the Congress approved the findings and proposals of that document. Wisconsin v. Duluth, 1878, 96 U.S. 379, 386-387. Cf. United States ex rel. Chapman v. Federal Power Commission, 1953, 345 U.S. 153. See, also, United States v. Twin City Power Co., 1956, 350 U.S. 222, 223-224. And it did the same by referring to and specifically approving House Document 31 in the 1962 Act and adopting the proposals which it set out.

Upon considering this legislative history three facts appear. The first is that the actual amount of the domestic pumpage involved in the diversion and made available for navigation in the Illinois waterway by the Act of 1930 was in the order of 1,700 cfs, and in 1933 and thereafter it was believed that the volume of the pumpage would continue at this figure for some time to come, as in fact it has. The second is that the Chief of Engineers determined and reported to Congress in 1933 and 25 years later in 1958 that a diversion of 3,200 cfs, consisting of the domestic pumpage, which was known to amount to about 1,700 cfs, and the direct diversion of 1,500 cfs was and would continue to be sufficient for the purposes of the waterway. And the third

is that the Congress in enacting the River and Harbor Acts of 1935 and 1962, approved the engineering reports which determined that the domestic pumpage with which they were dealing was and would continue to be in the order of 1,700 cfs and that a diversion of 3,200 cfs, consisting of this amount of pumpage plus the direct diversion of 1,500 cfs, was sufficient to provide for the navigational needs of the Illinois waterway. It should be noted here that while the domestic pumpage is referred to in paragraph 4 of the decree of April 21, 1930 as "the water drawn by the City of Chicago for domestic water supply purposes" [281 U.S. 696, 697] it has been construed in practice as necessarily including the domestic pumpage of other communities in the northeastern Illinois metropolitan area which draw water for domestic purposes from Lake Michigan and discharge their sewage effluent into the Illinois waterway. [Findings IV-37, VIII-34] It should also be noted that what has been referred to as the direct diversion of 1,500 cfs consists of two components, the storm runoff from the Lake Michigan watershed which has been diverted into the canal but which in a state of nature would have flowed into the lake, amounting to about 550 cfs, and the water taken directly into the canal from Lake Michigan, amounting to about 950 cfs. [Findings I-15, IV-34]

As we have seen, the Congress made it quite clear in the Act of 1930 that it wished to have the Illinois waterway operated with the smallest practicable flow of water so as not substantially to injure navigation on the Great Lakes. This purpose would obviously be furthered by limiting the domestic pumpage authorized to be used for the waterway to its actual amount of 1,700 cfs, but would be defeated by authorizing an open-ended amount of domestic pumpage which might greatly increase as time passed. It was, after all, only the actual domestic pumpage of 1,700 cfs with which as a practical matter the Congress could deal in including domestic pumpage in the flow required for operation of the waterway. Its declared objective was to determine and authorize "the smallest flow of water with which said

project can be practically accomplished, in the development of a commercially useful waterway." The inclusion of possible increases in the domestic pumpage, the amounts of which were then unknown and which as it has turned out have not been realized, could form no logical element in this determination and would have been completely at war with the stated Congressional objective of keeping the diversion to a minimum.

I conclude, therefore, that the Congressional authorization made by the Act of 1930, as defined and limited by the engineering reports approved by the Acts of 1935 and 1962, was for the use of 1,700 cfs of domestic pumpage for the navigational needs of the waterway. Having also authorized for this purpose the 1,500 cfs direct diversion permitted by the decree of this Court, it necessarily follows that the Congressional authorization involved, and was limited to, a total diversion from Lake Michigan of 3,200 cfs, including both direct diversion and domestic pumpage.

In authorizing this total diversion of 3,200 cfs for the use of the Illinois waterway the Congress was concerned primarily with the total flow of water needed for navigation in the waterway. Its composition, whether from direct diversion or from domestic pumpage, was of interest to the Congress only to the extent that direct diversion was required to maintain satisfactory sanitary conditions in the waterway. Accordingly, since the Congress is concerned only with the total flow of water needed for navigation and the maintenance of satisfactory sanitary conditions in the waterway, it would not be inconsistent with the Congressional authorization for the defendants, within the maximum limit of 3,200 cfs, to withdraw more than 1,700 cfs in domestic pumpage and less than 1,500 cfs by way of direct diversion, if the full 1,500 cfs of storm runoff and lake water is not required to maintain reasonably satisfactory sanitary conditions in the waterway. Nor would it be inconsistent with that authorization for the defendants, within the maximum limit of 3,200 cfs to withdraw less by way of domestic pumpage and more by way of direct diversion

for the purpose of diluting and carrying away the sewage effluent discharged into the canal. But lake water in excess of the total diversion authorized by the Congress may not be diverted for this purpose in view of this Court's prior determination in these cases that it is inadmissible to divert water solely for such purpose.

## III. Lawfulness of the Diversion

The Lake States urge that this Court in its prior opinions in these cases determined that all diversions from Lake Michigan at Chicago, both direct and by way of domestic pumpage, are in violation of their riparian rights and are, therefore, unlawful. They explain the action of the Court in permitting the diversion of 1,500 cfs plus domestic pumpage as being an exercise of its extraordinary equity powers to meet conditions of hardship to the people of Chicago which a prohibition of all diversion would have imposed. I do not think that the Lake States read the opinions of this Court correctly. As I read the opinion handed down January 14, 1929, 278 U.S. 367, it holds that the direct diversion of water from Lake Michigan, even though authorized by a permit issued March 3, 1925 by the Secretary of War ostensibly under the authority conferred by section 10 of the Act of March 3, 1899, 30 Stat. 1151, 33 U.S.C. §403, was illegal and in violation of the rights of the Lake States only to the extent that the diverted water was being used to dilute and carry away Chicago's sewage and exceeded the amount needed to maintain navigation in the Chicago River. The Court thus made it clear that the amount of diversion needed to maintain navigation in the Chicago River was not illegal even though the water diverted for that purpose was also used to dilute and carry away sewage. It will be remembered that in 1929 there was no direct Congressional authority for a waterway from Lake Michigan to the Mississippi River. This did not come until the enactment of the River and Harbor Act of 1930. Thus the relation of the diversion to navigation at that time could

only be with respect to the needs of the Chicago River. The Court accordingly stated that it would by an appropriate decree compel the reduction of the diversion to a point where it rested on a legal basis, obviously its need for navigation, and thus restored the navigable capacity of Lake Michigan to its proper level.

The Court pointed out, however, that a decree bringing the unwarranted part of the diversion to an immediate end would involve an unnecessary hazard to the health of the people of the Chicago area since their sewage was still largely untreated. It was here that the Court invoked its equitable power to defer full relief for a period of time sufficient to enable the Sanitary District to construct and put into operation adequate plants for the disposition of the sewage through other means than lake diversion.* I find no suggestion in the opinion that the Court regarded the diversion of the domestic pumpage or of the water needed for navigation as being unlawful and permissible only through the exercise of the Court's equity powers, as the Lake States now argue. Indeed the opinion contains no discussion at all of the right of Chicago to take its domestic pumpage from the lake.

Nor was there any suggestion that all diversion was illegal in the second opinion of this Court, handed down April 14, 1930, 281 U.S. 179, which approved the recommendations made by Special Master Hughes after the second reference to him, and dealt with the form of the decree to be entered. It upheld the master's recommendation that the diversion should be reduced by stages, as the Sanitary District's sewage treatment works were completed, to the 1,500 cfs plus domestic pumpage required for navigation in the Chicago River, by December 31, 1938. For the first time at that late stage in the proceedings the Lake States, although still not assailing the withdrawal of water for domestic purposes, urged that the domestic pumpage

* It was at this point that the cases were referred back to Special Master Hughes for consideration of the most practical methods to attain this objective.

be ordered returned to the lake in the form of the effluent from the sewage treatment works which were to be built by the Sanitary District. The master had reported that the best way of preventing the pollution of the navigable waters involved was to permit an outflow of the sewage effluent from the drainage canal at Lockport into the Des Plaines River and that this effluent would be needed for navigation in the Chicago River in addition to the direct diversion of 1,500 cfs. This Court concluded that the course recommended by the master was more reasonable than the opposite demand of the Lake States which seemed to the Court excessive on the facts of the case. The Court accordingly entered the decree of April 21, 1930 permitting the diversion after December 31, 1938 of 1,500 cfs in addition to domestic pumpage. I conclude that the presently authorized diversion is not unlawful or in violation of the legal rights of the Lake States.

## IV. Applicability of the Principle of Equitable Apportionment

Since, as I have concluded, the diversion which has been authorized by the Congress for the purposes of navigation and which is thus withdrawn from consideration by the Court, is in the maximum amount of 3,200 cfs, an amount which approximates the actual diversion which has taken place since 1938, the decree of 1930 remains open for reconsideration and modification by this Court insofar as it authorizes an increased domestic pumpage which would bring the total permanent diversion above 3,200 cfs. This Court, upon occasion, has modified the 1930 decree by permitting temporary increases in the direct diversion to meet certain emergencies. [311 U.S. 107; 352 U.S. 945; 352 U.S. 983]. It now becomes necessary to consider whether the Lake States are entitled to a decree which would prohibit all diversion by the defendants in excess of 3,200 cfs, the amount authorized by the Congress. In determining that

question it is not the common law doctrine of riparian rights which is to be applied, as the Lake States argue. While that doctrine may be in force in those States for the determination of private water rights, F.P.C. v. Niagara Mohawk Power Corp., 1954, 347 U.S. 239, it is not applied by this Court to determine the relative rights of sovereign States contending for the use of the water of interstate streams. Kansas v. Colorado, 1907, 206 U.S. 46, 103-104. On the contrary, in the absence of other statutory direction, Arizona v. California, 1963, 373 U.S. 546, this Court has resolved the conflicting water claims of such States by applying the principle of equitable apportionment. Connecticut v. Massachusetts, 1931, 282 U.S. 660; New Jersey v. New York, 1931, 283 U.S. 336. See, also, Hinderlider v. La Plata Co., 1938, 304 U.S. 92, 101-103. Under this rule all the relevant facts and public interests are considered in order that a result may be achieved which is the most fair and equitable. Nebraska v. Wyoming, 1945, 325 U.S. 589, 599-600, 616-618. This Court has held that "Courts of equity may, and frequently do, go much farther both to give and withhold relief in furtherance of the public interest than they are accustomed to go when only private interests are involved." Virginian Ry. v. Federation, 1937, 300 U.S. 515, 552. The principle of equitable apportionment was defined, in Connecticut v. Massachusetts, 1931, 282 U.S. 660, 670-671, as follows:

> ". . . such disputes are to be settled on the basis of equality of right. But this is not to say that there must be an equal division of the waters of an interstate stream among the States through which it flows. It means that the principles of right and equity shall be applied having regard to the 'equal level or plane on which all the States stand, in point of power and right, under our constitutional system' and that, upon a consideration of the pertinent laws of the contending States and all other relevant facts, this Court will determine what is an equitable apportionment of the use of such waters."

Indeed, the State of New York itself was permitted to divert water out of a watershed for its domestic use in the case of New Jersey v. New York, 1931, 283 U.S. 336. In answer to the contention of the State of New Jersey that the common law rules governing private riparian proprietors apply equally to sovereign States, this Court said: [at pages 342-343] "Both States have real and substantial interests in the River that must be reconciled as best they may be. The different traditions and practices in different parts of the country may lead to varying results, but the effort always is to secure an equitable apportionment without quibbling over formulas."

It follows, I think, that whether the Court should modify the 1930 decree so as to prohibit all diversion by Illinois in excess of 3,200 cfs depends upon the application of the rule of equitable apportionment to the allocation of the water in controversy in these cases. The application of that principle to these cases obviously requires full consideration of the relative equities of the parties. To that subject, therefore, I now turn.

## V. Equitable Apportionment as Applied to These Cases

### A. Effect of Variations in Lake Levels Resulting from Natural Causes and Other Diversions.

Before considering the needs of the parties it should be pointed out that the levels of all the Great Lakes are subject, in a state of nature, to wide variations, both during the year and from year to year. [Findings III-1 et seq.] These variations have, of course, been reduced by regulation in the case of Lakes Superior [Findings I-12, II-37, III-12] and Ontario. [Findings II-30, III-23] Speaking generally, and excepting navigation by the deeper draft vessels and the production of hydroelectric power, it is principally at the times when Lakes Michigan, Huron, Erie and Ontario are at their lower stages that the additional lowering which would result from additional diversion by Illinois

would affect the Lake States detrimentally. At the higher stages the diversion might be beneficial in some respects. And it must be borne in mind also that as a result of the diversions by the Province of Ontario in Canada begun in 1939 and 1943 at Long Lake and Ogoki, respectively, from the Hudson Bay drainage into Lake Superior [Finding I-10] which total about 5,000 cfs [Finding I-11], and the Court-ordered reduction, beginning July 1, 1930, in the direct diversion out of Lake Michigan by the Sanitary District at Chicago from 6,660 cfs to 1,500 cfs after December 31, 1938 [Finding IV-37] the actual levels of Lakes Michigan and Huron have been raised approximately 9 inches and of Lake Erie approximately 6 inches above what they would have been if the Chicago diversion had remained at its 1930 rate and the Long Lake and Ogoki diversions had not existed. [Finding III-26] Lake Ontario, being regulated, has not been affected to the same extent. [Finding III-25] The foregoing figures do not take into account the reduction of about 3 inches in levels of Lakes Michigan and Huron resulting from the dredging during recent years of the navigation channels in the St. Clair River [Finding III-15] or the diversion by Canada through the Welland Canal of 7,000 cfs from Lake Erie which lowers the level of that lake about 4 inches. [Findings III-21, III-26]

The net present effect of the Long Lake–Ogoki in-diversion and the Chicago out-diversion is that the water supply to Lakes Michigan, Huron, Erie and Ontario is 1,800 cfs greater and the levels of Lakes Michigan and Huron are about 1.6 inches higher and of Lake Erie about one inch higher than they would be if neither of these diversions existed. [Findings III-16, III-26] Parenthetically it should be noted that the effect on lake levels of a permanent increase or decrease in diversion at Chicago would not be instantaneous. The full effect would not in fact be reflected until about 15 years after the increase or decrease had begun. [Findings III-27, X-601]

The fact is, however, that the Lake States are presently enjoying the somewhat higher levels which have resulted

from the Canadian diversion into Lake Superior and, in the absence of any international obligation to the contrary,* they along with Illinois are certainly entitled to do so. They would, of course, enjoy still higher lake levels if the present Illinois diversion of 3,200 cfs were eliminated. But, as we have seen, this diversion has been authorized by the Congress. The Lake States may, therefore, not assert legal injury by reason of it. But the question remains whether they would in fact suffer injury if the presently existing levels should be reduced by an increase in the present Illinois diversion above 3,200 cfs.

### B. The Needs of the Lake States

I turn then to consider the needs of the Lake States to preserve the existing lake levels and the damage which they would suffer as a result of an increased diversion by Illinois above the present 3,200 cfs. These fall into three main categories which will be discussed in order: those involving recreational, municipal and industrial develop-

* By a series of notes in 1940 the Governments of the United States and Canada agreed that the Province of Ontario might use for power at Niagara Falls additional water equivalent in quantity to the water diverted by the Province into Lake Superior through the Long Lake and Ogoki projects which was considered to be 5,000 cfs. [Finding II-6] It is, therefore, only the remaining flow of the Niagara River of which, less the amounts required by treaty to be permitted to flow over Niagara Falls, the State of New York is entitled to use one-half for the production of power at Niagara Falls. The Niagara River Water Diversion Treaty of 1950 between the United States and Canada did not affect the 1940 agreement relating to the 5,000 cfs being diverted at Long Lake and Ogoki into the Great Lakes system which remained reserved for the sole use of the Province of Ontario for power production. The treaty provides that the remaining outflow of Lake Erie should be divided equally between the United States and Canada, the amount of water required to maintain the scenic beauty of Niagara Falls being specifically excluded. [Finding IX-19; U. S. Ex. 5B] By agreement all flows available for power at the St. Lawrence project are divided equally with Canada, including that resulting from the Long Lake-Ogoki in-diversion. [Finding X-205]

ment, those involving navigation, and those involving the production of hydroelectric power.

1. *Recreational, Municipal and Industrial Development*

The Great Lakes and their connecting rivers provide vast outdoor recreational opportunities for great numbers of people living both in and outside the region. Use of the waters for pleasure boating and fishing and the shore areas for holiday resorts, camping and bathing, for hunting and fishing, and as habitats for wildlife and the propagation of fish is constantly becoming more important as our population grows and the demand for such outdoor recreational facilities increases. The social importance of such facilities to the physical and mental health of our people is more and more recognized. To meet this need the Lake States have provided networks of parks, forests and other recreational sites along the lake and river shores and are continually expanding them. Millions of dollars have been expended for the preservation of their scenic beauty. Indeed, the recreational features of a river may be of greater public benefit than the use of the river for the production of hydroelectric power. Namekagon Hydro Co. v. Federal Power Com'n, 7 Cir. 1954, 216 F. 2d 509. It has been held that the preservation of the natural beauty and the natural fisheries of a river are relevant factors into which the Federal Power Commission must inquire when considering an application for a license for the construction of a hydroelectric power facility. Scenic Hudson Preservation Conf. v. Federal Power Com'n, 2 Cir. 1965, 354 F. 2d 608, cert. den. 384 U.S. 941. In fact, the development and protection of recreational facilities have become matters of national concern and to these ends the Congress has enacted legislation to carry out the national policy of conserving land and water for outdoor recreation in cooperation with all the States. Federal Water Project Recreation Act of 1965, 79 Stat. 213, 16 U.S.C.A. §460*l*-12.

A significant lowering of the lake levels resulting from increased Illinois diversion would at times of low lake stage, particularly in the case of unregulated Lakes Michigan-Huron and Erie, cause injury to these recreational areas, would increase hazards to pleasure boating [Findings XII-8, XII-13, XII-15, XII-32], would upset the ecology of the marshlands which provide habitats for fish and wildlife [Findings XII-10, XII-12, XII-18, XII-27], and would injuriously affect the economy of those areas of the Lake States dependent upon lake-oriented tourism. (Findings XII-9, XII-11, XII-17, XII-29] The resulting damage to the Lake States at such times cannot be measured in terms of money but it would be substantial. [Findings in Topic XII]

The growing urban and industrial complex situated along the shores of the Great Lakes suffers economic as well as social losses from low water levels. Low levels reduce the efficiency of municipal and industrial water intakes, increase pumping costs, create unstable conditions at docks, and decrease the carrying capacity of vessels using those docks. Such injuries would result at times of low lake stage from a reduction in levels caused by an increased Illinois diversion. Here the damage to the Lake States would be substantial but not measurable in money. [Findings in Topic XI]

2. *Navigation*

The Great Lakes basin and immediately adjacent areas include a tremendous industrial and agricultural concentration. The region is rich in natural resources and has extensive agricultural areas. These give rise to a large amount of waterborne commerce on the Great Lakes. The great concentration of industry around the lakes is largely due to the immediate availability of iron ore, limestone and coal in the region, which can be brought together economically by low cost water transportation. Shipment by Great Lakes freighter is much the cheapest form of transportation available for the bulk commodities produced in the region.

Indeed, the economy of the entire basin is largely dependent upon the availability of cheap water transportation. [Finding IX-2]

The major portion of the commerce of the Great Lakes passes through two or more of the lakes. Although the lakes themselves are very deep, some of the connecting channels between them and the harbors along their shores are not. Some harbors have lesser depths than those available in the connecting channels [Findings IX-24, IX-83] and, for a variety of reasons, some channels and harbors have not been improved. [Finding IX-26] Moreover, there are not many natural harbors. [Finding IX-22] Because of this, Federal, State and local authorities and interests bordering the lakes have engaged over the years in huge projects to deepen the channels and to provide adequate harbors along the shores. More than $600,000,000 has been spent by the Federal Government alone in dredging harbors and the connecting channels. [Finding IX-6] This has involved dredging these channels to a depth of 27′, in order to provide a safe operating draft for vessels drawing 25.5′ of water when the lakes are at low water datum. [Findings IX-3, IX-4] The Welland Canal in Canada, which provides the navigational link between Lakes Erie and Ontario, also has an available safe draft of 25.5′ [Finding IX-12], as does the St. Lawrence Seaway which connects Lake Ontario with tidewater [Findings II-21 to II-26, II-28, II-29, IX-21] and which was completed by the Governments of the United States and Canada in 1959 at a very large cost. The Seaway has provided a means for shipping products of the Great Lakes basin directly to foreign ports in ocean-going vessels, without transshipment. [Finding IX-74] This is of substantial economic benefit to the region. The statistics show that the marine traffic to and from the Great Lakes through the Seaway has increased each year since it was opened. During 1964, a total of 6,779 vessels transited the St. Lawrence River section of the Seaway, of which 577 were of United States registry, 3,491 were of Canadian registry and 2,711 registered under the flags of other coun-

tries, transporting a total of 39,309,029 tons of commodities. [Finding IX-21]

The Great Lakes ports in the United States, of which there are 275 in all [Finding IX-23], handled in the year 1964 over 200,000,000 tons of bulk cargo (iron ore, coal, grain, limestone and petroleum products), an increase of approximately 50,000,000 tons since 1949. [Findings IX-27 to IX-57, IX-64] Because the Great Lakes navigation season is limited by winter weather to eight months of the year [Findings IX-58, IX-59] the ships must operate on an extremely tight time schedule and very complex and sophisticated methods have been developed for loading and unloading them in the least possible time. For example, the loading rate on board Great Lakes freighters at modern docks for iron ore cargo is 3,000 to 5,000 tons per hour and for coal is 3,000 tons per hour. [Findings IX-68, IX-69, IX-71] A special type of Great Lakes freighter has been developed. These vessels are designed to carry the greatest possible tonnage in ships whose dimensions are as large as they can be made while still being able to navigate the connecting channels and locks, the Welland Canal and the Seaway with safety. Some of these vessels are over 600′ long and have a maximum draft in excess of 25.5′. It is estimated that by 1985 more than 75 per cent of the United States and Canadian Great Lakes fleet will be of this large type. Some of the larger and newer ships can carry more than 115 tons of cargo for each inch of immersion. [Findings IX-60 to IX-63] Consequently, especially in periods of low water, increments in lake levels of as little as one inch are important to Great Lakes carriers, who customarily load their vessels to capacity in accordance with the depths available in the critical channels and harbors. [Finding IX-70] To assist them in this, shippers are advised by the Lake Carriers Association during the navigation season of changes in available depths of one inch or more. [Findings IX-77, IX-78] It appears, however, that on occasion, Great Lakes vessels do not utilize the full depth of water available. [Findings IX-103 to IX-108]

When the lakes are at or near low water stage the larger ships of the Great Lakes fleet, if loaded to their maximum permissible load lines, cannot navigate the connecting channels and many of the harbors. If a further reduction in the present lake levels were to be brought about by an additional Illinois diversion in excess of the present 3,200 cfs, these large vessels of the Great Lakes bulk cargo fleet would suffer an additional loss in cargo carrying capacity. This loss would be measured by the extent of the Illinois-caused reduction in levels, at every stage of lake levels at which the available depth of water in the connecting channels and harbors of origin and destination was less than the maximum permissible drafts of the vessels. Likewise, even the smaller ships, which have an ample depth of water in the connecting channels at all stages of lake levels, are often limited, especially at low stages, when entering the many harbors which have not been dredged to depths of 27′, and this loss in cargo capacity would be greater if present lake levels were further reduced by an increased Illinois diversion.

An additional diversion by Illinois from Lake Michigan in the order of 1,000 cfs would result after 15 years in a lowering of the levels of Lakes Michigan and Huron of about one inch and of Lake Erie about six-tenths of an inch. [Finding III-26] The Corps of Engineers estimated that the reduction in cargo carrying capacity to the United States bulk cargo fleet on the Great Lakes which would result in the year 1985 from such an additional Illinois diversion would be 330,000 tons with a resulting economic loss of $363,000 in that year alone. [Finding IX-90] General James H. Stratton, a witness for the Lake States, estimated that the loss in 1985 would be substantially larger. [Finding IX-98] Both figures are subject to the reservation stated in Finding IX-101. In each case the estimate was, in effect, an average of losses which would occur over a period of years, with the estimated 1985 commerce and fleet, assuming the same frequency of controlling lake levels during that period as were experienced during

the years 1922 through 1956. [Finding IX-81] In a given year of low levels of the lakes losses might be substantially in excess of those predicted. These figures of estimated losses do not take into account possible losses to other industries which are closely associated with the shipping industry or to those dependent upon cheap water transportation. I think it has been clearly shown that the Lake States would suffer serious loss in the navigation of the Great Lakes if the diversion by Illinois at Chicago should be increased by any substantial amount above the present 3,200 cfs.

3. *Production of Hydroelectric Power*

The production of hydroelectric power is the third field in which the Lake States assert that injury to them results from the diversion by Illinois of water from Lake Michigan. This particular contention involves the State of New York alone. At the time of the original hearings in these cases there was no hydroelectric power project within the area of the Lake States large enough to be affected by the diversion. Consequently, as I indicated in the preliminary statement [p. 4], the Court struck from the bill of complaint filed by the State of New York the allegations with respect to alleged injury to the production of power as prematurely raised. [274 U.S. 488, 490] In view of subsequent developments, the State of New York filed, with leave of the Court, a supplemental and amended complaint in No. 3, Original, asserting damage to its production of hydroelectric power, both present and prospective, resulting from the Illinois diversion at Chicago. [Preliminary statement, pp. 17-19] This issue is, therefore, now appropriately raised.

The Power Authority of the State of New York [Finding X-101], under licenses from the Federal Power Commission [Findings II-23, II-27, X-301, X-302], and pursuant to agreement between the Governments of the United States and Canada [Finding II-22], completed two enormous hydroelectric power projects, one, in cooperation with The Hydro-Electric Power Commission of Ontario, on the St. Lawrence River at Massena, New York [Finding X-

201], and the other on the Niagara River at Niagara Falls, New York. [Finding II-11] These two plants, together with the neighboring power plants of Ontario Hydro on the St. Lawrence and Niagara Rivers, constitute one of the largest hydroelectric power developments in the world. The St. Lawrence project involves the Moses-Saunders power dam on the St. Lawrence River. The southern half of the power dam, with 16 turbine-generators, is operated by the Power Authority and the northern half, also with 16 turbine-generators, by Ontario Hydro. [Finding X-203] The 32 turbine-generators of the power dam are capable of accommodating and utilizing the entire flow of the St. Lawrence River under existing plans for the regulation of the outflow of Lake Ontario. The plant of the Power Authority on the Niagara River is also capable of accommodating and utilizing the portion of the normal flow of the Niagara River which is available by treaty to the United States for power purposes. [Finding X-206]

The share of the Power Authority of the State of New York of the cost of the hydroelectric power project on the St. Lawrence River was approximately $325,000,000. [Finding X-202] The cost to the Power Authority of the Niagara project was approximately $737,000,000. [Finding X-304] This entire amount, more than $1,000,000,000, was financed by the public sale of revenue bonds by the Power Authority. [Finding X-102] The Authority operates without profit and markets its power for the benefit of the people of the State as a whole. It is particularly required to make power available to domestic and rural consumers at the lowest possible cost. [Finding X-103] It has contracted to sell all the power and energy which it can generate at both the St. Lawrence and Niagara plants. [Findings X-104, X-210, X-211, X-310 to X-312]

To a substantial extent, the availability of low cost Niagara power is essential to the economy of the portion of New York State known as the Niagara frontier, particularly to the electrochemical and electrometallurgical industries located in that area. [Finding X-303] Likewise the

industrial development of northern New York is largely dependent on St. Lawrence power. Moreover the Niagara and St. Lawrence projects are interconnected by high voltage transmission lines so that the operations of the two systems can be coordinated and used simultaneously to meet the needs of the entire system. [Finding X-213]

I have found as a fact that an increase in the Illinois diversion at Chicago of 1,000 cfs would cause a reduction at the Niagara and St. Lawrence plants in capacity and energy having an economic value to the State of New York of $930,000 per annum. [Finding X-622] Smaller increases in the diversion would, of course, cause smaller economic losses. It can thus be seen that any substantial increase in the Illinois diversion would cause substantial pecuniary losses to the State of New York through its Power Authority which, if the increase in diversion became greater, would become more serious.

### C. Relations with Canada

The United States and Canada share Lakes Superior, Huron, Erie and Ontario and the upper St. Lawrence River as boundary waters. It is obvious that the interests of the Canadian Provinces of Ontario and Quebec in the waters of the Great Lakes and their connecting rivers are substantially the same as those of the Lake States. The relations of the United States and Canada with respect to these boundary waters have always been amicable. The Boundary Waters Treaty of 1909 [36 Stat. 2448] and the Niagara River Water Diversion Treaty of 1950 [1 U.S.T. 694] seem clearly to have contemplated the acceptance by Canada of the existing diversion at Chicago. [Findings II-1, II-9] Certainly the notes which Canada has delivered to the Department of State after 1930 have expressed opposition to any further unilateral increased diversions above the existing 3,200 cfs. [Findings II-38; IV-101 (g) and (h)]. Thus the Government of Canada in note No. 782, dated November 2, 1961, a copy of which was transmitted to me by the

Solicitor General at the request of that Government, expressed its particular concern with the type of additional diversion under consideration in Case No. 11 by the Elmhurst-Villa Park-Lombard Water Commission. [U.S. Ex. 5A] In its letter of January 2, 1962 transmitting that note to the Solicitor General, the Department of State expressed the view that the note was "a clear indication of the high degree of concern with which the Government of Canada would view a judgment adverse to its interests in these cases, and particularly Case No. 12, Original, 1960 Term (now Case No. 11, Original)." The Department further stated that it "considers it appropriate that the attention of the Supreme Court be directed to the considerable effect which its judgment may have on the relations of the United States with Canada." [U.S. Ex. 5]

As I have already indicated, the existing diversion has been recognized and accepted by Canada. This is made clear in a letter from the Department of State to the Solicitor General dated March 2, 1960, which was submitted to me as Appendix "A" to the Response of the United States to plaintiff's motion for an interim order in Case No. 12 [now Case No. 11]. In that letter it is said:

> "The main issue presented by Nos. 2, 3 and 4, Original, namely, whether the defendants should be required to return to the Great Lakes Basin water which originally was taken therefrom in the form of 'domestic pumpage,' does not appear to us to raise any foreign relations problems which ought to be brought to the attention of the Special Master by the United States. The present diversion for 'domestic pumpage' at Chicago constitutes a long-established use, to which Canada has not objected and which, on the contrary, has been recognized by the two countries, in their various joint arrangements for construction of the St. Lawrence Seaway, improvement of the Great Lakes Connecting Channels, and development of power in the International Rapids Section of the St. Lawrence River, to be part of the existing regime of the Great Lakes Basin."

These views of the Department of State I accept, since weighing the effect of given actions upon our relations with foreign powers is a matter peculiarly within the competence of the political branches of the government. Oetjen v. Central Leather Co., 1918, 246 U.S. 297, 302. I accordingly conclude that the maintenance of the present diversion does not involve a problem of international relations, but that a substantial unilateral increase in the diversion would not be consistent with furthering our friendly relations with Canada.

## D. The Needs of Illinois

### 1. *Domestic Water Supply*

I turn to consider the needs of Illinois for Great Lakes water and the injuries which it is alleged the State and its people will suffer if the diversion of additional water from Lake Michigan is enjoined. At the outset I observe that the only need urged by Illinois for lake water is for domestic pumpage and the amount required to maintain the Sanitary and Ship Canal in a reasonably sanitary condition. The State of Illinois seeks in these proceedings merely to maintain its right under the 1930 decree of this Court to take its domestic pumpage from the lake when and as needed. It seeks no affirmative action in this regard except in Case No. 11, Original, in which it asks to have the right declared of the Elmhurst-Villa Park-Lombard Water Commission to take presently about 25 cfs [see Findings XV-4, XV-20, XV-21] of additional water from the lake for domestic use. But Illinois strongly opposes the Lake States' contention that it should not be entitled to supply from the lake the domestic water needs of its Northeastern Metropolitan Region.*

The needs of that whole region concern us here. For although the decree of 1930 refers in paragraph 4 to "the

* The Northeastern Illinois Metropolitan Region comprises Cook, DuPage, Kane, Lake, McHenry and Will Counties. See Ill. Ex. 654.

water drawn by the City of Chicago for domestic water supply purposes" and to "the amount of water pumped by the City of Chicago into its water mains" in fixing the method to be employed for computing the amount of the direct diversion, the fact is that the computation required by that paragraph cannot produce an accurate result unless there is also taken into account the domestic pumpage of all the other communities which draw their domestic water supply directly from the lake and discharge their sewage effluent into the Illinois waterway. Among these are Evanston, Wilmette, Kenilworth, Winnetka and Glencoe. [Finding VIII-34] Some of these communities, as well as Chicago, in turn sell part of their pumpage to communities lying to the west of them in the Northeastern Illinois Metropolitan Region. [Findings IV-37, IV-60]

Under these circumstances it has been the practice since 1930 in computing the amount of the direct diversion under paragraph 4 of the decree to treat the Chicago pumpage to which that paragraph refers as including not only the water which Chicago pumps for use in the city and for sale to its suburban customers but also the domestic pumpage of all the other communities which discharge their sewage effluent into the canal. By deducting this total pumpage, which approximates 1,700 cfs, from the total amount of water discharged from the canal to the Des Plaines River at Lockport, the amount of the diversion into the canal diverted directly and by way of storm runoff can be and has been over the years computed with substantial accuracy. [Finding IV-37] It is quite clear, therefore, that in considering whether the State of Illinois should be limited in the amount of domestic pumpage to be diverted from Lake Michigan, this Court is dealing, and should deal, with the pumpage of all the communities in the Northeastern Illinois Metropolitan Region whose domestic water supply comes from the lake and is not returned to it in the form of sewage effluent. We are, of course, not concerned with the pumpage of those communities, such as Waukegan, North Chicago, the Lake County Water District, and Fort Sheridan and

the Great Lakes Naval Training Station, which return all their sewage effluent to the lake.

It is well settled that the use of water for domestic purposes* is to be given first priority, as indeed it must be if human health is to be preserved and human activities are to continue. Connecticut v. Massachusetts, 1931, 282 U.S. 660, 673. As this Court has said, a stream of water "offers a necessity of life". New Jersey v. New York, 1931, 283 U.S. 336, 342. This is recognized by the Boundary Waters Treaty of 1909 which in Article VIII gives first priority to the use of the boundary waters for domestic and sanitary purposes. [U.S.Ex.5C] This, I think, is not to say that one riparian State may divert water for domestic purposes from a common stream or lake to the injury of other riparian States which have an equal right to it if the diversion of that water would be rendered unnecessary by better conservation of its existing water resources or the use of water from other sources the use of which would not injure the other States, or both. Under such circumstances the diversion of that water from the common stream or lake, even though solely for domestic purposes, may well be unreasonable and, therefore, inequitable. Cf. Rancho Santa Margarita v. Vail, 1938, 11 Cal. 2d 501, 556, 81 P. 2d 533, 561; Restatement, Torts, §853, Comment h.

In considering this matter we must remember that the requirements of the Northeastern Illinois Metropolitan Region for domestic water from the lake have increased very little in the past 35 years and today are substantially at the level of the amount, 1,700 cfs, authorized by the Congress in 1930 as a part of the water required for the navigation of the Illinois waterway. [Finding IV-37] With this amount, as I have already suggested, the Court is not concerned because of the Congressional authorization. The question remains, however, whether the future needs of Illinois for additional pumpage from the lake are so immediate and imperative as to outweigh the claims of the

* It is not disputed that domestic use in the setting of the present cases includes use by industrial and commercial establishments supplied with water withdrawn as domestic pumpage.

Lake States to the enjoyment and use of the water which would be diverted from the Great Lakes system by such additional pumpage, or whether, on the other hand, these needs can be met from other sources and by reasonable conservation and management of existing supplies, including that now drawn from the lake under the Congressional authorization.

2. *Disposition of Sewage Effluent*

The Lake States do not contest the right of Illinois to withdraw additional water from the lake for domestic purposes. Their contention is that any water so withdrawn, or its equivalent, must be returned to the lake from which it came. The State of Illinois, on the other hand, insists that it is entitled to continue to discharge the sewage effluent into the canal. I do not understand, however, that the right to take water for domestic use involves a duty, after it is used, to return it in the form of sewage or its treated effluent to the body of water from which it has been taken. On the contrary such water may be wholly consumed by its domestic use or its residue in the form of sewage effluent disposed of in such places as will do the least harm to the public interests. The applicable principle was well stated in Wyoming Hereford Ranch v. Hammond Packing Co., 1925, 33 Wyo. 14, 41-42, 236 P. 764, 772, as follows:

> ". . . It is well known that the disposition of sewage is one of the important problems that embarrass municipalities. In order to dispose of it without injury to others, a city may often be confronted with the necessity of choosing between several different plans, and in the selection of the plan to be followed we think it should be permitted to exercise a wide discretion. In determining how it will make a proper disposition of that which may be termed a potential nuisance, we think the city should not be hampered by a rule that would always require the sewage to be treated as waste or surplus waters. Sewage is some-

> thing which the city has on its hands, and which must be disposed of in such a way that it will not cause damage to others. It would often be considered the height of efficiency if it could be disposed of in some other manner than by discharging it into a stream. Even in this state, where the conservation of water for irrigation is so important, we would not care to hold that in disposing of sewage the city could not adopt some means that would completely consume it. It might, we think, be diverted to waste places, or to any chosen place where it would not become a nuisance, without any consideration of the demands of water users who might be benefited by its disposition in some other manner."

I am in complete accord with Special Master Hughes who, in his report on re-reference in these cases, said:

> "If the City of Chicago is entitled to take its water supply from Lake Michigan for the ordinary and reasonable uses of its inhabitants, it cannot be said that the State or the City is subject to any established rule of law which requires it to turn into the Lake what is no longer water but sewage or the effluent of sewage treatment plants. If there were a way of destroying the sewage or sewage effluent altogether, or evaporating it, it does not appear that the State or the City would violate any right of the complainants in doing so. (Fisk v. Hartford, 69 Conn. 375) . . ." [p. 121].

The observation made by this Court in United States v. Standard Oil Co., 1966, 384 U.S. 224, 225, is applicable here: "This case comes to us at a time in the Nation's history when there is greater concern than ever over pollution—one of the main threats to our free-flowing rivers and to our lakes as well." This Court in 1930 rejected the same contention which was then made by the Lake States—that the domestic pumpage after purification by the sewage

treatment works be returned to Lake Michigan—stating [281 U.S. 179, 200]:

> ". . . But purification is not absolute. How nearly perfect it will be with the colossal works that the defendants have started is somewhat a matter of speculation. The master estimates that with efficient operation the proposed treatment should reach an average of 85 per cent purification and probably will be 90 per cent or more. Even so we are somewhat surprised that the complainants should desire the effluent returned."

And now, more than 35 years later, it is apparent that complete purification has not been achieved, nor has it been shown that it is possible. [Findings IV-14 to IV-16]

Although I have found that it would be physically possible to return part of the sewage effluent of the Sanitary District to the lake, after chlorination, [Findings V-401 et seq.], it would be contrary to the public interest, in my view, to require Illinois to do so. For even with chlorination there is no assurance that the viruses would all be eliminated from the returned effluent and a gradual increase in the dissolved solids, nutrients for algal growth, and various organic chemical contaminants in the southern basin of Lake Michigan would certainly ensue.* [Findings VII-68 et seq.]

I fully agree with the opinion of the United States Public Health Service, reached after a comprehensive study of the Illinois waterway and Lake Michigan, that the discharge of treated sewage effluent to Lake Michigan would not be in the best interest of the protection of the public health in the use of the lake for water supply and recreation; that the damage to the water quality of Lake Michigan from such discharges over an extended period would be great; and that future uses of Lake Michigan would be

* The State of Illinois quite properly points out that the discharge of the sewage effluent into the lake might well have a serious effect upon the lakefront beaches and other recreational facilities at Chicago. [Finding XIII-6]

impaired thereby. [Finding VII-76] Moreover such a pollution of one of our largest reservoirs of comparatively pure fresh water would be contrary to the goals of pollution abatement and conservation of water resources to which the United States is committed by the Federal Water Pollution Control Act of 1948 and its amendments and supplements. 33 U.S.C.A. §§ 466 et seq.

For 66 years the sewage effluent of the Chicago region has been discharged into the Sanitary and Ship Canal from which it has flowed into the Des Plaines River and thence into the Illinois and Mississippi Rivers. Although diluted by storm runoff and water drawn directly from the lake, now averaging a total of 1,500 cfs, the water of the canal has always carried a substantial pollution load and it still does so. This load is reduced, however, by the natural processes of oxidation as the water passes down the Des Plaines and upper Illinois Rivers and the water reaches the lower Illinois River at Peoria in a less polluted condition. [Findings VI-30, VI-31, VI-32, VI-52] Whether any of the Chicago pollution remains in the water discharged by the Illinois River into the Mississippi River at Grafton has not been established. This was doubted even in the days when Chicago's sewage was being discharged untreated into the canal. See Missouri v. Illinois, 1906, 200 U.S. 496. I am satisfied from the evidence, and conclude, that the disposal of Chicago's sewage effluent by discharge into the canal is more in the public interest than would be its discharge into Lake Michigan, and is not unlawful, provided, of course, that the sanitary condition of the canal and rivers is maintained in a reasonably tolerable condition by sufficient treatment and dilution of the effluent.

The fact is that the existing regime under which approximately 1,700 cfs of sewage effluent is diluted by approximately 1,500 cfs of storm runoff and directly diverted lake water has been adequate to maintain the waters of the canal in a reasonably tolerable sanitary state for the purposes of navigation, including its use by pleasure craft, and from the standpoint of those who work along its

banks. The waters of the canal are, of course, much too polluted for recreational use, such as swimming and fishing, but such use can hardly be expected of a stream which must serve as the conduit for the disposal of the entire sewage effluent, even though treated, of so vast a population as that of the Northeastern Illinois Metropolitan Region. [See Findings VI-1 et seq.] There are, however, a number of ways in which Illinois can improve the water quality of the Sanitary and Ship Canal and at the same time make it possible to reduce the direct diversion and increase the domestic pumpage, while keeping within the 3,200 cfs limit, in order to meet future needs for an increased domestic water supply. There are also ways of conserving the domestic pumpage from the lake so as to keep it within the present amount of 1,700 cfs for some years to come and thereby to be able to continue the present direct diversion of 1,500 cfs, if needed, without exceeding the limit of 3,200 cfs. Moreover there are procedures by which Illinois, if and when faced with the need for an increased domestic water supply, can utilize existing unused ground supplies and stream flows. In this connection it would be possible for the State to use Lake Michigan for the temporary storage of seasonal high stream flows, if necessary. And, finally, it would be physically possible to divert water from other sources into the Great Lakes to compensate for additional diversion by Illinois from Lake Michigan.

## E. Methods of Water Resource Management Available in Northeastern Illinois Metropolitan Region

### 1. *Improvement of Water Quality of the Sanitary and Ship Canal*

The sewage treatment plants of the Sanitary District, the effluent from which is discharged into the various channels of the Sanitary and Ship Canal, are described in Findings IV-89 to IV-94. They are well designed and built and, when operating properly, compare favorably with the best

plants in the United States. During recent years they have removed on the average 89.1 per cent of the biochemical oxygen demand [see Findings VI-8 et seq.] and 85.6 per cent of the suspended solids in the sewage delivered to the plants. [Findings IV-14, V-23] As is the case with other sewage treatment plants, however, the efficiency of the plants of the Sanitary District varies from time to time. The reasons for this are not all known. Some of the causative factors, however, are the variable characteristics of the sewage, unusual discharges of industrial wastes, the weather and the difficulty in keeping all parts of the plants in operation at a high state of efficiency at all times. [Finding IV-16] It is, therefore, impossible to avoid some pollution of the waters of the canal by the effluent discharged into it from the sewage treatment works.

There are, however, as I have suggested, methods available to Illinois to reduce the pollution load on the canal and to improve its water quality. A substantial amount of this pollution load is derived from the untreated sewage and industrial wastes which are spilled directly into the canal at times when the runoff from storms is too great to be handled by the treatment works and causes the sewers to overflow the diversion chambers through which the raw sewage is normally diverted to those works. [Findings IV-72 to IV-87, V-1, V-3, VI-16] Sewers of this type, called combined sewers, which carry storm runoff as well as sanitary sewage and industrial wastes [Finding VI-21] serve about 83 per cent of the population served by the Sanitary District, the other 17 per cent being served by separate sanitary sewers, that is, sewers which carry only sewage and deliver their entire flow to the treatment works in all kinds of weather. [Findings IV-74, IV-75]

One obvious expedient would be to discontinue completely the further construction of combined sewers and to substitute separate sanitary and storm sewers for existing combined sewers wherever feasible. [Finding V-20] Another step which could be taken to reduce the pollution load on the canal would be to expand the existing treatment

works so that during periods of storm runoff they could treat combined storm and sewage flows of up to two times their present rated capacities. This could be done in two phases, the plants being expanded in the first phase to the extent needed to avoid outages and to insure efficient operation at one and one-half times the rated capacities. [Findings V-5 to V-12]

Much spillage of sewage into the canal has occurred that could have been prevented if the treatment works had been operated at more nearly maximum capacity during periods of storm runoff and for longer periods of time. [Findings V-4, V-7] Facilities could also be built to provide primary treatment prior to discharge into the canal of a substantial amount of the combined sewage and storm runoff encountered during periods of storm flow which could not be accommodated by the treatment works. This treatment could consist of the settlement and removal of solids in settling tanks or holding basins. [Finding V-13]

Furthermore the treatment works could be provided with standby equipment adequate to treat completely the sewage which is now occasionally bypassed or incompletely treated because of equipment failure or plant outage. [Findings V-8, V-21, V-22] It would also be possible to chlorinate the treatment plant effluent so as to reduce its biochemical oxygen demand and destroy most of the bacteria and some of the viruses which it carries. [Findings V-26, V-27, VII-70]

A number of industrial plants located on or near the canal discharge untreated industrial waste directly into it. [Findings V-24, VI-20] This pollution of the canal could be greatly reduced either by requiring the plants in question to connect to the sewerage system or to provide their own adequate treatment. [Finding V-25]

Finally, in addition to the measures outlined above, the pollution load on the canal could be reduced by artificial aeration which would introduce additional oxygen into the water of the canal from the air and thus accelerate the oxidation of its pollution land. [Findings V-102, V-103]

Experiments by the Sanitary District in 1962 with a floating aerator indicate that this procedure is entirely feasible. [Findings V-104 to V-108]

2. *Conservation of Domestic Pumpage from Lake Michigan*

As the result of a water conservation program initiated by the City of Chicago in 1930 the domestic pumpage of the city from Lake Michigan was actually reduced in the ensuing period of 30 years in spite of a substantial increase in population during that period [Finding V-201], with the result that the domestic pumpage of 1,700 cfs which was included in 1930 in the Congressionally authorized diversion continues to be adequate to meet the needs of the metropolitan region. Nonetheless, a substantial portion of the domestic pumpage of the city is still lost through leakage from distribution mains and leakage and waste at consumer service pipes and fixtures. [Finding V-202] Indeed the evidence shows that a more adequate leak detection and repair program in the City of Chicago would save approximately 160 cfs now lost through leakage in the city's water mains. [Findings V-203 to V-206] Furthermore, leakage and waste from customer service pipes and fixtures in the city would be greatly reduced through universal metering. [Findings V-207, V-208] Although the city has completed a program for metering all three-flat and larger buildings, single-family and two-family dwellings in Chicago are not presently metered. It is estimated that complete metering of the city would save not less than 62 cfs of domestic water supply [Finding V-214], and that a thorough program of fixture inspection and repair would save another 62 cfs. [Finding V-213] Thus Illinois has it within its power by these means to conserve approximately 285 cfs of the domestic pumpage from the lake which is now wasted and lost.

3. *Use of Presently Unused Ground and Surface Water*

It appears also that in the Northeastern Illinois Metropolitan Region there presently exists a substantial unused

water resource in the form of ground and surface water which, with proper overall management, could be made available for domestic supply. The evidence indicates that this may amount to 390 cfs or possibly even more.* [Finding IV-99. And see Technical Report No. 4, "The Water Resource in Northeastern Illinois: Planning Its Use", Northeastern Illinois Metropolitan Area Planning Commission, June 1966, chap. V] Included are the seasonal high flows of the Kankakee, Fox and Des Plaines Rivers which could be stored in reservoirs for later use or diverted through tunnels into Lake Michigan for storage in the lake pending subsequent withdrawal as domestic pumpage. [Findings V-301 et seq; Technical Report No. 4, supra, pp. 92, 167-171]

4. *Compensating Diversions*

Diversion into the lake to compensate for additional withdrawal of domestic pumpage could be effected, with the approval of the State of Wisconsin and the United States, at Portage, Wisconsin, at which point the Fox River of Wisconsin (which ultimately flows into Lake Michigan at Green Bay) is only one and one-half miles northeast of the Wisconsin River (which flows into the Mississippi) and is about five feet lower than the Wisconsin, the two rivers being connected at that point by an ancient canal and lock. In a state of nature before the present levees were built along the Wisconsin River that river in times of seasonal high water overflowed its banks and approximately 700 cfs of its flood water found its way each year into the Fox River and thence into Lake Michigan. [Findings V-316, V-317]

It would also be physically possible, with the consent and cooperation of the Federal Government and of the Dominion of Canada and the Province of Ontario, to divert

* This is not to say that the pumpage in the region from the deep sandstone aquifers may not be up to or in excess of their practical sustained yield. Indeed, I have so found. [Findings XV-53 et seq.] But it appears that there may well be considerable quantities of additional ground water available in the shallow dolomite aquifers. [Findings XV-26, XV-31, XV-32]

substantial amounts of additional water from the Hudson Bay watershed into Lake Superior or the Georgian Bay of Lake Huron. [Finding V-318]

5. *Feasibility of Such Water Resource Management*

It thus appears that there are means which are available to the State of Illinois to conserve the present domestic water supply of its Northeastern Metropolitan Region by reducing leakage and waste and to enlarge it without resorting to additional diversion from the lake (a) by improving the water quality of the canal and thereby making it possible to divert more of the presently authorized 3,200 cfs in the form of domestic pumpage and correspondingly less as direct diversion, (b) by utilizing more of the presently unused ground and surface water resources of the region, and (c) by taking more than 3,200 cfs from the lake and compensating for the excess by an equivalent diversion into the Great Lakes. Illinois urges that many of these proposals are not feasible from a financial standpoint and should not be required in view of the alleged disproportion between their cost and the economic benefits to be derived by the Lake States from the retention in the lake of the water which might otherwise have to be diverted as additional domestic pumpage. The estimated cost of various of these proposals is set out in my findings of fact in Topic V. It is undoubtedly true that the cost of some of them would be high. Others, however, as my findings of fact indicate, would not be unreasonably costly when considered in the light of the obligation of the State of Illinois to make the best use of the water resources available to it before resorting to additional lake water to which the Lake States have a claim. However, it will be time enough, in my opinion, to decide upon the feasibility, from the financial and other standpoints, of the various means available to Illinois to conserve and increase its water resources when and if in the future that State makes application to this Court for leave to divert in excess of 3,200 cfs from Lake Michigan for domestic use.

It is sufficient now to say that some at least of these expedients are entirely feasible from every standpoint and should be employed in any program for the enlightened management and use of water resources. In this category would certainly fall the best procedures available for the detection and repair of leaking mains and customer service lines and fixtures, the universal metering of customer services, the fuller use of available but presently unused ground and surface water supplies, the elimination of untreated industrial wastes from the canal, the complete discontinuance of the construction of combined sewers, and the artifical aeration of the canal. Whether Illinois should employ these or any of the other expedients which I have described, or still others which scientific and engineering research may make available in the future is, I believe, for that State to determine in the first instance and, therefore, need not now be decided. It is perfectly clear, however, that the State of Illinois has the duty so to manage its water resources and regulate the use of the water now available to it as to conserve this essential commodity to the utmost practicable extent for the use of its people. This surely means that the State must definitely undertake the task of managing its water resources, at least in its Northeastern Metropolitan Region, on a broad regional basis in the most modern scientific manner and that all feasible methods for developing the supply and conserving the use of domestic water which are reasonably available to it should be employed, before the State receives authority to divert more than the present 3,200 cfs from Lake Michigan.

In this connection a statement by the Northeastern Illinois Metropolitan Area Planning Commission which is contained in its Technical Report No. 4, entitled "The Water Resource in Northeastern Illinois: Planning its Use", June 1966, p. i, is most pertinent. The Commission is a public body created by the Legislature of Illinois and its views are entitled to consideration. In the report the Commission said:

"The concentration of people and urban development in the metropolitan area has placed many demands upon the water resource. But as a counterbalance to these pressures, science and technology have developed an array of alternative measures to manage both the resource and its use. A variety of water sources can be developed in conjunction with a variety of measures to manage the use of water.

"Public and private decision makers are on a threshold from which lead many choices. The choices in water resource management made now will chart the course of programs for many years to come. Will land and water be managed to fulfill the goals and aspirations of the people? Will proper management of the water resource and its use avoid situations in which water problems act as deterrents to sound economic growth? The answer to both of these questions can be 'yes,' but only if the metropolitan area is willing to take advantage of its natural resources and to select from the array of management alternatives those which are best suited to bring about a compatible relationship between resource and use and among the several water uses."

The State of Illinois has ample sovereign power to undertake such a program for the modern scientific management of its water resources and the regulation of the use of the water. In my opinion it should be required to do so before it is authorized to divert more of the lake water in which the Lake States have an equal interest.

6. *Future Effect of Such Water Resource Management*

The evidence shows that at the present time the authorized diversion of 3,200 cfs is sufficient, with the existing ground and surface water resources, to provide an adequate domestic water supply for the region while maintaining the Sanitary and Ship Canal in a reasonably satisfactory sanitary condition. It has been estimated that by the year

2000 approximately 540 cfs of additional domestic pumpage from Lake Michigan may be required for the region even if all ground and surface supplies are utilized. [Finding IV-99] There is good reason to believe, however, that if comprehensive and thorough procedures for the management of this water resource and the regulation of water use in the region are employed by a public agency fully empowered by the State to carry them out on a comprehensive regional basis, the water required for domestic purposes in the year 2000 will be little, if any, greater than that now being used for those purposes. [Technical Report No. 4, supra, pp. 127-134] Some of these available procedures I have already mentioned and there may well be others now available or to be developed in the future.

F. Evaluation of Equities as Between the Lake States and Illinois

This Court has made it clear that the equitable apportionment of interstate water among riparian States is to be determined according to principles of right and equity upon a consideration of all relevant facts and having regard for the equal level on which all the States stand. Connecticut v. Massachusetts, 1931, 282 U.S. 660, 670-671. In the present cases, three established facts stand out sharply as most significant in such a determination.

The first is that the Lake States would suffer substantial injury as the result of an increased diversion by Illinois from Lake Michigan. The second is that such an increased diversion would similarly injure the Dominion of Canada and its Provinces of Ontario and Quebec and would, therefore, be likely to have a harmful effect upon the foreign relations of this country. And the third is the fact that the State of Illinois has no imperative need to divert water in excess of 3,200 cfs from Lake Michigan at the present time and that it has means available to it so to conserve and manage its existing water resources as to meet its increased water needs for many years to come without resort to additional lake water. The fact

that these means may be substantially more expensive than merely pumping more water out of Lake Michigan should not, in my opinion, be given controlling weight as against the injury to the Lake States and the possible harm to our foreign relations which would result from such additional diversion.

Evaluating the relevant facts I am compelled to conclude that right and equity require that the State of Illinois be enjoined from diverting from Lake Michigan more than the 3,200 cfs authorized by Act of Congress, until such time as it appears that the water needs of its Northeastern Metropolitan Region can no longer be met through the well managed use of all its existing water resources including the water authorized by Congress to be diverted from Lake Michigan.

What the situation may be in the future cannot now be predicted with any certainty, however, and it may well be appropriate and, indeed, necessary for the Court, 25 or 30 years hence, again to review and re-evaluate the demands and the potentialities of the situation.* Certainly, in a matter involving the basic needs and economy of so many States and so many millions of people no decision of the moment can be regarded as settling questions of this magnitude for all future time. But if and when in the future the State of Illinois should make application for leave to increase its diversion from Lake Michigan it will surely be incumbent upon the State to show that it has employed all feasible and appropriate measures to manage and conserve its existing water resources.

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* It is possible that in the future the construction of compensating or regulatory works, if undertaken by the United States, with the consent of Canada, in the outflow channels of Lakes Huron and Erie could minimize or even eliminate the injury from increased diversion from Lake Michigan which might be suffered by the Lake States in the areas of recreational, municipal and industrial development and of navigation. [Findings III-34 to III-37] Such construction would not, however, diminish the injury to the production of hydroelectric power from loss of flow resulting from such additional diversion. [Finding III-38] See United States v. Chandler-Dunbar Co., 1913, 229 U.S. 53, 67.

## VI. The Complaint in No. 11, Original

With respect to the complaint of the State of Illinois on behalf of the Elmhurst-Villa Park-Lombard Water Commission in No. 11, Original, a further word is required. That complaint seeks a declaratory judgment that the Commission is entitled to withdraw from Lake Michigan its needs for domestic pumpage, presently estimated at about 25 cfs. The communities served by the Commission are within the Northeastern Illinois Metropolitan Region and to the extent that ground and surface water is not available they should be entitled to withdraw domestic pumpage from the lake, just as the City of Chicago and other communities in the area are now doing. But any such withdrawal must be included within the overall maximum authorized diversion of 3,200 cfs and must, of course, involve the discharge into the Illinois waterway of the sewage effluent resulting therefrom.

It will, therefore, be necessary for the State of Illinois, through the agency which it empowers to perform the task, to apportion among the municipalities and water commissions of its Northeastern Metropolitan Region, in such manner and in such amounts as may be deemed appropriate, the water available for domestic supply in the area, including so much of the presently authorized 3,200 cfs of lake water as is not required to be taken directly into the canal in order to maintain it in a reasonably satisfactory sanitary condition. Accordingly, the complaint in No. 11 should be dismissed, without prejudice to the right of the Elmhurst-Villa Park-Lombard Water Commission to share in the presently authorized 3,200 cfs of lake water to the extent that the State of Illinois may authorize.

## Conclusions

The conclusions which I have reached may be stated as follows:

1. In the exercise of its constitutional power to regulate interstate and foreign commerce the Congress may authorize the diversion of water from Lake Michigan to the Illinois waterway for the purposes of navigation.

2. The Congress has exercised this power by authorizing to be used for the navigation of the Illinois waterway the water authorized to be diverted from Lake Michigan, both directly and as domestic pumpage, by the decree of this Court entered April 21, 1930 in these cases.

3. The water thus authorized by the Congress to be diverted from Lake Michigan and used for the navigation of the Illinois waterway is limited to a maximum amount of 3,200 cubic feet per second.

4. The State of Illinois and its instrumentalities may take by way of direct diversion of storm runoff and lake water so much of such 3,200 cfs of water as may from time to time be needed to maintain the Sanitary and Ship Canal in a reasonably satisfactory sanitary condition and the remainder thereof as domestic pumpage from the lake.

5. The diversion of 3,200 cfs of water from Lake Michigan by the State of Illinois and its instrumentalities as thus authorized by the Congress is lawful and the States of Minnesota, Wisconsin, Michigan, Ohio, Pennsylvania and New York have not suffered a legally recognizable injury by reason thereof.

6. The amount of water thus authorized by the Congress to be diverted from Lake Michigan for purposes of navigation is not subject to reduction by this Court under the judicial power.

7. The State of Illinois may not divert, either directly or through its instrumentality the Metropolitan Sanitary District of Greater Chicago, additional water from Lake Michigan solely for the purpose of diluting and carrying away the sewage effluent of the Northeastern Illinois Metropolitan Region.

8. The State of Illinois and its instrumentalities may not be compelled to return to Lake Michigan the sewage effluent derived from its domestic pumpage from the lake.

9. Whether the State of Illinois and its instrumentalities are entitled to divert additional water from Lake Michigan as domestic pumpage is to be determined under the rule of equitable apportionment.

10. Necessary domestic use by riparian States is the use of the water of the Great Lakes having first priority.

11. The State of Illinois is, however, under the duty of employing all those means which are practicable and reasonably available to it for conserving its own water resources for domestic use in its Northeastern Metropolitan Region before seeking to take additional water from Lake Michigan for such use.

12. Under the rule of equitable apportionment the need of the State of Illinois for the diversion of additional water from Lake Michigan for domestic use in its Northeastern Metropolitan Region is to be weighed against the need of the States of Minnesota, Wisconsin, Michigan, Ohio, Pennsylvania and New York for the maintenance of lake levels and flows undiminished by additional diversion and the injuries which they would suffer if those levels and flows were thus diminished. The Illinois need must also be considered in the light of the effect which the additional diversion might have on the present friendly relations between the United States and Canada.

13. The needs of the States of Minnesota, Wisconsin, Michigan, Ohio, Pennsylvania and New York to maintain,

undiminished by additional diversion, the existing lake levels and flows for recreational, municipal and industrial purposes, for purposes of navigation and for the production of hydroelectric power have been established by the evidence and it has been shown that they would suffer serious injury as the result of an additional diversion by the State of Illinois from Lake Michigan in any substantial amount.

14. The present friendly relations between the United States and Canada could be harmed by an increased diversion by the State of Illinois from Lake Michigan.

15. The existing resources of the Northeastern Illinois Metropolitan Region for water for domestic use, including the existing diversion of 1,700 cfs from Lake Michigan, are presently adequate to meet the needs of the region, and any additional water needed for such use in the years immediately ahead can be obtained by the employment of means which are feasible and reasonably available to the State of Illinois and its instrumentalities to improve the water quality of the Sanitary and Ship Canal and to manage and conserve the existing water supply and its use and to make available additional supplies of ground and surface water.

16. Under the rule of equitable apportionment the State of Illinois is not presently entitled to divert water from Lake Michigan in excess of 3,200 cfs in derogation of the rights of the States of Minnesota, Wisconsin, Michigan, Ohio, Pennsylvania and New York.

17. The Elmhurst-Villa Park-Lombard Water Commission is not entitled to draw water from Lake Michigan except as a part of the 3,200 cfs authorized by the Congress for the Illinois waterway and only if the sewage effluent resulting from such diversion is discharged into the Illinois waterway.

## Recommended Decree

The decree of this Court entered on April 21, 1930 should be superseded by a new decree enjoining the State of Illinois and its municipalities, political subdivisions, agencies and instrumentalities, including the Metropolitan Sanitary District of Greater Chicago, from diverting from Lake Michigan more than 3,200 cfs in all, of which an amount necessary to maintain the Sanitary and Ship Canal in a reasonably satisfactory sanitary condition may be diverted into the canal directly from the lake and as storm runoff and the remainder may be withdrawn as domestic pumpage by the City of Chicago and other communities in the Northeastern Illinois Metropolitan Region, each to the extent authorized by the State of Illinois or its duly empowered agency.

In accordance with recommendations of the United States Public Health Service the basic accounting period for determining diversion flows should be changed from the calendar year to a water year terminating at the end of February. The accounting method should also be modified to permit a period of two years for achieving the required balance of an average diversion of 3,200 cfs, when necessary. [Finding VI-56] The domestic pumpage to be taken into account should, of course, include not only the pumpage of the City of Chicago but also that of all other communities in the Northeastern Illinois Metropolitan Region which may now or hereafter be authorized by the State of Illinois to take their domestic water supply from the lake within the limits fixed by the decree. This would include the Elmhurst-Villa Park-Lombard Water Commission if and when the State of Illinois, or the agency to which the State delegates the power to manage its water resources, empowers the Commission to use a part of the presently authorized 3,200 cfs of diversion from the lake. It would not, of course, include those communities which return all

their sewage effluent to the lake, as some of them presently do.

It is quite possible that at some time in the future the use by the State of Illinois of all the practicable means which are reasonably available to it to manage and conserve the water resources of its Northeastern Metropolitan Region will prove inadequate to provide for the needs of an increased population and expanded industrial complex. The State of Illinois should, therefore, have leave, if and when this occurs, upon a proper showing, to make application for a modification of the decree to permit an additional diversion of domestic pumpage from the lake.

The complaint in No. 11, Original Docket, should be dismissed without prejudice to the right of the Elmhurst-Villa Park-Lombard Water Commission to come in on the presently authorized 3,200 cfs of diverted Lake Michigan water to the extent which may be authorized by the State of Illinois.

The parties in all four cases should bear their own costs. The plaintiffs and defendants in Nos. 1, 2 and 3, Original Docket, should each as a group bear one-half of the special master's expenses.

The following decree is accordingly recommended:

IT IS ORDERED, ADJUDGED AND DECREED that:

1. The State of Illinois and its municipalities, political subdivisions, agencies and instrumentalities, including, among others, the cities of Chicago, Evanston, Highland Park, Highwood and Lake Forest, the villages of Wilmette, Kenilworth, Winnetka and Glencoe, the Elmhurst-Villa Park-Lombard Water Commission, the Chicago Park District and the Metropolitan Sanitary District of Greater Chicago, their employees and agents and all persons assuming to act under their authority, are hereby enjoined from diverting any of the waters of Lake Michigan or its watershed into the Illinois waterway, whether by way of domestic pumpage from the lake the sewage effluent derived from which reaches the Illinois waterway, or by way

of storm runoff from the Lake Michigan watershed which is diverted into the Sanitary and Ship Canal, or by way of direct diversion from the lake into the canal, in excess of a biennial average for all of them combined of 3,200 cubic feet per second, this being the total amount of water presently authorized by Act of Congress to be diverted from the lake for the navigation of the Illinois waterway. "Domestic pumpage", as used in this decree, includes water supplied to commercial and industrial establishments and "domestic use" includes use by such establishments. The water thus authorized by the Congress, and permitted by this decree, to be diverted from Lake Michigan and its watershed may be apportioned by the State of Illinois among its municipalities, political subdivisions, agencies and instrumentalities for domestic use or for direct diversion into the Sanitary and Ship Canal to maintain it in a reasonably satisfactory sanitary condition, in such manner and amounts and by and through such instrumentalities as the State may deem proper, subject to any regulations which the Congress may impose in the interests of navigation or pollution control.

2. The amount of water diverted into the Sanitary and Ship Canal directly from Lake Michigan and as storm runoff from the Lake Michigan watershed shall be determined by deducting from the total flow in the canal at Lockport (a) the total amount of domestic pumpage from Lake Michigan by the State of Illinois and its municipalities, political subdivisions, agencies and instrumentalities the sewage effluent derived from which reaches the canal, (b) the total amount of domestic pumpage from ground and surface sources outside the Lake Michigan watershed the sewage effluent derived from which reaches the canal, (c) the total estimated storm runoff from the upper Illinois River watershed reaching the canal, and (d) the total amount of domestic pumpage from Lake Michigan by municipalities and political subdivisions of the State of Indiana the sewage effluent derived from which reaches the canal.

3. For the purpose of determining whether the total amount of water diverted from Lake Michigan by the State of Illinois and its municipalities, political subdivisions, agencies and instrumentalities is not in excess of the maximum amount permitted by this decree, the amounts of domestic pumpage from the lake by the State and its municipalities, political subdivisions, agencies and instrumentalities the sewage effluent derived from which reaches the Illinois waterway, either above or below Lockport, shall be added to the amount of direct diversion into the canal from the lake and storm runoff reaching the canal from the Lake Michigan watershed computed as provided in paragraph 2 of this decree. The accounting period shall consist of the period of twelve months terminating on the last day of February. A period of two years shall be permitted, when necessary, for achieving an average diversion which is not in excess of the maximum permitted amount. The measurements and computations required by this decree shall be made by the appropriate officers, agencies or instrumentalities of the State of Illinois under the general supervision and direction of the Corps of Engineers of the United States Army.

4. The State of Illinois may make application for a modification of this decree so as to permit the diversion of additional water from Lake Michigan for domestic use when and if it appears that the reasonable needs of the Northeastern Illinois Metropolitan Region (comprising Cook, Du Page, Kane, Lake, McHenry and Will Counties) for water for such use cannot be met from the water resources available to the region, including both ground and surface water and the water authorized by Act of Congress and permitted by this decree to be diverted from Lake Michigan, and if it further appears that all feasible means reasonably available to the State of Illinois and its municipalities, political subdivisions, agencies and instrumentalities have been employed to improve the water quality of the Sanitary and Ship Canal and to conserve and manage the water resources of the region and the use of water

therein in accordance with the best modern scientific knowledge and engineering practice.

5. This decree supersedes the decree entered by this Court in Nos. 1, 2 and 3, Original Docket, on April 21, 1930, as enlarged May 22, 1933.

6. The complaint of the State of Illinois in No. 11, Original Docket, on behalf of its instrumentality, the Elmhurst-Villa Park-Lombard Water Commission, is hereby dismissed, without prejudice to that Commission sharing, to the extent which the State of Illinois may hereafter authorize, in the water presently authorized by Act of Congress and permitted by this decree to be diverted from Lake Michigan.

7. Any of the parties hereto may apply at the foot of this decree for any other or further action or relief, and this Court retains jurisdiction of the suits in Nos. 1, 2 and 3, Original Docket, for the purpose of making any order or direction, or modification of this decree, or any supplemental decree, which it may deem at any time to be proper in relation to the subject matter in controversy.

8. All the parties to these proceedings shall bear their own costs. The costs and expenses of the special master shall be equally divided between the plaintiffs as a group and the defendants as a group in Nos. 1, 2 and 3, Original Docket. The costs and expenses thus imposed upon the plaintiffs and defendants shall be borne by the individual plaintiffs and defendants, respectively, in equal shares.

The foregoing report is respectfully submitted.

ALBERT B. MARIS
*Special Master*

Philadelphia, Pa.
December 8, 1966

# Appendix

## Prehearing Order

The court having re-opened the decree of April 21, 1930, in causes Nos. 2, 3 and 4, and having given the complainant leave to file its complaint in cause No. 12, and having appointed me as special master in each of these causes with directions to hold hearings with all convenient speed and to submit such reports as I may deem necessary, and the parties, by their counsel, having appeared before me at a pre-hearing conference held in Chicago on October 19 and 20, 1959, the following action was taken:

### I. Legal Issues

Without prejudice to the right of the parties to seek the determination of any other issues properly raised by the pleadings, the principal issues which appear to me to be raised by the pleadings, including the amended application to reopen the decree in Nos. 2, 3 and 4 and the answer thereto, are the following:

A. The legal issues in Nos. 2, 3 and 4 are:

(1) Whether the court should enjoin the State of Illinois and the Metropolitan Sanitary District of Greater Chicago from discharging any of the treated effluent emanating from the sewage and industrial treatment facilities of the District into the Sanitary and Ship Canal and whether the court should require them by mandatory injunction to return all of said effluent to Lake Michigan from which it originally came in the form of "domestic pumpage", the injunctions to be made effective at such times and under such terms as to the court should seem meet and just.

(2) Whether the court should appoint a permanent master invested with such authority as he may require for the purpose of maintaining surveillance over the operation of the sewers, interceptors, and other sewage and water collecting facilities and the

sewage disposal and industrial treatment plants and works operated by the Metropolitan Sanitary District of Greater Chicago.

(3) Whether the court should require the State of Illinois and the Metropolitan Sanitary District of Greater Chicago to put into effect measures other than the return to Lake Michigan of the Chicago domestic pumpage effluent which will reduce either the direct diversion or limit or restrict the Chicago domestic pumpage, to the end that the total amount of diversion of water, including storm water runoff, from Lake Michigan at Chicago will be reduced or restricted.

B. The legal issues in No. 12 are:

(1) Whether the State of Illinois, through its instrumentality, the Elmhurst-Villa Park-Lombard Water Commission, is entitled under the circumstances of this case to withdraw water from Lake Michigan in order to provide a water supply to the City of Elmhurst and the Villages of Villa Park and Lombard in view of the fact that those municipalities although in the State of Illinois are situated outside the Great Lakes watershed.

(2) If so, whether the enforcement of its right to withdraw such water should be conditioned (a) upon the return to Lake Michigan of the residue after use and appropriate treatment of the water withdrawn from Lake Michigan by the Commission or (b) upon the institution of other measures adequate to compenstate the other Great Lakes states, either in money or in other substitute water, for any loss which they will suffer by reason of the withdrawal of such water from Lake Michigan.

## II. Procedure

A. It is ordered that these causes shall be consolidated for hearing, subject to the order for the presentation of evidence hereinafter fixed. All evidence offered by the parties

at the hearings shall be available to all of them in each of the causes to the extent that it is relevant to the issues involved therein without having been specifically offered as evidence in the particular cause.

B. The order of procedure for the presentation of evidence at the hearings shall be as follows:

(1) The State of Illinois shall present its evidence in chief in cause No. 12.

(2) (a) The States of Wisconsin, Minnesota, Ohio, Pennsylvania, Michigan and New York shall present their answering evidence in cause No. 12 and (b) those states shall present their evidence in chief in causes Nos. 2, 3 and 4.

(3) (a) The State of Illinois shall present its rebuttal evidence in cause No. 12 and (b) it and the Metropolitan Sanitary District of Greater Chicago shall present their answering evidence in causes Nos. 2, 3 and 4.

(4) The States of Wisconsin, Minnesota, Ohio, Pennsylvania, Michigan and New York shall present their rebuttal evidence in causes Nos. 2, 3 and 4.

C. The parties have agreed, subject to their right to substitute others upon notice to the special master, that at the hearing of these cases before the special master the following counsel will speak for the states indicated, namely:

| | |
|---|---|
| For the State of Illinois and the Metropolitan Sanitary District of Greater Chicago in Nos. 2, 3 and 4 | — Thomas M. Thomas, Esq., and Joseph H. Pleck, Esq. |
| For the State of Illinois in No. 12 | — George E. Billett, Esq., and Charles A. Bane, Esq. |
| For the State of Wisconsin | — Hon. John W. Reynolds |
| For the State of Minnesota | — Counsel to be designated by the Attorney General of Minnesota |

| | |
|---|---|
| For the State of Ohio | — Jay C. Flowers, Esq. |
| For the Commonwealth of Pennsylvania | — Lois G. Forer, Esq. |
| For the State of Michigan | — Nicholas V. Olds, Esq. |
| For the State of New York | — Randall J. LeBoeuf, Jr., Esq., and Craigh Leonard, Esq. |

In the case of the States of Wisconsin, Minnesota, Ohio, Pennsylvania, Michigan and New York it has been further agreed that Hon. John W. Reynolds, Hon. Mark McElroy, Hon. Paul L. Adams and Randall J. LeBoeuf, Jr., Esq., or one or more of them to be selected by the group from time to time, will speak for those states as a group.

D. It is ordered that the testimony in chief of expert witnesses, including their statements of their training, experience and qualifications, shall be reduced to writing, preferably in question and answer form, and copies thereof shall be furnished to the special master and opposing counsel not less than two weeks in advance of the dates on which the witnesses are to be called upon to testify. At the conclusion of the direct examination of a witness the parties entitled to cross-examine him shall have the right to defer cross-examination for a reasonable period of time, to be determined in each instance by the special master, until such parties have had an opportunity to study the testimony of the witness, except where such an opportunity is manifestly not required.

E. The parties have agreed that an objection made by one party to the testimony of a witness or to the admission of an exhibit shall be available to all other parties on the same side of the cases without specific reference to them or reservation by them of the right to rely thereon. It has been further agreed that the special master should ordinarily rule upon objections to evidence or exhibits at the time the objections are made with leave to the objecting party, in case the objection is overruled and if so advised, to make a motion to strike the testimony or exhibit after the exami-

nation and cross-examination with respect thereto have been completed.

F. The parties have agreed that copies of exhibits proposed to be offered in evidence by them shall be furnished to counsel for the opposing parties at least two weeks prior to the date on which the exhibits are to be offered in evidence. In the case of exhibits which can be readily reproduced the State of Illinois and the Metropolitan Sanitary District of Greater Chicago shall furnish eight copies to counsel for the States of Wisconsin, Minnesota, Ohio, Pennsylvania, Michigan and New York and the states just mentioned shall furnish three copies to George A. Lane, Esq., for the State of Illinois and the Metropolitan Sanitary District of Greater Chicago in Nos. 2, 3 and 4 and two copies to George E. Billett, Esq., for the State of Illinois in No. 12. In the case of an exhibit which cannot be reproduced in numbers without undue expense a single copy may be furnished to opposing counsel provided it is so furnished at least one month in advance of the time when the exhibit is to be offered in evidence. In the case of an exhibit comprising a document from a public source copies need not be furnished if they are readily available to the public and an accurate description of the document and of the place where copies may be procured are furnished to opposing counsel at least one month in advance of the time when the exhibit is to be offered in evidence. All parties offering exhibits shall furnish one copy to the special master and shall reserve one copy for the United States, in case it is given leave to intervene as a party.

G. Exhibits shall be numbered for identification by the parties prior to being furnished to opposing counsel and offered in evidence. Exhibits offered by the State of Illinois in No. 12 shall be numbered "Ill. 1" and following numbers up to 100. Exhibits offered by the State of Illinois and the Metropolitan Sanitary District of Greater Chicago in Nos. 2, 3 and 4 shall be numbered "Ill. 101" and the following numbers. Exhibits offered by the States of Wiscon-

sin, Minnesota, Ohio, Pennsylvania, Michigan and New York shall be numbered "L.S. 1" and following, the numbering of such exhibits not necessarily to be consecutive.

H. The parties have agreed that the identification and authentication of documents offered as exhibits from public sources shall be regarded as conceded without proof unless opposing counsel to whom they have been submitted in advance notify counsel who propose to offer the exhibits of objections to their identity or authenticity prior to the date on which they are to be offered in evidence.

I. The parties have agreed to employ a competent reporter to report the special master's hearings. The parties will make their own arrangements with the reporter for the number of copies of the transcript, daily or otherwise, which each of them desires for its own use. In addition the parties will arrange with the reporter to provide one copy of the transcript for the use of the special master and for ultimate filing in the Supreme Court. The parties have agreed that Peter G. Kuh, Esq., and Nicholas V. Olds, Esq., shall serve as a committee to supervise the work of the reporter and to provide for making necessary corrections in the preliminary transcript. All proposed corrections shall be submitted to the committee within two weeks after the preliminary transcript is prepared by the reporter.

J. It is ordered that the parties arrange for the adequate current indexing of the transcript of the testimony and the exhibits both by subject matter and by witness' name or exhibit number, and furnish copies of the index to the special master currently as it is prepared.

K. The parties have agreed that physical arrangements, necessary personnel, financial arrangements and other administrative matters involved in the conduct of the hearings in these cases shall be dealt with on their behalf by a business committee consisting of Lawrence J. Fenlon, Esq., for the Metropolitan Sanitary District of Greater

Chicago and the State of Illinois (in Nos. 2, 3 and 4), George E. Billett, Esq., for the State of Illinois (in No. 12), Roy G. Tulane, Esq., for the State of Wisconsin, counsel to be designated by the Attorney General for the State of Minnesota, Jay C. Flowers, Esq., for the State of Ohio, Lois G. Forer, Esq., for the Commonwealth of Pennsylvania, Nicholas V. Olds, Esq., for the State of Michigan and Craigh Leonard, Esq., for the State of New York, of which committee Nicholas V. Olds, Esq., has been appointed chairman and Lawrence J. Fenlon, Esq., co-chairman. It has been further agreed that the special master may confer from time to time with respect to any such matters with the chairman or co-chairman of the committee who will take them up with the committee for action.

L. It is ordered that if any material is submitted to the special master by any party copies thereof shall be made available by such party to opposing counsel at or before the time of such submission.

M. It is ordered that the parties at times hereafter to be fixed by the special master shall submit to the special master their requests for findings of fact and conclusions of law and that the special master before filing his report with the court shall submit a draft thereof to counsel for all parties for the purpose of receiving their suggestions with respect thereto.

October 20, 1959

ALBERT B. MARIS
*Special Master*

## L. S. Ex. 19B

MAP, GREAT LAKES DRAINAGE BASIN

# U. S. LAKE SURVEY
## CORPS OF ENGINEERS, U. S. ARMY
# GREAT LAKES—ST. LAWRENCE RIVER DRAINAGE SYSTEM

SCALE OF MILES
25 0 25 50 75 100 125 150 175

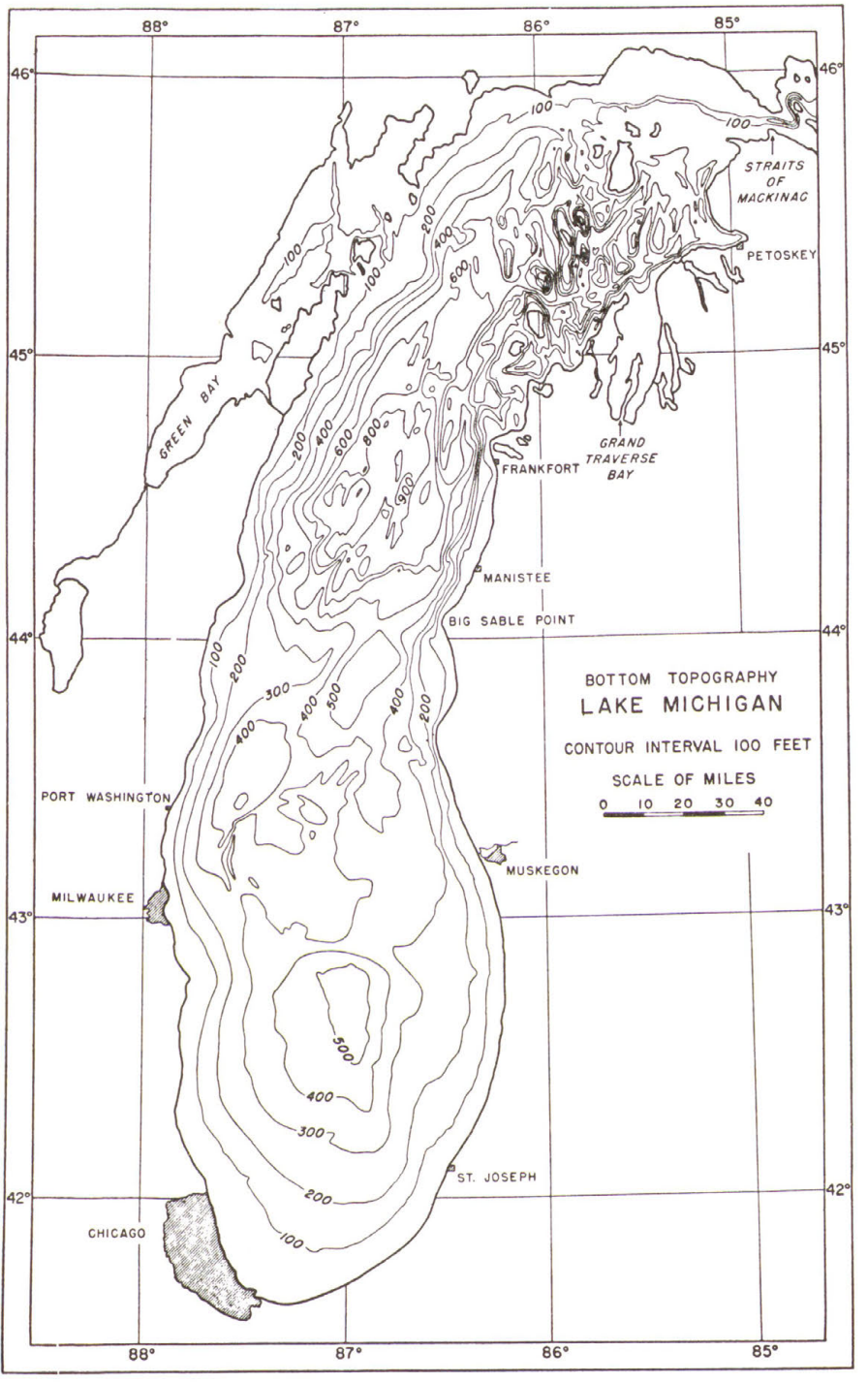
LAKE STATES Exhibit No. 19B
admitted in evidence Feb. 4, 1960
Special Master

Special Master

Ogoki River To Hudson Bay
Dam
Diversions into Lake Superior
LAKE NIPIGON
Dam
Power Houses
Nipigon River
Kenogami River To Hudson Bay
Long Lake
Dam
Aguasabon River
Dam
International Boundary
PORT ARTHUR
MINNESOTA
LAKE SUPERIOR
St. Louis River
DULUTH
SUPERIOR
HOUGHTON
Deepest sounding
MARQUETTE
WISCONSIN
ONTARIO
DIVIDE BETWEEN GREAT LAKES DRAINAGE BASIN AND OTHER DRAINAGE BASINS
Navigation Locks: Regulating works and power diversions
Point Iroquois
SAULT STE MARIE
St. Marys River
ESCANABA
GREEN BAY
LAKE MICHIGAN
STRAITS OF MACKINAC
LAKE HURON
International Boundary
Deepest sounding
GEORGIAN BAY
FRENCH RIVER
BAY CITY
MUSKEGON
MILWAUKEE
PORT HURON
St. Clair River
Lake St. Clair
DETROIT
Detroit River
CHICAGO
Sanitary and Ship Canal
Illinois Waterway To Mississippi River
Diversion from Lake Michigan into Mississippi River Basin
TOLEDO
CLEVELAND
INDIANA
OHIO
PENNSYLVANIA
DIVIDE BETWEEN GREAT LAKES DRAINAGE BASIN AND OTHER DRAINAGE BASINS
Ottawa River
MONTREAL
International Boundary
Iroquois Dam
OGDENSBURG
St. Regis River
TORONTO
LAKE ONTARIO
Burlington Bay
Deepest sounding
OSWEGO
NIAGARA FALLS
ROCHESTER
Power diversions
Navigation and power diversions
WELLAND CANAL
Niagara River
Navigation diversion into New York Canals
BUFFALO
Deepest sounding
LAKE ERIE
NEW YORK

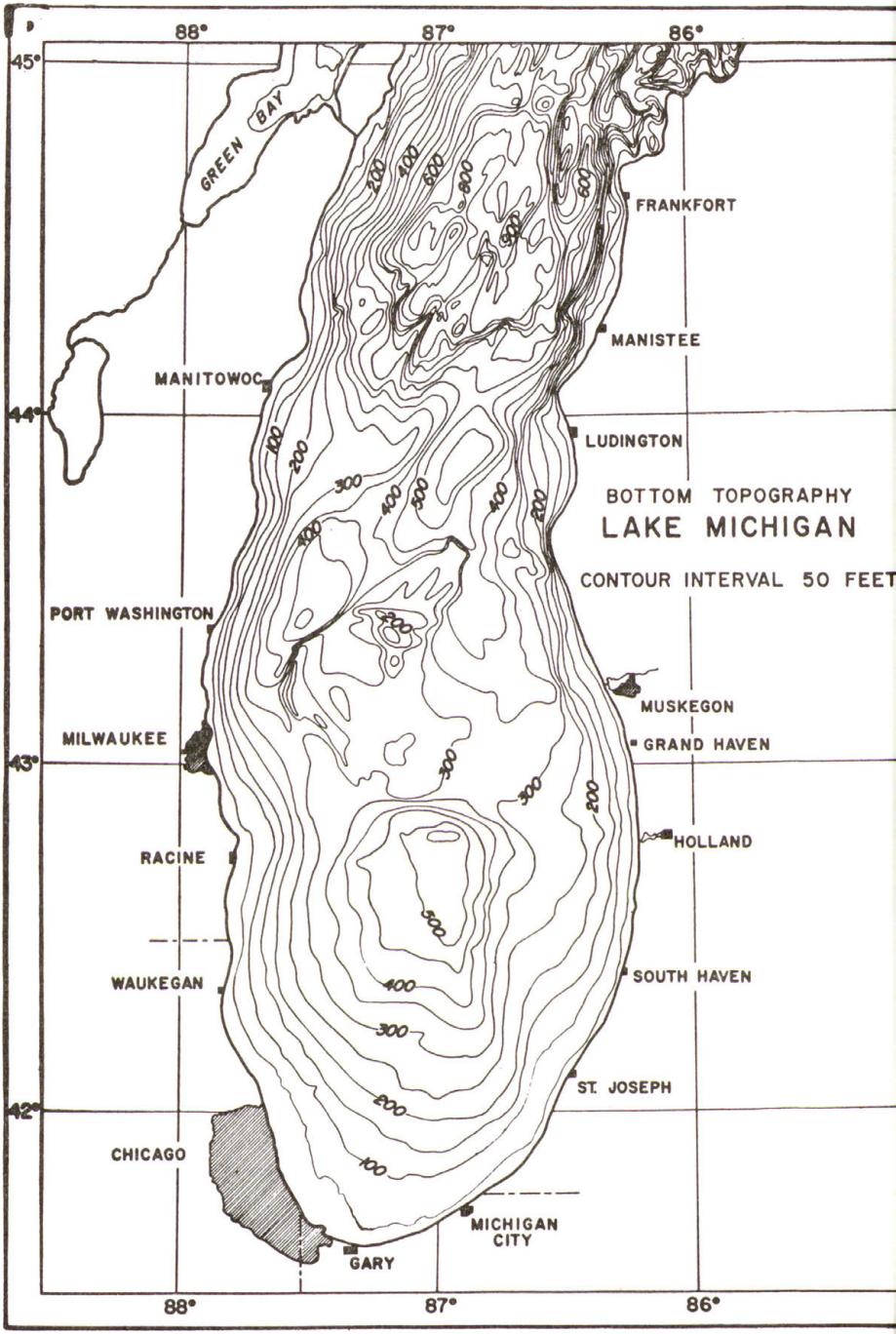
# Ill. Ex. 646

## Map, Bottom Topography, Lake Michigan



## Ill. Ex. 647

MAP, BOTTOM TOPOGRAPHY, SOUTHERN LAKE MICHIGAN



**U. S. Ex. 5C (for identification)**

[1909 BOUNDARY WATERS TREATY]

36 Stat. 2448

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# TREATY SERIES, No. 548

# BOUNDARY WATERS AND QUESTIONS ARISING ALONG THE BOUNDARY BETWEEN THE UNITED STATES OF AMERICA AND CANADA

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BETWEEN THE UNITED STATES OF AMERICA AND GREAT BRITAIN

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Signed at Washington, January 11, 1909.

Ratification advised by the Senate of the United States, with understanding, March 3, 1909.

Ratified by the President of the United States, April 1, 1910.

Ratified by Great Britain, March 31, 1910.

Ratifications exchanged at Washington, May 5, 1910.

Proclaimed by the President of the United States, May 13, 1910.

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BY THE PRESIDENT OF THE UNITED STATES OF AMERICA

## A PROCLAMATION.

WHEREAS a Treaty between the United States of America and His Majesty the King of the United Kingdom of Great Britain and Ireland and of the British Dominions beyond the Seas, Emperor of India, to prevent disputes regarding the use of boundary waters and to settle all questions which are now pending between the United States and the Dominion of Canada involving the rights, obligations, or interests of either in relation to the other or to the

inhabitants of the other, along their common frontier, and to make provision for the adjustment and settlement of all such questions as may hereafter arise, was concluded and signed by their respective Plenipotentiaries at Washington on the eleventh day of January, one thousand nine hundred and nine, the original of which Treaty is word for word as follows:

The United States of America and His Majesty the King of the United Kingdom of Great Britain and Ireland and of the British Dominions beyond the Seas, Emperor of India, being equally desirous to prevent disputes regarding the use of boundary waters and to settle all questions which are now pending between the United States and the Dominion of Canada involving the rights, obligations, or interests of either in relation to the other or to the inhabitants of the other, along their common frontier, and to make provision for the adjustment and settlement of all such questions as may hereafter arise, have resolved to conclude a treaty in furtherance of these ends, and for that purpose have appointed as their respective plenipotentiaries:

The President of the United States of America, Elihu Root, Secretary of State of the United States; and

His Britannic Majesty, the Right Honorable James Bryce, O.M., his Ambassador Extraordinary and Plenipotentiary at Washington;

Who, after having communicated to one another their full powers, found in good and due form, have agreed upon the following articles:

PRELIMINARY ARTICLE.

For the purposes of this treaty boundary waters are defined as the waters from main shore to main shore of the lakes and rivers and connecting waterways, or the portions thereof, along which the international boundary between the United States and the Dominion of Canada passes, including all bays, arms, and inlets thereof, but not includ-

ing tributary waters which in their natural channels would flow into such lakes, rivers, and waterways, or waters flowing from such lakes, rivers, and waterways, or the waters of rivers flowing across the boundary.

ARTICLE I.

The High Contracting Parties agree that the navigation of all navigable boundary waters shall forever continue free and open for the purposes of commerce to the inhabitants and to the ships, vessels, and boats of both countries equally, subject, however, to any laws and regulations of either country, within its own territory, not inconsistent with such privilege of free navigation and applying equally and without discrimination to the inhabitants, ships, vessels, and boats of both countries.

It is further agreed that so long as this treaty shall remain in force, this same right of navigation shall extend to the waters of Lake Michigan and to all canals connecting boundary waters, and now existing or which may hereafter be constructed on either side of the line. Either of the High Contracting Parties may adopt rules and regulations governing the use of such canals within its own territory and may charge tolls for the use thereof, but all such rules and regulations and all tolls charged shall apply alike to the subjects or citizens of the High Contracting Parties and the ships, vessels, and boats of both of the High Contracting Parties, and they shall be placed on terms of equality in the use thereof.

ARTICLE II.

Each of the High Contracting Parties reserves to itself or to the several State Governments on the one side and the Dominion or Provincial Governments on the other as the case may be, subject to any treaty provisions now existing with respect thereto, the exclusive jurisdiction and control over the use and diversion, whether temporary or permanent, of all waters on its own side of the line which

in their natural channels would flow across the boundary or into boundary waters; but it is agreed that any interference with or diversion from their natural channel of such waters on either side of the boundary, resulting in any injury on the other side of the boundary, shall give rise to the same rights and entitle the injured parties to the same legal remedies as if such injury took place in the country where such diversion or interference occurs; but this provision shall not apply to cases already existing or to cases expressly covered by special agreement between the parties hereto.

It is understood, however, that neither of the High Contracting Parties intends by the foregoing provision to surrender any right, which it may have, to object to any interference with or diversions of waters on the other side of the boundary the effect of which would be productive of material injury to the navigation interests on its own side of the boundary.

ARTICLE III.

It is agreed that, in addition to the uses, obstructions, and diversions heretofore permitted or hereafter provided for by special agreement between the Parties hereto, no further or other uses or obstructions or diversions, whether temporary or permanent, of boundary waters on either side of the line, affecting the natural level or flow of boundary waters on the other side of the line, shall be made except by authority of the United States or the Dominion of Canada within their respective jurisdictions and with the approval, as hereinafter provided, of a joint commission, to be known as the International Joint Commission.

The foregoing provisions are not intended to limit or interfere with the existing rights of the Government of the United States on the one side and the Government of the Dominion of Canada on the other, to undertake and carry on governmental works in boundary waters for the deepening of channels, the construction of breakwaters, the im-

provement of harbors, and other governmental works for the benefit of commerce and navigation, provided that such works are wholly on its own side of the line and do not materially affect the level or flow of the boundary waters on the other, nor are such provisions intended to interfere with the ordinary use of such waters for domestic and sanitary purposes.

ARTICLE IV.

The High Contracting Parties agree that, except in cases provided for by special agreement between them, they will not permit the construction or maintenance on their respective sides of the boundary of any remedial or protective works or any dams or other obstructions in waters flowing from boundary waters or in waters at a lower level than the boundary in rivers flowing across the boundary, the effect of which is to raise the natural level of waters on the other side of the boundary unless the construction or maintenance thereof is approved by the aforesaid International Joint Commission.

It is further agreed that the waters herein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other.

ARTICLE V.[1]

The High Contracting Parties agree that it is expedient to limit the diversion of waters from the Niagara River so that the level of Lake Erie and the flow of the stream shall not be appreciably affected. It is the desire of both Parties to accomplish this object with the least possible injury to investments which have already been made in the construction of power plants on the United States side of

[1] Paragraphs 3, 4, and 5 of Article V, page 3, terminated October 10, 1950, upon entry into force on that date of the treaty concerning the uses of the waters of the Niagara River signed at Washington February 27, 1950 (TIAS 2130: 1 UST 694).

the river under grants of authority from the State of New York, and on the Canadian side of the river under licenses authorized by the Dominion of Canada and the Province of Ontario.

So long as this treaty shall remain in force, no diversion of the waters of the Niagara River above the Falls from the natural course and stream thereof shall be permitted except for the purposes and to the extent hereinafter provided.

The United States may authorize and permit the diversion within the State of New York of the waters of said river above the Falls of Niagara, for power purposes, not exceeding in the aggregate a daily diversion at the rate of twenty thousand cubic feet of water per second.

The United Kingdom, by the Dominion of Canada, or the Province of Ontario, may authorize and permit the diversion within the Province of Ontario of the waters of said river above the Falls of Niagara, for power purposes, not exceeding in the aggregate a daily diversion at the rate of thirty-six thousand cubic feet of water per second.

The prohibitions of this article shall not apply to the diversion of water for sanitary or domestic purposes, or for the service of canals for the purposes of navigation.

## ARTICLE VI.

The High Contracting Parties agree that the St. Mary and Milk Rivers and their tributaries (in the State of Montana and the Provinces of Alberta and Saskatchewan) are to be treated as one stream for the purposes of irrigation and power, and the waters thereof shall be apportioned equally between the two countries, but in making such equal apportionment more than half may be taken from one river and less than half from the other by either country so as to afford a more beneficial use to each. It is further agreed that in the division of such waters during the irrigation season, between the 1st of April and 31st of October, inclusive, annually, the United States is entitled

to a prior appropriation of 500 cubic feet per second of the waters of the Milk River, or so much of such amount as constitutes three-fourths of its natural flow, and that Canada is entitled to a prior appropriation of 500 cubic feet per second of the flow of St. Mary River, or so much of such amount as constitutes three-fourths of its natural flow.

The channel of the Milk River in Canada may be used at the convenience of the United States for the conveyance, while passing through Canadian territory, of waters diverted from the St. Mary River. The provisions of Article II of this treaty shall apply to any injury resulting to property in Canada from the conveyance of such waters through the Milk River.

The measurement and apportionment of the water to be used by each country shall from time to time be made jointly by the properly constituted reclamation officers of the United States and the properly constituted irrigation officers of His Majesty under the direction of the International Joint Commission.

## ARTICLE VII.

The High Contracting Parties agree to establish and maintain an International Joint Commission of the United States and Canada composed of six commissioners, three on the part of the United States appointed by the President thereof, and three on the part of the United Kingdom appointed by His Majesty on the recommendation of the Governor in Council of the Dominion of Canada.

## ARTICLE VIII.

This International Joint Commission shall have jurisdiction over and shall pass upon all cases involving the use or obstruction or diversion of the waters with respect to which under Articles III and IV of this treaty the approval of this Commission is required, and in passing upon such cases the Commission shall be governed by the following

rules or principles which are adopted by the High Contracting Parties for this purpose:

The High Contracting Parties shall have, each on its own side of the boundary, equal and similar rights in the use of the waters hereinbefore defined as boundary waters.

The following order of precedence shall be observed among the various uses enumerated hereinafter for these waters, and no use shall be permitted which tends materially to conflict with or restrain any other use which is given preference over it in this order of precedence:

(1) Uses for domestic and sanitary purposes;

(2) Uses for navigation, including the service of canals for the purposes of navigation;

(3) Uses for power and for irrigation purposes.

The foregoing provisions shall not apply to or disturb any existing uses of boundary waters on either side of the boundary.

The requirement for an equal division may in the discretion of the Commission be suspended in cases of temporary diversions along boundary waters at points where such equal division can not be made advantageously on account of local conditions, and where such diversion does not diminish elsewhere the amount available for use on the other side.

The Commission in its discretion may make its approval in any case conditional upon the construction of remedial or protective works to compensate so far as possible for the particular use or diversion proposed, and in such cases may require that suitable and adequate provision, approved by the Commission, be made for the protection and indemnity against injury of any interests on either side of the boundary.

In cases involving the elevation of the natural level of waters on either side of the line as a result of the construction or maintenance on the other side of remedial or protective works or dams or other obstructions in boundary

waters or in waters flowing therefrom or in waters below the boundary in rivers flowing across the boundary, the Commission shall require, as a condition of its approval thereof, that suitable and adequate provision, approved by it, be made for the protection and indemnity of all interests on the other side of the line which may be injured thereby.

The majority of the Commissioners shall have power to render a decision. In case the Commission is evenly divided upon any question or matter presented to it for decision, separate reports shall be made by the Commissioners on each side to their own Government. The High Contracting Parties shall thereupon endeavor to agree upon an adjustment of the question or matter of difference, and if an agreement is reached between them, it shall be reduced to writing in the form of a protocol, and shall be communicated to the Commissioners, who shall take such further proceedings as may be necessary to carry out such agreement.

ARTICLE IX.

The High Contracting Parties further agree that any other questions or matters of difference arising between them involving the rights, obligations, or interests of either in relation to the other or to the inhabitants of the other, along the common frontier between the United States and the Dominion of Canada, shall be referred from time to time to the International Joint Commission for examination and report, whenever either the Government of the United States or the Government of the Dominion of Canada shall request that such questions or matters of difference be so referred.

The International Joint Commission is authorized in each case so referred to examine into and report upon the facts and circumstances of the particular questions and matters referred, together with such conclusions and recommendations as may be appropriate, subject, however, to

any restrictions or exceptions which may be imposed with respect thereto by the terms of the reference.

Such reports of the Commission shall not be regarded as decisions of the questions or matters so submitted either on the facts or the law, and shall in no way have the character of an arbitral award.

The Commission shall make a joint report to both Governments in all cases in which all or a majority of the Commissioners agree, and in case of disagreement the minority may make a joint report to both Governments, or separate reports to their respective Governments.

In case the Commission is evenly divided upon any question or matter referred to it for report, separate reports shall be made by the Commissioners on each side to their own Government.

ARTICLE X.

Any questions or matters of difference arising between the High Contracting Parties involving the rights, obligations, or interests of the United States or of the Dominion of Canada either in relation to each other or to their respective inhabitants, may be referred for decision to the International Joint Commission by the consent of the two Parties, it being understood that on the part of the United States any such action will be by and with the advice and consent of the Senate, and on the part of His Majesty's Government with the consent of the Governor General in Council. In each case so referred, the said Commission is authorized to examine into and report upon the facts and circumstances of the particular questions and matters referred, together with such conclusions and recommendations as may be appropriate, subject, however, to any restrictions or exceptions which may be imposed with respect thereto by the terms of the reference.

A majority of the said Commission shall have power to render a decision or finding upon any of the questions or matters so referred.

If the said Commission is equally divided or otherwise unable to render a decision or finding as to any questions or matters so referred, it shall be the duty of the Commissioners to make a joint report to both Governments, or separate reports to their respective Governments, showing the different conclusions arrived at with regard to the matters or questions so referred, which questions or matters shall thereupon be referred for decision by the High Contracting Parties to an umpire chosen in accordance with the procedure prescribed in the fourth, fifth, and sixth paragraphs of Article XLV of The Hague Convention for the pacific settlement of international disputes, dated October 18, 1907. Such umpire shall have power to render a final decision with respect to those matters and questions so referred on which the Commission failed to agree.

ARTICLE XI.

A duplicate original of all decisions rendered and joint reports made by the Commission shall be transmitted to and filed with the Secretary of State of the United States and the Governor General of the Dominion of Canada, and to them shall be addressed all communications of the Commission.

ARTICLE XII.

The International Joint Commission shall meet and organize at Washington promptly after the members thereof are appointed, and when organized the Commission may fix such times and places for its meetings as may be necessary, subject at all times to special call or direction by the two Governments. Each Commissioner, upon the first joint meeting of the Commission after his appointment, shall, before proceeding with the work of the Commission, make and subscribe a solemn declaration in writing that he will faithfully and impartially perform the duties imposed upon him under this treaty, and such declaration shall be

entered on the records of the proceedings of the Commission.

The United States and Canadian sections of the Commission may each appoint a secretary, and these shall act as joint secretaries of the Commission at its joint sessions, and the Commission may employ engineers and clerical assistants from time to time as it may deem advisable. The salaries and personal expenses of the Commission and of the secretaries shall be paid by their respective Governments, and all reasonable and necessary joint expenses of the Commission, incurred by it, shall be paid in equal moieties by the High Contracting Parties.

The Commission shall have power to administer oaths to witnesses, and to take evidence on oath whenever deemed necessary in any proceeding, or inquiry, or matter within its jurisdiction under this treaty, and all parties interested therein shall be given convenient opportunity to be heard, and the High Contracting Parties agree to adopt such legislation as may be appropriate and necessary to give the Commission the powers above mentioned on each side of the boundary, and to provide for the issue of subpoenas and for compelling the attendance of witnesses in proceedings before the Commission. The Commission may adopt such rules of procedure as shall be in accordance with justice and equity, and may make such examination in person and through agents or employees as may be deemed advisable.

## ARTICLE XIII.

In all cases where special agreements between the High Contracting Parties hereto are referred to in the foregoing articles, such agreements are understood and intended to include not only direct agreements between the High Contracting Parties, but also any mutual arrangement between the United States and the Dominion of Canada expressed by concurrent or reciprocal legislation on the part of Congress and the Parliament of the Dominion.

ARTICLE XIV.

The present treaty shall be ratified by the President of the United States of America, by and with the advice and consent of the Senate thereof, and by His Britannic Majesty. The ratifications shall be exchanged at Washington as soon as possible and the treaty shall take effect on the date of the exchange of its ratifications. It shall remain in force for five years, dating from the day of exchange of ratifications, and thereafter until terminated by twelve months' written notice given by either High Contracting Party to the other.

IN FAITH WHEREOF the respective plenipotentiaries have signed this treaty in duplicate and have hereunto affixed their seals.

DONE at Washington the 11th day of January, in the year of our Lord one thousand nine hundred and nine.

ELIHU ROOT [SEAL]

JAMES BRYCE [SEAL]

AND WHEREAS the Senate of the United States by their resolution of March 3, 1909, (two-thirds of the Senators present concurring therein) did advise and consent to the ratification of the said Treaty with the following understanding, to wit:

"*Resolved further, as a part of this ratification,* That the United States approves this treaty with the understanding that nothing in this treaty shall be construed as affecting, or changing, any existing territorial or riparian rights in the water, or rights of the owners of lands under water, on either side of the international boundary at the rapids of the St. Mary's river at Sault Ste. Marie, in the use of the waters flowing over such lands, subject to the requirements of navigation in boundary waters and of navigation canals, and without prejudice to the existing right

of the United States and Canada, each to use the waters of the St. Mary's river, within its own territory, and further, that nothing in this treaty shall be construed to interfere with the drainage of wet swamp and overflowed lands into streams flowing into boundary waters, and that this interpretation will be mentioned in the ratification of this treaty as conveying the true meaning of the treaty, and will, in effect, form part of the treaty;"

AND WHEREAS the said understanding has been accepted by the Government of Great Britain, and the ratifications of the two Governments of the said treaty were exchanged in the City of Washington, on the 5th day of May, one thousand nine hundred and ten;

NOW, THEREFORE, BE IT KNOWN THAT I, William Howard Taft, President of the United States of America, have caused the said treaty and the said understanding, as forming a part thereof, to be made public, to the end that the same and every article and clause thereof may be observed and fulfilled with good faith by the United States and the citizens thereof.

IN TESTIMONY WHEREOF, I have hereunto set my hand and caused the seal of the United States to be affixed.

DONE at the City of Washington this thirteenth day of May in the year of our Lord one thousand nine hundred and ten,

[SEAL] and of the Independence of the United States of America the one hundred and thirty-fourth.

WM H TAFT

By the President:

P C KNOX
*Secretary of State.*

# PROTOCOL OF EXCHANGE [1]

On proceeding to the exchange of the ratifications of the treaty signed at Washington on January 11, 1909, between the United States and Great Britain, relating to boundary waters and questions arising along the boundary between the United States and the Dominion of Canada, the undersigned plenipotentiaries, duly authorized thereto by their respective Governments, hereby declare that nothing in this treaty shall be construed as affecting, or changing, any existing territorial, or riparian rights in the water, or rights of the owners of lands under water, on either side of the international boundary at the rapids of the St. Mary's River at Sault Ste. Marie, in the use of the waters flowing over such lands, subject to the requirements of navigation in boundary waters and of navigation canals, and without prejudice to the existing right of the United States and Canada, each to use the waters of the St. Mary's River, within its own territory; and further, that nothing in this treaty shall be construed to interfere with the drainage of wet, swamp, and overflowed lands into streams flowing into boundary waters, and also that this declaration shall be deemed to have equal force and effect as the treaty itself and to form an integral part thereto.

The exchange of ratifications then took place in the usual form.

IN WITNESS WHEREOF, they have signed the present Protocol of Exchange and have affixed their seals thereto.

DONE at Washington this 5th day of May, one thousand nine hundred and ten.

PHILANDER C KNOX [SEAL]
JAMES BRYCE [SEAL]

[1] This protocol of exchange was ratified by Great Britain June 4, 1910.

**U. S. Ex. 5E (for identification)**

[1940 EXCHANGE OF NOTES]

54 Stat. 2426

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EXECUTIVE AGREEMENT SERIES NO. 187

# GREAT LAKES–ST. LAWRENCE WATERWAY

AGREEMENT
BETWEEN THE UNITED STATES OF AMERICA
AND CANADA

*Effected by Exchanges of Notes*
*Signed October 14 and 31*
*and November 7, 1940*

*The Secretary of State to the Canadian Minister*

DEPARTMENT OF STATE
WASHINGTON

*October 14, 1940*

SIR:

I have the honor to refer to the conversations which have taken place recently between officials of the Governments of the United States and Canada in regard to the desirability of taking immediate steps looking to the early development of certain portions of the Great Lakes-St. Lawrence Basin project. These conversations have indicated that there is apprehension in both countries over the possibility of a power shortage; these apprehensions have been heightened by the necessity for increased supplies of power in consequence of Canada's war effort and of the major national defense effort in the United States.

In the light of these considerations the Government of the United States proposes that each Government appoint forthwith a Temporary Great Lakes-St. Lawrence Basin Committee consisting of not more than five members. These

two Committees would cooperate in preliminary engineering and other investigations for that part of the project which is located in the International Rapids Section of the St. Lawrence River, in order that the entire project may be undertaken without delay when final decision is reached by the two Governments. The Government of the United States is prepared to advance the necessary funds up to $1,000,000 to pay for these preliminary engineering and other investigations, on the understanding that their cost shall ultimately be prorated by agreement between the two Governments.

Meanwhile, to assist in providing an adequate supply of power to meet Canadian defense needs and contingent upon the Province of Ontario's agreeing to provide immediately for diversions into the Great Lakes System of waters from the Albany River Basin which normally flow into Hudson Bay, the Government of the United States will interpose no objection, pending the conclusion of a final Great Lakes-St. Lawrence Basin agreement between the two countries, to the immediate utilization for power at Niagara Falls by the Province of Ontario of additional waters equivalent in quantity to the diversions into the Great Lakes Basin above referred to.

I shall be glad if you will let me know if your Government is in accord with the foregoing proposals.

Accept, Sir, the renewed assurances of my highest consideration.

For the Secretary of State:

ADOLF A. BERLE, JR.

The Honorable

LORING C. CHRISTIE,
*Minister of Canada.*

*The Canadian Minister to the Secretary of State*

No. 316. CANADIAN LEGATION

WASHINGTON

October 14, 1940.

SIR:

I have the honour to refer to your note of October 14, in which you proposed that the Governments of Canada and the United States take immediate steps looking to the early development of certain portions of the Great Lakes-St. Lawrence Basin project.

I am instructed to inform you that the Canadian Government is in accord with the proposals which you have made.

I have the honour to be, with the highest consideration Sir,

Your most obedient, humble servant,

LORING C. CHRISTIE

The Honourable CORDELL HULL,
*Secretary of State of the United States,*
*Washington, D. C.*

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*The Canadian Minister to the Secretary of State*

No. 340 CANADIAN LEGATION,

WASHINGTON,
*October 31, 1940.*

SIR:

I have the honour to refer to the third paragraph of your note of October 14 concerning the Great Lakes-St. Lawrence Basin project, in which you state that to assist

in providing an adequate supply of power to meet Canadian defence needs and contingent upon the Province of Ontario's agreeing to provide immediately for diversions into the Great Lakes System of waters from the Albany River Basin which normally flow into Hudson Bay, the Government of the United States would interpose no objection, pending the conclusion of a final Great Lakes-St. Lawrence Basin agreement between the two countries, to the immediate utilization for power at Niagara Falls by the Province of Ontario of additional waters equivalent in quantity to the diversions into the Great Lakes Basin above referred to.

I am instructed to inform you that the Canadian Government has received appropriate assurances that the Hydro-Electric Power Commission of Ontario is prepared to proceed immediately with the Long Lac-Ogoki diversions and that this action has been approved by the Government of the Province.

The Canadian Government is therefore giving appropriate instructions to authorize the additional diversion of 5,000 cubic feet per second at Niagara by the Hydro-Electric Power Commission of Ontario.

I have the honour to be, with the highest consideration, Sir,

Your most obedient, humble servant,

LORING C. CHRISTIE

The Honourable CORDELL HULL,
*Secretary of State of the United States,*
*Washington, D. C.*

*The Secretary of State to the Canadian Minister*

DEPARTMENT OF STATE
WASHINGTON

*November 7, 1940.*

SIR:

I have the honor to acknowledge the receipt of your Note No. 340 of October 31, 1940, stating that the Hydro-Electric Power Commission of Ontario is prepared to proceed immediately with the Long Lac-Ogoki diversions of waters from the Albany River Basin into the Great Lakes System and that this action has been approved by the Government of the Province.

I note also that the Canadian Government is giving appropriate instructions to authorize the additional diversion of 5,000 cubic feet per second of water at Niagara Falls by the Hydro-Electric Power Commission of Ontario.

Accept, Sir, the renewed assurances of my highest consideration.

For the Secretary of State:

A. A. BERLE, JR.

The Honorable
LORING C. CHRISTIE,
*Minister of Canada.*

# U. S. Ex. 5B (for identification)

[1950 NIAGARA RIVER WATER DIVERSION TREATY]

1 UST 694

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TREATIES AND OTHER INTERNATIONAL ACTS SERIES 2130

## USES OF THE WATERS OF THE NIAGARA RIVER

Convention between the UNITED STATES OF AMERICA and CANADA

Signed at Washington February 27, 1950

Ratification advised by the Senate of the United States of America August 9, 1950, subject to a reservation

Ratified by the President of the United States of America August 24, 1950, subject to said reservation

Ratified by Canada October 5, 1950

Ratifications exchanged at Ottawa October 10, 1950

Proclaimed by the President of the United States of America October 30, 1950, subject to said reservation

Entered into force October 10, 1950

BY THE PRESIDENT OF THE UNITED STATES OF AMERICA

## A PROCLAMATION

WHEREAS a treaty between the United States of America and Canada concerning uses of the waters of the Niagara River was signed at Washington on February 27, 1950 by their respective plenipotentiaries, the original of which treaty is word for word as follows:

The United States of America and Canada, recognizing their primary obligation to preserve and enhance the scenic beauty of the Niagara Falls and River and, consistent with that obligation, their common interest in providing for the most beneficial use of the waters of that River,

Considering that the quantity of water which may be diverted from the Niagara River for power purposes is at

present fixed by Article V of the treaty with respect to the boundary waters between the United States of America and Canada, signed at Washington January 11, 1909, between the United States of America and Great Britain, [1] and by notes exchanged between the Government of the United States of America and the Government of Canada in 1940, [2] 1941, [3] and 1948 [4] authorizing for emergency purposes temporary additional diversions,

Recognizing that the supply of low-cost power in northeastern United States and southeastern Canada is now insufficient to meet existing and potential requirements and considering that the water resources of the Niagara River may be more fully and efficiently used than is now permitted by international agreement,

Desiring to avoid a continuing waste of a great natural resource and to make it possible for the United States of America and Canada to develop, for the benefit of their respective peoples, equal shares of the waters of the Niagara River available for power purposes, and,

Realizing that any redevelopment of the Niagara River for power in the United States of America and Canada is not advisable until the total diversion of water which may be made available for power purposes is authorized permanently and any restrictions on the use thereof are agreed upon,

Have resolved to conclude a treaty in furtherance of these ends and for that purpose have appointed as their plenipotentiaries:

The United States of America:

Dean Acheson, Secretary of State of the United States of America, and

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[1] Treaty Series 548; 36 Stat., Pt. 2, p. 2448.

[2] Executive Agreement Series 187; 54 Stat., Pt. 2, p. 2426.

[3] Executive Agreement Series 209; 55 Stat., Pt. 2, p. 1276.

[4] Department of State *Bulletin*, Jan. 16, 1949, p. 85.

Canada:

H. H. Wrong, Ambassador Extraordinary and Plenipotentiary of Canada to the United States of America,

Who, after having communicated to one another their full powers, found in good and due form, have agreed upon the following articles:

*Article I*

This Treaty shall terminate the third, fourth, and fifth paragraphs of Article V of the treaty between the United States of America and Great Britain relating to boundary waters and questions arising between the United States of America and Canada dated January 11, 1909, and the provisions embodied in the notes exchanged between the Government of the United States of America and the Government of Canada at Washington on May 20, 1941, October 27, 1941, November 27, 1941, and December 23, 1948, regarding temporary diversions of water of the Niagara River for power purposes.

*Article II*

The United States of America and Canada agree to complete in accordance with the objectives envisaged in the final report submitted to the United States of America and Canada on December 11, 1929, by the Special International Niagara Board, [1] the remedial works which are necessary to enhance the beauty of the Falls by distributing the waters so as to produce an unbroken crestline on the Falls. The United States of America and Canada shall request the International Joint Commission to make recommendations as to the nature and design of such remedial works and the allocation of the task of construction as between the United States of America and Canada. Upon approval by the United States of America and Canada of such recommendations the construction shall be undertaken pursuant

[1] Senate Doc. No. 128, 71st Cong., 2d Sess.

thereto under the supervision of the International Joint Commission and shall be completed within four years after the date upon which the United States of America and Canada shall have approved the said recommendations. The total cost of the works shall be divided equally between the United States of America and Canada.

*Article III*

The amount of water which shall be available for the purposes included in Articles IV and V of this Treaty shall be the total outflow from Lake Erie to the Welland Canal and the Niagara River (including the Black Rock Canal) less the amount of water used and necessary for domestic and sanitary purposes and for the service of canals for the purposes of navigation. Waters which are being diverted into the natural drainage of the Great Lakes System through the existing Long Lac-Ogoki works shall continue to be governed by the notes exchanged between the Government of the United States of America and the Government of Canada at Washington on October 14 and 31 and November 7, 1940, and shall not be included in the waters allocated under the provisions of this Treaty.

*Article IV*

In order to reserve sufficient amounts of water in the Niagara River for scenic purposes, no diversions of the water specified in Article III of this Treaty shall be made for power purposes which will reduce the flow over Niagara Falls to less than one hundred thousand cubic feet per second each day between the hours of eight a.m., E.S.T., and ten p.m., E.S.T., during the period of each year beginning April 1 and ending September 15, both dates inclusive, or to less than one hundred thousand cubic feet per second each day between the hours of eight a.m., E.S.T., and eight p.m., E.S.T., during the period of each year beginning September 16 and ending October 31, both dates inclusive, or to less than fifty thousand cubic feet per second at any

other time; the minimum rate of fifty thousand cubic feet per second to be increased when additional water is required for flushing ice above the Falls or through the rapids below the Falls. No diversion of the amounts of water, specified in this Article to flow over the Falls, shall be made for power purposes between the Falls and Lake Ontario.

*Article V*

All water specified in Article III of this Treaty in excess of water reserved for scenic purposes in Article IV may be diverted for power purposes.

*Article VI*

The waters made available for power purposes by the provisions of this Treaty shall be divided equally between the United States of America and Canada.

*Article VII*

The United States of America and Canada shall each designate a representative who, acting jointly, shall ascertain and determine the amounts of water available for the purposes of this Treaty, and shall record the same, and shall also record the amounts of water used for power diversions.

*Article VIII*

Until such time as there are facilities in the territory of one party to use its full share of the diversions of water for power purposes agreed upon in this Treaty, the other party may use the portion of that share for the use of which facilities are not available.

*Article IX*

Neither party shall be responsible for physical injury or damage to persons or property in the territory of the other which may be caused by any act authorized or provided for by this Treaty.

*Article X*

This Treaty shall be ratified and the instruments of ratification thereof exchanged at Ottawa. The Treaty shall come into force upon the date of the exchange of ratifications [1] and continue in force for a period of fifty years and thereafter until one year from the day on which either party shall give notice to the other party of its intention of terminating the Treaty.

In witness whereof, the undersigned plenipotentiaries have signed this Treaty.

Done in duplicate at Washington this twenty-seventh day of February, 1950.

FOR THE UNITED STATES OF AMERICA:
DEAN ACHESON

FOR CANADA:
H. H. WRONG

WHEREAS the Senate of the United States of America by their resolution of August 9, 1950, two-thirds of the Senators present concurring therein, did advise and consent to the ratification of the said treaty with the following reservation:

"The United States on its part expressly reserves the right to provide by Act of Congress for redevelopment, for the public use and benefit, of the United States' share of the waters of the Niagara River made available by the provisions of the Treaty, and no project for redevelopment of the United States' share of such waters shall be undertaken until it be specifically authorized by Act of Congress";

WHEREAS the text of the aforesaid reservation was communicated by the Government of the United States of America to the Government of Canada and thereafter the Government of Canada gave notice of its acceptance of the aforesaid reservation;

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[1] Oct. 10, 1950.

WHEREAS the said treaty was ratified by the President of the United States of America on August 24, 1950, in pursuance of the aforesaid advice and consent of the Senate and subject to the aforesaid reservation, and was duly ratified also on the part of Canada on October 5, 1950;

WHEREAS the respective instruments of ratification of the said treaty were duly exchanged at Ottawa on October 10, 1950, and a protocol of exchange of instruments of ratification was signed on that date by the respective plenipotentiaries of the United States of America and Canada recording the acceptance by the Government of Canada of the aforesaid reservation;

AND WHEREAS it is provided in Article X of the said treaty that the treaty shall come into force on the date of the exchange of ratifications;

NOW, THEREFORE, be it known that I, Harry S. Truman, President of the United States of America, do hereby proclaim and make public the said treaty between the United States of America and Canada concerning uses of the waters of the Niagara River, to the end that the same and every article and clause thereof, subject to the reservation hereinbefore recited, may be observed and fulfilled with good faith by the United States of America and by the citizens of the United States of America and all other persons subject to the jurisdiction thereof.

IN TESTIMONY WHEREOF, I have hereunto set my hand and caused the Seal of the United States of America to be affixed.

DONE at the city of Washington this thirtieth day of October in the year of our Lord one thousand nine [SEAL] hundred fifty and of the Independence of the United States of America the one hundred seventy-fifth.

HARRY S TRUMAN

By the President:

DEAN ACHESON

*Secretary of State*

# L. S. Ex. 313

[I. J. C. ORDER ON MICHIGAN NORTHERN POWER CO. APPLICATION]

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INTERNATIONAL JOINT COMMISSION

*In the matter of*

THE APPLICATION OF THE
MICHIGAN NORTHERN POWER COMPANY

FOR APPROVAL OF THE OBSTRUCTION, DIVERSION, AND USE OF THE WATERS OF THE ST. MARYS RIVER ON THE UNITED STATES SIDE OF THE INTERNATIONAL BOUNDARY AT SAULT STE. MARIE, MICH.

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## ORDER AND OPINION

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Filed June 30, 1913. Decided May 26, 1914.

INTERNATIONAL JOINT COMMISSION.

UNITED STATES.

JAMES A. TAWNEY, *Chairman.*
OBADIAH GARDNER,
R. B. GLENN,
WHITEHEAD KLUTTZ, *Secretary.*

CANADA.

TH. CHASE CASGRAIN, K. C., *Chairman.*
HENRY A. POWELL, K. C.,
CHARLES A. MAGRATH,
LAWRENCE J. BURPEE, *Secretary.*

INTERNATIONAL JOINT COMMISSION.

APPLICATION OF THE MICHIGAN NORTHERN POWER CO. FOR THE APPROVAL OF THE OBSTRUCTION, DIVERSION, AND USE OF THE WATERS OF THE ST. MARYS RIVER ON THE UNITED STATES SIDE OF THE INTERNATIONAL BOUNDARY AT SAULT STE. MARIE, MICH.

## ORDER OF APPROVAL

The above application having come on for final hearing at the city of Detroit, in the State of Michigan, March 9 and 10, 1914, and the hearing having been continued to and concluded at the city of Washington April 9, 1914, the commission, after hearing all the parties, examining the locus in quo, and carefully considering the application and all the evidence presented, including the statements of engineer representatives of the United States and of the Dominion of Canada in respect thereto, finds as follows, viz:

1. The Michigan Northern Power Co. is a corporation duly organized and existing under the laws of the State of Michigan; it is the owner and successor in title and interest to all the property and to all the rights and privileges claimed and set forth by Clarence M. Brown, receiver for the Michigan Lake Superior Power Co. in its application for approval of the obstruction, diversion, and use of the waters of the St. Marys River on the United States side of the boundary at Sault Ste. Marie, Mich., filed June 30, 1913, as described therein; and, by order of the commmission entered at Ottawa October 7, 1913, the said Michigan Northern Power Co. was duly substituted for said receiver of the said Michigan Lake Superior Power Co. as applicant.

2. Due and official notice of the filing of said application and of the time and place of the final hearing thereon was given to all parties interested in both countries; the

right to appear and be heard on the final hearing was duly extended, under the rules of the commission, to all municipalities on both sides of the international boundary and to private corporations and to others who appeared and were heard and participated in the examination of witnesses; and no application was made by anyone so appearing for additional protective works or for any other relief on account of anticipated injury or damage in consequence of the construction, maintenance, and operation of the proposed works, upon said final hearing.

3. The compensating or remedial works mentioned and described in the said application as amended on the final hearing will, when constructed, be located wholly within the jurisdiction and upon property owned by the United States south of the international boundary line in the St. Marys River, at Sault Ste. Marie, Mich., and upon the upper side of the International Bridge crossing the St. Marys River. According to the plans therefor, as finally approved, said compensating works when completed will consist of a certain dike about 200 feet in length and 8 Stoney sluice gates about 50 feet in the clear, and are intended to obstruct and divert the waters of said river on the United States side thereof through a power canal. The Government of the United States in time will become the owner of said compensating works.

4. Said St. Marys River is the natural outlet of Lake Superior and said river and lake are boundary waters as defined by the treaty of January 11, 1909, between Great Britain and the United States.

5. It is conceded by the applicant and both Governments that the construction and operation of the proposed works will affect the natural level and flow of the waters of said river and of Lake Superior on the other side of the line, and that the effect will therefore be international; and the interest of both Governments, as well as the interests of navigation and other public and private interests in both

countries, will be suitably and adequately protected and indemnified by international or joint control of said works. Said compensating works when constructed according to the finally approved plans and under the conditions with respect to their construction and operation hereinafter prescribed will constitute a mechanically operated discharge cross section for the discharge of the waters of said lake on the United States side of the international boundary, which, with the existing power canal of the applicant, which has a discharge capacity of about 30,000 cubic feet per second, and the United States power canal, known as the Chandler-Dunbar Canal, which has a discharge capacity of about 5,000 cubic feet per second, will afford an aggregate discharge capacity equal to the existing discharge capacity of said river on the United States side of the international boundary; and the levels of Lake Superior under these conditions can be regulated within a more restricted range than is now possible under existing conditions of discharge.

6. From 1860 to 1913, or for a period of 54 years, the extreme range of levels of Lake Superior, that is, between the highest and the lowest monthly mean level, as shown by the United States official records thereof, was about 3.5 feet; from the evidence it would seem that if the said compensating and other works of the applicant are constructed, maintained, and operated according to the said approved plans and the conditions hereinafter stated in respect to their construction and operation, the range of monthly mean levels of Lake Superior may be reasonably confined within 2.5 feet and ordinarily within the lesser range of 1.5 feet between an elevation of 602.1 and 603.6 above mean tide at New York, according to the system of levels established by the United States in 1903; and that under proper international joint control the levels of said lake may be regulated so as to benefit navigation and reasonably protect the property and interests, public and private, in both countries above said works.

7. The equal division of the waters of said St. Marys River between the United States and Canada was conceded upon the hearing by their duly appointed representatives.

8. At the time and place of the final hearing on the said application of the Michigan Northern Power Co., the application of the Algoma Steel Corporation (Ltd.), a corporation organized and existing under the laws of the Province of Ontario, for approval of its proposed obstruction, diversion, and use of the waters of the said St. Marys River on the Canadian side of the international boundary by constructing certain compensating or remedial and other works therein for that purpose, was also finally heard and approved.

9. Said Michigan Northern Power Co. and the Algoma Steel Corporation are separate and distinct organizations; they are in no way related in interest, financially or otherwise; and they are not owned or in any way operated or controlled by the same interests, and have no working or other relations between them. Their several works are intended, planned, and will accomplish only the obstruction and diversion of the waters on the respective sides of said river in the United States and Canada for power purposes, and each of said works will be constructed and can be operated independently of the other; when the said works are finally completed on both sides of the boundary in said river, the interests of navigation and reasonable protection to public and private property on both sides of the international boundary line will require that they be operated under international joint control as one complete work or project.

Now, therefore, it is hereby ordered, that subject to the conditions hereinafter stated in respect to the construction of said compensating or remedial works of said applicant, its successors or assigns, and subject also to such conditions and rules as are hereinafter stated and authorized in respect to the control and operation of said works, the obstruction, diversion, and use of the waters of said

river on the United States side of the international boundary for power purposes as prayed and found herein and the construction and maintenance of said compensating works to be constructed for that purpose, together with the plans therefor as finally approved by the Secretary of War and the Chief of Engineers of the United States, April 6, 1914, and submitted upon the final hearing, be, and the same are all hereby approved upon the conditions following as to their construction, maintenance, and operation, and as to their control, which conditions with the said remedial, protective, or compensating works the commission deems to be, and requires as suitable and adequate conditions for the protection and indemnity of all interests on both sides of the international boundary, and which conditions are hereby made a part of this order of approval.

CONDITIONS AS TO CONSTRUCTION.

1. The works to be built hereunder by the said Michigan Northern Power Co., its successors or assigns, shall consist of a dike about 200 feet long and eight Stoney sluice gates and their appurtenances, each gate to be about 52 feet in the clear and located in said river, as described in said application and shown by the approved plans therefor.

2. The sills of said Stoney sluice gates shall not be higher than elevation 591.2 above said mean tide at New York, and the river bed, both upstream and downstream from said works, shall be excavated to an elevation of 590.7 above said mean tide or lower if required by the Secretary of War.

3. All the detail plans for the construction of said works by the said Michigan Northern Power Co., its successors or assigns, and the order in which they are to be built shall be subject to the approval of the Secretary of War of the United States or of any officer duly designated by him for that purpose; and the Secretary of War or any officer designated by him shall guard against any undue

rise of Lake Superior during the construction of the compensating works of the Michigan Northern Power Co. by requiring said company to do any and all things which, in his judgment, may be deemed necessary for that purpose: *Provided, however*, That at no time during the construction of any of said works shall there be more than one cofferdam in the whole width of the St. Marys River, and such cofferdam shall not be larger than is ample for the construction of four Stoney sluice gates of the dimensions above mentioned.

4. The said works shall be constructed by the applicant within such time and upon such further requirements as to the detail of construction as the Secretary of War may hereafter prescribe.

CONDITIONS AS TO CONTROL AND OPERATION.

Ordered further, that as additional conditions of approval of said application, the said compensating works, power canal, head gates and by-passes of the applicant, the Michigan Northern Power Co., its successors or assigns, shall be maintained, operated, and controlled, whether operated independently or in connection with the works of said Algoma Steel Corporation (Ltd.), its successors or assigns, or in connection with any other works in said river in accordance with the following provisions, viz:

5. All compensating works heretofore built and all such works built under this order of approval and all power canals, including their head gates and by-passes, shall be so operated as to maintain the level of Lake Superior as nearly as may be between levels 602.1 and 603.6 above said mean tide at New York, and in such manner as not to interfere with navigation. The operation of all the said works, canals, head gates and by-passes for the above purposes shall be under the direct control of the board hereinafter authorized, which board shall be known as "the board of control."

6. The mean elevation of Lake Superior shall be ascertained by taking the mean of the readings of at least four

automatic gauges, half the number to be maintained by the United States, and half by Canada; these gauges to be located so that their combined readings will indicate as nearly as may be the mean or average condition of the whole lake. The records of these gauges shall be furnished to the board charged with the control of the compensating works referred to at such intervals as it may require.

7. The officer of the Corps of Engineers charged with the improvement of the Falls of the St. Marys River on the American side and an officer appointed by the Canadian Government shall form said board whose duty it shall be to formulate rules under which the compensating works and power canals and their head gates and by-passes shall be operated so as to secure as nearly as may be the regulation of Lake Superior as set forth herein. It shall be the further duty of said board to see that any rules or regulations now or hereafter made by proper authority for the control of said works are duly obeyed.

8. To guard against unduly high stages of water in Lake Superior the rules formulated by said board, when tested by the physical conditions which existed during any year of recorded high water in Lake Superior, when the monthly mean elevation of the lake exceeded 603.6 above said mean tide at New York, shall give no monthly mean level of the lake greater than the maximum monthly mean actually experienced in said year.

9. To guard against unduly high stages of water in the lower St. Marys River, the excess discharge at any time over and above that which would have occurred at a like stage of Lake Superior prior to 1887, shall be restricted so that the elevation of the water surface immediately below the locks shall not be greater than 584.5 above said mean tide.

10. Each power company shall keep continuous records satisfactory to said board, which will show the quantity of water used by it, and shall furnish to the board when required full information from said records.

11. At all times said board shall determine the amount of water available for power purposes. Said board will cause the amount of water so used to be reduced whenever in its opinion such reductions are necessary in order to prevent unduly low stages of water in Lake Superior, and will fix the amounts of such reductions: *Provided,* That whenever the monthly mean level of the lake is less than 602.1 above said mean tide of New York, the total discharge permitted shall be no greater than that which it would have been at the prevailing stage and under the discharge conditions which obtained prior to 1887: *Provided further,* Before any flow of primary water on either side of the river is reduced, the use of all secondary water shall be discontinued.

12. If the compensating works constructed in accordance with the plans hereby approved, together with those already constructed, and the power canals, head gates, and by-passes, can not be operated independently or in conjunction with similar works in the St. Marys River on the Canadian side of the boundary so as to secure the regulation of the level of Lake Superior, as provided herein, they may be altered so as to provide for a greater flow, and in a manner to be determined by the International Joint Commission upon the application of either or both Governments, or upon the application of any person or corporation, either public or private, transmitted to said commission through his or its Government; and any change or alterations in said works or in the discharge cross-section area in said river at the outlet of Lake Superior ordered by this commission on such application shall be made in accordance with said order by either or both of the owners of the compensating works in said river, their successors or assigns, as a further condition of the approval herein. Whenever it is required that the said works shall be altered, any greater flow desired shall be secured in equal parts on each side of the boundary line, and the cost of securing such total greater flow shall be borne equally by the owners of the two parts of the said works, or the commission may on like application make such other order as it may deem necessary.

13. Should ice interfere with navigation, due to the presence of the compensating works, the board shall take measures to obviate this difficulty, and may call upon the owners of said works to do any work necessary for this purpose.

14. Should currents which unduly interfere with navigation be developed by the operation of the power works on either side of the river, the power company operating said works shall alter them or construct such other works as its Government may deem necessary to remedy this condition and in a manner approved by such Government.

15. The cost of maintaining all parts of the compensating works shall be borne by the respective owners thereof, and this work of maintenance shall be done in a manner satisfactory to said board. The rules to be adopted by said board for the operation of the compensating works shall be framed so as to equalize the cost of maintenance between the owners of the component parts of the entire system as nearly as may be in proportion to the amount of primary water used for power development on each side of the international boundary.

16. Should the Government of the United States or any corporation or municipality acquire title to the said power canal, head gates, by-passes, and compensating works of the Michigan Northern Power Co. already constructed, or the compensating works by this order approved, the approval of the construction and maintenance of all of said works hereby given shall, subject to the conditions herein provided, inure to the benefit of such Government or corporation, and all the powers, duties, and obligations hereby conferred or imposed upon the Michigan Northern Power Co. shall apply to and are hereby conferred and imposed upon its successors or assigns.

17. In the event of a disagreement between the members of said board, in respect to anything required of said board herein or in respect to the duties or powers of said

board or as to the exercise of such duties or powers, the question at issue shall, upon the application of either Government, be referred to this commission for its decision.

18. The approval herein granted is subject to all rights of navigation in the St. Marys River now or hereafter existing.

19. Until the compensating works of the said Algoma Steel Corporation (Ltd.), or any other compensating works of like character and extent are constructed in said river on the Canadian side thereof the conditions herein, not reasonably applicable to the control and operation of the compensating works and power works of the Michigan Northern Power Co., its successors or assigns, or that can not be complied with independently of said compensating works on the Canadian side of said river, shall not be operative, but as to such conditions they shall become operative when said works on the Canadian side of the international boundary are constructed and in operation: *Provided, however,* That this shall not be construed so as to render inoperative the condition that said compensating works of said applicant, its successors or assigns, are to be operated under international joint control as herein provided and subject to any rules hereafter prescribed by said Board of Control for their operation.

20. "Primary water" as used herein shall be understood to mean the amount of water which is continuously available for use for power purposes. "Secondary water" shall be understood to mean an amount of water, over and above that designated as primary water, which is intermittently available for use for power purposes.

Dated at New York City, N. Y., May 26, 1914.

TH. CHASE CASGRAIN.
JAMES A. TAWNEY.
HENRY A. POWELL.
OBADIAH GARDNER.
CHARLES A. MAGRATH.
ROBERT B. GLENN.

INTERNATIONAL JOINT COMMISSION.

APPLICATION OF THE MICHIGAN NORTHERN POWER CO. FOR THE APPROVAL OF THE OBSTRUCTION, DIVERSION, AND USE OF THE WATERS OF THE ST. MARYS RIVER ON THE UNITED STATES SIDE OF THE INTERNATIONAL BOUNDARY AT SAULT STE. MARIE, MICH.

## OPINION.

By substitution, the Michigan Northern Power Co., a corporation organized under the laws of the State of Michigan, duly filed its application June 30, 1913, for approval of its proposed obstruction, diversion, and use, as therein described, of the waters of the St. Marys River at Sault Ste. Marie, Mich., wholly within the jurisdiction of the United States, together with plans for the construction of the compensating works for that purpose.

Statements in response were filed by the Governments of the Dominion of Canada and the Province of Ontario, to which reply statements were filed by the applicant and by the Government of the United States. A brief was also filed on behalf of the United States. The final hearing was begun at the city of Detroit, in the State of Michigan, March 9, 1914, and was there continued to April 7, following, and concluded at the city of Washington April 9, 1914.

The obstruction, diversion, and use of these waters and the compensating works contemplated to make the same effective, constitute, as claimed by the applicant, "uses, obstructions, and diversions" of the waters of said river within the meaning of Article III of the treaty between the United States and Great Britain, signed at Washington, January 11, 1909.

The jurisdictional questions, therefore, to be determined, are—

First. Has the Government of the United States authorized the obstruction, diversion, and use of the waters in question?

Second. Are the plans accompanying the application finally approved by the Chief of Engineers and the Secretary of War of the United States, as required by law?

Third. Are the waters of the St. Marys River and other waters affected by the proposed obstruction and diversion boundary waters within the meaning of the treaty?

Fourth. Will the obstruction and diversion of these waters, as proposed, affect their natural level and flow on the other side of the international boundary?

Fifth. Will such effect be to raise the natural level of the waters in question, on either side of the boundary, so as to require "additional remedial or protective works" to compensate for the proposed use and diversion, and what other provisions, if any, are necessary to suitably and adequately protect the interests on both sides of the boundary, which otherwise may be injured thereby?

These questions affect the Governments, as well as the interests of their respective peoples living along the boundary marked by the St. Marys River and Lake Superior. They also relate to a project, which, in some respects, exceeds in importance and magnitude anything of the kind ever before undertaken. These questions, therefore, are not alone international in their character and effect, but their determination by the commission being final, they are of the highest importance to all those whose interests in the two countries are involved.

Appreciating its responsibility in the premises, and the necessity of ascertaining all the facts as to the character of the proposed obstruction and the effect thereof upon public and private interests in both countries, and also realizing the importance of avoiding every opportunity for unnecessary conflict upon questions of fact between the governments and their people, the commission, from the beginning to the close of the hearings, afforded to all concerned, every opportunity to confer and acquaint themselves with all the

essential facts in the possession of either, in relation to the purpose, character, extent and effect of the proposed obstruction and diversion of these waters and the compensating works and their operation and control, and to present the same as finally ascertained and mutually agreed upon.

Before the conclusion of the hearing, with few exceptions, everything of a controversial nature in connection with the proposed project and its effect on the boundary waters in question, was eliminated and a common understanding reached and presented by both Governments as to almost all the facts not admitted by the pleadings. The principle conditions under which the works of the applicant should be constructed and operated and their operation controlled, if constructed and operated in connection with similar works on the Canadian side of said river, was in the main agreed upon by both Governments.

From the pleadings, the evidence of the parties, and from the agreement of the two Governments, thus presented and received, it appears that the proposed obstruction and diversion of the waters referred to are located wholly within the jurisdiction of the United States; that they have been duly authorized by that Government, and that the plans for the construction of the compensating works intended for this purpose have been finally approved as required by the laws of that country.

It likewise appears that the waters in question are boundary waters and that their obstruction and diversion as proposed will affect the natural level and flow, and to some extent raise the low levels thereof on both sides of the international boundary. These facts being thus admitted the jurisdiction of the commission over the subject matter of the application is conclusive.

It is not demanded nor is it claimed by anyone that any additional "remedial or protective works" are necessary to prevent injury on either side of the international boundary. On the contrary, both Governments and all of the parties agree that if the construction and diversion is effected as

proposed, and if the compensating works for that purpose are constructed according to the approved plans and agreed conditions, and they are then properly and efficiently operated, they will not alone compensate for the diversion, but will also make it possible to regulate the levels of Lake Superior within a more restricted range of levels than is now possible under the existing discharge capacity of the outlet of said lake. For 54 years prior to 1914 the highest and lowest monthly mean level was about 3.5 feet. With the works of the applicant in place and properly operated it was shown that the monthly mean levels of Lake Superior can be reasonably confined within 2.5 feet, and ordinarily within the lesser range of 1.5 feet, between the elevation of 602.1 and 603.6, above mean tide at New York City, according to the system of levels established by the United States in 1903. Therefore, the sufficiency of the works as planned, to accomplish the diversion sought and also for regulating the levels of Lake Superior to the advantage of navigation and to the advantage of the people in both countries, is not questioned.

To accomplish these necessary results, however, two things are absolutely essential. First, the works as planned must be constructed under proper conditions; and, second, when constructed they must be properly operated and controlled. While no "remedial or protective works" in addition to the works of the applicant, as planned, are deemed necessary, yet the treaty places upon the commission the responsibility of requiring as a condition of its approval "that suitable and adequate provision, approved by it, be made for the protection and indemnity against injury of any interest on either side of the boundary."

The compensating works of the applicant can not be operated automatically. They will be operated mechanically, with the aid of human agencies, and if they are not properly maintained and operated, they would be capable of causing irreparable injury to public and private interests on both sides of the international boundary. The responsibility, then, for the proper construction and operation of these works

having been placed by the high contracting parties upon the commission, it is our duty to make suitable and adequate provision, both as to the conditions of construction and control and operation.

As to the conditions under which the works should be constructed, there is no difference between the Governments or the respective parties on either side of the line. Upon the question of control, however, and the authority under which such control shall be exercised so long as the works of the applicant, including its power canals, head gates, and by-passes, are maintained and operated independent of and disconnected with similar works on the Canadian side, there is wide difference of opinion. As to this, the two Governments disagree, and public and private interests in both countries are not in accord with the position of the United States.

The Dominion of Canada claims that the possible effect of inefficient or improper control of the works in question would be serious, and necessarily international, and that therefore the operation of these works should be under international control, whether maintained and operated as an independent project or in connection with other or similar compensating works on the Canadian side of said river.

On the other hand, the position of the Government of the United States is that the works of the applicant, being located wholly within its jurisdiction, it should be given full and final authority and control over their operation; also that it would be responsible to its own people and to the Government and people of Canada for the proper and efficient exercise of that authority and control.

The municipalities on both sides of the line support the position of the Canadian Government. They also claim that under no circumstance should the control of these works be under the authority of the owner, and that, it appearing that the Government of the United States will become the owner of these compensating works, their control and operation should not be under the exclusive authority of the

United States, but should be under international joint control.

Upon this question the power of the commission, as a condition of its order, to place the control of these works, and the authority for the exercise of that control, exclusively under the Government of the United States, or under the joint control of both Governments is not disputed. The question, therefore, is one of expediency, to be determined in the light of all the facts, and also in the light of that provision of the treaty which places on the commission the responsibility of suitably and adequately providing for the protection of the interests of the people in both countries against injury on account of the works of the applicant or on account of the manner in which such works are thereafter controlled and operated.

Lake Superior is a body of water about 32,000 square miles in area. The natural outlet of this lake is the St. Marys River. The discharge cross section of this river at the outlet of the lake was, in a state of nature, about 16,000 square feet. This has been reduced by obstructions heretofore placed in the river to about 6,000 square feet. It is now proposed to entirely obstruct the remaining cross section on the United States side with the compensating and other works of the applicant. At the same time it is proposed to likewise obstruct the remaining unobstructed cross section on the Canadian side with the compensating and other works of the Algoma Steel Corporation (Ltd.). These obstructions when in place will consist of 16 Stoney sluice gates, each about 52 feet in the clear, 8 on each side of the boundary. These sluice gates will be operated mechanically and will be capable of entirely obstructing the remaining natural discharge cross section of the river or outlet of Lake Superior. While it is claimed that with the power canal of the applicant and other canals on the United States side of the river, and the discharge capacity of these eight Stoney sluice gates, the present discharge capacity at the outlet of the lake will be increased, nevertheless, the fact remains that the greater part of this discharge cross sec-

tion, for the discharge of the waters of Lake Superior, must be operated mechanically, which emphasizes the importance of the control and operation of these works as the only means of safety to the people and their interests in both countries.

It is not the fact that the works in question will in time become the property of the United States or that the diversion of these waters and the maintenance and operation of these works will, from the beginning, be a source of revenue to that Government, or that the ability of the United States to control their operation is questioned that impels us to believe that international rather than national control will more suitably and adequately protect the interests of the people in both countries and at the same time protect navigation interests. It is rather because of the magnitude of the undertaking involved in the attempt to regulate the levels of such a vast body of water within that range of levels necessary to insure adequate protection to the interests of the people in both countries, and the serious international consequences and possible international complications that would almost certainly follow if for any reason the undertaking failed under national control that prompts the commission to favor international rather than national control. It must be remembered, too, that the attempt to utilize the waters on either or both sides of this river for power purposes, and at the same time improve existing conditions as to the discharge capacity of the outlet of Lake Superior and regulate lake levels, is in its effect international and largely experimental, or as stated by one of the witnesses—

> The body of water sought to be controlled in Lake Superior, with its area of between 31,000 or 32,000 square miles, is a project that has never before been taken hold of by man.

It is for these reasons the commission concludes that, whether the works of the applicant are maintained and

operated independently or in connection with any other works on the Canadian side of the river, they should be maintained and operated under international control. Also, that the exercise of this control should be in the manner and under substantially the same conditions the two Governments proposed and recommended for the international control of said works if maintained and operated in connection with the works of the Algoma Steel Corporation (Ltd.) or other similar works on the other side of the international boundary.

To make international joint control over the works of both companies effective, the two Governments proposed, as a condition of the order of approval, that there should be a board of control, consisting of two members, one to be appointed by each Government; that this board be authorized to formulate rules under which the compensating works of the applicant, its power canals and their head gates and by-passes, shall be operated so as to secure as nearly as may be the regulation of Lake Superior within the range of monthly mean levels recommended and found necessary. Having concluded to place the works of the applicant under international control without reference to similar works on the other side, the commission also concludes that the exercise of such international control shall be through and under the direction of a board as above suggested.

But the Governments also proposed that in the event of a disagreement between the members of this board in respect to anything required of them under the order of approval such questions of difference "shall upon the application of either Government be referred to this commission for its recommendation."

In view of the purpose for which such questions are to be referred it is the judgment of the commission that they should be referred for decision rather than for recommendation. Such questions could relate only to the maintenance or operation of the works. They could arise only in

connection with the execution of the order of approval. If, as the Governments concede, the commission has the power to impose, as a condition of its order, the reference of these questions to it for recommendation, it certainly has the power to make that condition a reference for a decision. It is obvious that these questions of difference would not be comparable in importance to the many questions which, under the treaty, the commission is authorized to decide. The nature and importance of these questions are not relevant therefore to the question of the power of the commission to reserve as a condition of its order the decision of these questions.

It seems equally clear that it would be advisable as well as desirable that this should be done. The differences between the members of the board may be vital to the protection of the interests of the people on both sides of the line, and require a prompt, if not an immediate, decision. If the commission were to act only in an advisory capacity, leaving the final determination to the two Governments, it might be months before a final decision could be reached, and most likely would be. Then, too, the differences may be of such a character, and affect the interests of the Governments in a manner, that would prompt them to sustain the position of their representative on the board of control rather than yield to or compromise with the other Government, thus creating rather than settling differences between the Governments as contemplated, and necessitating a reference of the question under the treaty.

Realizing the magnitude of the problem involved in the proposed utilization of these waters for power purposes, and at the same time improving the present discharge conditions at the outlet of Lake Superior and regulating the levels of that lake within a given desired range, and that possibly the works for that purpose when constructed as authorized and approved might be found inadequate, necessitating alterations therein, it was agreed by both Governments that authority for such future alterations should be

provided for as a condition of our order of approval, as follows:

> If the compensating works constructed in accordance with the plans hereby approved, together with those already constructed, can not be operated so as to secure the regulation of the level of Lake Superior, as provided herein, they shall be altered so as to provide for a greater flow, and in a manner satisfactory to the two Governments.

Although Mr. Stewart, the engineer representative of the Canadian Government, joined Lieut. Col. Patrick in submitting the foregoing condition, yet when explaining this condition in connection with other conditions proposed, he said: "As to the fourteenth paragraph, in regard to the 'manner satisfactory to the two Governments,' I think your suggestion of the joint commission would probably be better, and would carry things out a little more rapidly than the other way." He then added, "They could get a verdict much quicker." That is, he favored leaving the question of any alteration of the compensating works hereafter found necessary to the commission as the representative of both Governments.

This was also the position of the principal municipalities on both sides of the line. The mayor of Fort William, Ontario, Mr. S. C. Young, said:

> We do not feel justified, Mr. Chairman, in offering any objection to these compensating works at Sault Ste. Marie, but we would like to have something to say about the control. If the control is to be in the hands of the Governments of the United States and Canada, we have nothing whatever to say, because we feel that our interests will be properly safeguarded. On the other hand, if control is to be left in the hands of a private corporation, then we will have to continue to fight our way through until the conditions are such

that we know beyond any doubt that our interests will be safeguarded.

The CHAIRMAN. Well, suppose it were left to the International Joint Commission, would that suit your two cities?

Mr. YOUNG. That would suit us absolutely. We would be quite content to leave the matter absolutely in the hands of the two Governments through the joint commission; and if that is the case, we will simply retire and leave the matter in your hands.

In discussing this condition Mr. W. H. Hoyt, an engineer representing the cities of Duluth, Minn., and Superior, Wis., and the commercial interests in both cities, said:

I think that the suggestions that came out in your discussion with the engineers in regard to that are good. In other words, to keep that control, if possible—and I do not see why it is not possible—entirely in the hands of the commission. It will be much easier for the public to reach the commission directly and quickly and get results, in our opinion, than it will be if we have to go in a roundabout way through the channels of the Governments.

As to the pecuniary interest of the applicant and the Government of the United States in the use of these waters for power purposes, Mr. Hoyt also said:

I will state that question came out in public discussion, and while we do not like to admit that such a condition might exist, nevertheless that feeling is quite common in the minds of the public, that the interests at the Soo are diametrically opposed to the interests at the upper end of the lake, and that when the control is in the hands of the Government, drawing a certain amount of income from it, the interests of the Government and our interests are in conflict. Everything at

the Soo and below is diametrically opposed to the interests above the minute you leave the Soo going north.

In explaining this condition Lieut. Col. Patrick, of the Corps of Engineers, United States Army, said: "It was drafted with a view that the applications were to be considered jointly"; that is, as the commission understands it, if the application of the Michigan Northern Power Co. was to be approved independent of similar works on the other side, and that if said works were to be maintained and operated under United States control, that then this condition was not to be considered as a condition of our order of approval in this case.

In that event the right to require any future changes or alterations in the works of the applicant to make them adequate for the purposes intended would be in the United States alone. On the other hand, if these works are maintained and operated in connection with similar works on the Canadian side, then the United States is willing to share with Canada the responsibility of hereafter determining the necessity of any alterations in said works and authorizing the same in a manner satisfactory to both Governments. The United States in effect concedes that the commission has the power under the treaty, as a condition of its order, to vest in both Governments the right to hereafter determine the questions of the sufficiency of the works, and authorize the Governments to make or order changes therein and to prescribe the manner in which such changes shall be made, if the works are constructed, maintained, and operated in connection with similar works on the other side.

To the suggestion, however, that under the treaty the works could not be constructed at all without the approval of this commission, and that whether approved as an independent project or otherwise, it might be deemed necessary in order to suitably and adequately protect the interests on either or both sides of the line for the commission to reserve to itself, as a condition of its order, the right to

hereafter direct alterations in said works if found necessary, counsel for the United States contended that the commission does not have the power to thus retain jurisdiction for any purpose whatever. On this question counsel claims that the power of the commission "is limited to approving or disapproving the application and the plans presented." That when its decision is made the commission will have done all it is required to do and that it should then leave to the United States any changes or alterations if the works are maintained and operated independent of similar works on the other side, and that otherwise such changes and alterations should only be authorized and made in a manner satisfactory to both Governments as suggested in the condition under consideration.

Counsel further claims that if conditions are attached to the order of approval they "should be such as look to the respective Governments for enforcement or compliance rather than to the commission," and also "that the burden of responsibility incident to the accomplishment of the project and for the carrying out of the commissions' orders should be placed upon the two Governments, and in no case should they be assumed by the commission." In support of these claims it is argued that "the commission is a creation of the two Governments and that its power and authority are only such as have been vested in it by the treaty." "I do not think," says counsel, "that it has any administrative functions; certainly it has no powers of an executive character. It has no way of enforcing its orders, but must rely upon the executive authority of the respective Governments. In fine, it is an instrumentality for ascertaining, fixing, and expressing international purposes concerning the things with which it has to do, but it is not an arm for executing the international will."

This presents two important questions:

First. What are the powers of the commission under the treaty in respect to the conditions it may impose as conditions of its order of approval; and

Second. Is its duty and responsibility under the treaty, to provide "suitable and adequate protection and indemnity of all interests on either side of the line which may be injured thereby," discharged and fully met when conditions for that purpose are imposed, leaving it to either or both Governments to execute and enforce its order, even to the extent of, in effect, reconstructing these works which, in the first instance, neither Government had the power to do without the approval of this commission?

The power of the commission under the treaty, to reserve as a condition of its order the right to hereafter, on application, modify such order in any manner found to be necessary to make the works of the applicant fully adequate for all the purposes they were originally intended, is so obvious from the language of the treaty, that if this power were questioned by anyone, other than by one of the high contracting parties, it would not call for serious consideration.

This power is not only conferred by the treaty, but its existence is a necessary concomitant to the carrying out of the true intent and purpose of the treaty in respect to the prevention and settlement of disputes between the two Governments and their people regarding the use of boundary waters. Without this power to approve conditionally, in cases where the proposed obstructions and diversions affect the rights and interests of the people on the other side, the purpose of the treaty would entirely fail.

In Tucker *v.* Alexandross (183 U. S. 424), Justice Brown, in discussing the treaty involved in that case, said:

> As treaties are solemn engagements entered into between independent nations for the common advancement of their interests and the interests of civilization, and as their main object is, not only to avoid war and secure a lasting and perpetual peace, but to promote a friendly feeling between the people of the two countries, they should be interpreted in that broad and liberal spirit which is calculated to make for the exist-

> ence of a perpetual amity, so far as it can be done without the sacrifice of individual rights or of those principles of personal liberty which lie at the foundation of our jurisprudence.

The rule here laid down is the general rule of interpretation recognized and applied by courts in their interpretation of treaties. This treaty implies, and it is a matter of common knowledge that for many years prior, questions of difference and in some instances serious controversies existed between the United States and Canada, and between their people, growing out of the use of the waters that mark the boundary between them. One purpose of the treaty, therefore, was to provide for the final settlement of existing differences and to prevent differences arising thereafter from this cause. This purpose is clearly expressed in the preamble, as follows:

> Being equally desirous to prevent disputes regarding the use of boundary waters and to settle all questions which are now pending between the United States and the Dominion of Canada involving the rights, obligations, or interests of either in relation to the other or to the inhabitants of the other, along their common frontier, and to make provision for the adjustment and settlement of all such questions as may hereafter arise, have resolved to conclude a treaty in furtherance of these ends.

In furtherance of the purpose thus stated, and in all cases like the one in question, Article III of the treaty expressly prohibits any further or other uses, or obstructions, or diversions of boundary waters except those theretofore permitted or thereafter provided for by special agreement between the parties, where the natural level or flow of these waters on the other side of the line would be affected, except when authorized by the Government within whose jurisdiction the proposed obstructions and diversions were

to be accomplished, and then only with the approval of this commission.

As was well said by Mr. Turner in a previous opinion in this case—

> Neither Government needed the aid of the commission to prevent it from acting improvidently in granting persons or corporations authority to use, obstruct, or divert its navigable waters. They were fully capable of taking care of themselves. But in taking care of themselves on their own side of the line, they did not always consider, or at least did not always adequately provide for taking care of the interests of their neighbor on the other side of the line.

It was for these reasons and because of this situation that provision was made in Article VIII of the treaty, giving to this commission discretion, limited only by its judgment, as to the conditions under which any proposed obstruction, diversion, or use of boundary waters should thereafter be approved. And for this purpose this article divides the cases in which this discretion may be exercised into two classes, as follows:

> The commission in its discretion may make its approval in any case conditional upon the construction of remedial or protective works to compensate so far as possible for the particular use or diversion proposed. *And in such cases may* require that suitable and adequate provision, approved by the commission, be made for the protection and indemnity against injury of any interests on *either* side of the boundary.

It will be observed from this paragraph that only in cases where remedial or protective works proposed are necessary to compensate, so far as possible, for the particular use or diversion proposed, that the commission may in its discretion require suitable and adequate provision for the protection and indemnity against injury of interests on either side of the boundary.

Since no remedial or protective works in addition to those of the applicant in this case are necessary, the question of the power of the commission under this paragraph need not be considered. The next succeeding paragraph of Article VIII, however, clothes the commission with discretionary power in a different class of cases, as follows:

> In cases involving *the elevation of the natural level* of waters on either side of the line as a result of the construction or maintenance on the other side of remedial or protective works or dams or other obstructions in boundary waters or in waters flowing therefrom or in waters below the boundary in rivers flowing across the boundary, the commission shall require, as a condition of its approval thereof, that suitable and adequate provision, approved by it, be made for the protection and indemnity of all interests on the other side of the line which may be injured thereby.

It will be observed from the language of this paragraph that in the cases therein referred to the commission is not only given discretionary power in respect to the conditions of its order of approval, but it is made the duty of the commission to "require" such conditions in connection with its order of approval, as in its judgment may be necessary to suitably and adequately protect and indemnify all interests which may be injured on the other side of the line.

It is conceded in this case that the elevation of the natural level of the boundary waters in question on the other side of the line will follow as one of the effects of the obstruction and diversion in question. It will be observed, therefore, under these circumstances that the commission not only has the power to impose such conditions, as conditions of its order of approval, as it may in its judgment deem necessary to suitably and adequately protect all interests on the other side of the line, but it is made its duty to do so.

In the exercise of this power there are no limitations whatever, except the judgment of the commission, as to

what is suitable and adequate for that purpose. To hold otherwise, would be to make the commission and its final decisions under the treaty a source of international disputes rather than the instrumentality, as contemplated by the treaty, for the settlement and prevention of controversies between these two countries. This would be so because, if the works in question proved inadequate (and both Governments manifest doubt as to their ultimate adequacy), injury on the other side of the line would follow. In that case these works would have to be altered. The nature of these alterations and the manner in which they should be made would, under these circumstances, lead almost inevitably to differences, to settle which it might be necessary to again invoke the jurisdiction of this commission. In holding, therefore, that the commission has the power under the treaty to retain jurisdiction for the purposes above stated, we are at the same time exercising that power in harmony with the intent and purpose of the treaty and in a manner "calculated to make for the existence of a perpetual amity" between these two countries without sacrificing, or in any way jeopardizing, the rights or the privileges of either.

In construing this paragraph of the treaty, it is especially significant that the Governments have not reserved to themselves any responsibility whatever for protecting the rights and interests of the people on the other side of the line from injury on account of the obstructions and diversions proposed. They do not even recognize that they have any responsibility in the premises beyond the power they have given the commission to protect the interests on the other side of the line by suitable provisions placed in its order for that purpose. Therefore, where, as in this case, the contemplated project is of such exceptional magnitude, and doubt is manifested by both Governments as to the adequacy of the works intended to make the obstructions and diversions effective, thereby involving possible injury to large public and private interests, it is clear that if, in the judgment of the commission, it is necessary to suitably

and adequately protect the interests on the other side of the line, it retain jurisdiction over these works to the end that such jurisdiction may at any time hereafter be invoked for that purpose, it is the duty, as well as the responsibility, of the commission to do so, and for this purpose full power is conferred by the treaty.

It is unnecessary to consider the question of whether, under the treaty, the commission has or has not administrative or executive powers. In requiring the reference to it of questions of difference between the members of the Board of Control for the decision of the commission, rather than for its recommendation, and also in reserving jurisdiction over the subject matter of the application for the purpose hereafter of modifying its present order by requiring alterations in the works of the applicant, if such alterations should become necessary, the commission is not exercising either administrative or executive powers. It is exercising only the judicial powers given to it by the treaty to finally determine whether or not the works in question shall be approved; and if so, upon what condition that approval shall be based.

Accordingly, the order of approval in this case has been made, entered, and filed, as required under the provisions of the treaty.

Opinion by Mr. Tawney.

# L. S. Ex. 313 A

[I. J. C. ORDER ON ALGOMA STEEL CORP. APPLICATION]

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INTERNATIONAL JOINT COMMISSION

*In the matter of*

THE APPLICATION OF THE
ALGOMA STEEL CORPORATION, LIMITED

FOR APPROVAL OF THE OBSTRUCTION, DIVERSION, AND USE OF THE WATERS OF THE ST. MARYS RIVER, ON THE CANADIAN SIDE OF THE INTERNATIONAL BOUNDARY AT SAULT STE. MARIE, ONTARIO

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## ORDER AND OPINION

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Filed October 7, 1913. Decided May 27, 1914

INTERNATIONAL JOINT COMMISSION.

UNITED STATES.

JAMES A. TAWNEY, *Chairman.*
OBADIAH GARDNER,
R. B. GLENN,
WHITEHEAD KLUTTZ, *Secretary.*

CANADA.

TH. CHASE CASGRAIN, K. C., *Chairman.*
HENRY A. POWELL, K. C.,
CHARLES A. MAGRATH,
LAWRENCE J. BURPEE, *Secretary.*

INTERNATIONAL JOINT COMMISSION.

APPLICATION OF THE ALGOMA STEEL CORPORATION (LTD.), FOR THE APPROVAL OF THE OBSTRUCTION, DIVERSION, AND USE OF THE WATERS OF THE ST. MARYS RIVER ON THE CANADIAN SIDE OF THE INTERNATIONAL BOUNDARY AT SAULT STE. MARIE, ONTARIO.

## ORDER OF APPROVAL.

The above application having come on for final hearing at the city of Detroit, in the State of Michigan, March 9 and 10, and the hearing having been continued to and concluded at the city of Washington, April 9, 1914, the commission after hearing all the parties, examining the locus in quo, and carefully considering the application and all the evidence presented, including the statements of engineer representatives of the Dominion of Canada and of the United States in respect thereto, finds as follows, viz:

1. Algoma Steel Corporation (Ltd.), a corporation duly organized and existing under the laws of the Province of Ontario, filed with the commission on October 7, 1913, an application for approval of the obstruction of the waters of the St. Marys River on the Canadian side of the boundary at Sault Ste. Marie, Ontario, as described therein.

2. Due and official notice of the filing of said application and of the time and place of the final hearing thereon was given to all parties interested in both countries; the right to appear and be heard on the final hearing was duly extended, under the rules of the commission, to all municipalities on both sides of the international boundary and to private corporations and to others, who appeared and were heard and participated in the examination of wit-

nesses; and no application was made by anyone so appearing for additional protective works, or for any other relief on account of anticipated injury or damage in consequence of the construction, maintenance, and operation of the proposed works, upon said final hearing.

3. The compensating or remedial works mentioned and described in the said application as amended on the final hearing will, when constructed, be located wholly within the jurisdiction of and upon property situate within the Dominion of Canada, north of the international boundary, in the St. Marys River at Sault Ste. Marie, Ontario, and upon the upper side of the international bridge crossing the St. Marys River. The applicant has represented that it already owns certain compensating works in the bed of the St. Marys River, consisting of a crib and a rock-and-earth fill dam above the tenth span of the international bridge and four Stoney sluice gates about 50 feet in the clear operated between piers above the ninth span of said bridge, which said works are located on the Canadian side of the said river. The applicant proposes to construct additional compensating works in the bed of the St. Marys River extending southerly from the said above-mentioned works practically to the international boundary, of similar construction to those above described. The character of the proposed additional compensating works is shown on plans filed in the present cause and numbered 953 and 954. The said plans were duly submitted to the Governor General in council, and approved by an order dated March 5, 1914, under certain conditions, viz:

1. That the company shall furnish legal evidence that it has the right to use the site of the said works.

2. Full control of the works and the discharges on the Canadian side of the boundary line is to be vested in the department of public works, or as directed by the International Joint Commission, and all ex-

penses for upkeep of the works are to be borne by the company.

3. That the works shall be completed on the Canadian side of the boundary line within three years from the date of the approval of the plans.

4. That the Government of the Dominion of Canada may take over the works on the Canadian side of the boundary line, at any time, on terms to be arranged between the company and the Government, or by expropriation.

5. That the provincial government of Ontario may, at any time, make such alterations and additions to the works on the Canadian side of the boundary line, at its own cost, as may be called for in connection with the development of power, as shown on the plan submitted with the statement in response on behalf of the Province of Ontario, dated November 3, 1913, which was filed with the International Joint Commission when the matter was before the commission.

4. By an amendment to its application the applicant has prayed for the approval of the diversion, for power purposes, by itself, its successors or assigns, or by the Province of Ontario, of primary or continuous water from St. Marys River, up to an aggregate maximum, including the amount of water heretofore permitted, of 30,000 cubic feet per second, and in addition thereto a further flow of secondary water, that may be intermittently available for power purposes, up to an aggregate maximum of 5,000 cubic feet per second.

5. Said St. Marys River is the natural outlet of Lake Superior, and said river and lake are boundary waters as defined by the treaty of January 11, 1909, between Great Britain and the United States.

6. It is conceded by the applicant and both Governments that the construction and operation of the proposed works will affect the natural level and flow of waters of said river and of Lake Superior on the other side of the line, and that the effect will therefore be international; and the interests of both Governments, as well as the interests of navigation and other public and private interests in both countries, will be suitably and adequately protected and indemnified by international or joint control of said works. Said compensating works, when constructed according to the finally approved plans and under the conditions with respect to their construction and operation hereinafter prescribed, will constitute a mechanically operated discharge cross section for the discharge of the waters of said lake on the Canadian side of the international boundary, which, with the existing power canal of the applicant, which has a discharge capacity of about 15,000 cubic feet per second, will afford an aggregate discharge capacity fully equal to the existing discharge capacity of said river on the Canadian side of the international boundary, and the levels of Lake Superior under these conditions can be regulated within a more restricted range than is possible under existing conditions of discharge.

7. From 1860 to 1913, or for a period of 54 years, the extreme range of levels of Lake Superior—that is, between the highest and the lowest monthly mean level—as shown by the United States official records thereof, was about 3.5 feet. From the evidence it would seem that if the said compensating and other works of the applicant are constructed, maintained, and operated according to the said approved plans and the conditions hereinafter stated in respect to their construction and operation, the range of monthly mean levels of Lake Superior may be reasonably confined within 2.5 feet and ordinarily within the lesser range of 1.5 feet, between an elevation of 602.1 and 603.6 above mean tide at New York, according to the system of levels estab-

lished by the United States in 1903; and that under proper international joint control the levels of said lake may be regulated so as to benefit navigation and reasonably protect the property and interests, public and private, in both countries above said works.

8. The equal division of the waters of said St. Marys River between the United States and Canada was conceded upon the hearing by their duly appointed representatives.

9. At the time and place of the final hearing on the said application of the Algoma Steel Corporation (Ltd.), the application of the Michigan Northern Power Co., a corporation organized and existing under the laws of the State of Michigan, for approval of its proposed obstruction, diversion, and use of the waters of the said St. Marys River on the United States side of the international boundary by constructing certain compensating or remedial and other works therein for that purpose, was also finally heard and approved.

10. Said Algoma Steel Corporation (Ltd.) and Michigan Northern Power Co. are separate and distinct organizations; they are in no way related in interest, financially or otherwise, and they are not owned or in any way operated or controlled by the same interests, and have no working or other relations between them. Their several works are intended, planned, and will accomplish only the obstruction and diversion of the waters on the respective sides of said river in Canada and the United States for power purposes, and each of said works will be constructed and can be operated independently of the other; when the said works are finally completed on both sides of the international boundary in said river the interests of navigation and reasonable protection to public and private property on both sides of the international boundary will require that they be operated under international joint control as one complete work or project.

Now, therefore, it is hereby ordered, that subject to the conditions of the order in council of March 5, 1914, hereinabove in part recited (except that the time for the completion of the said works, if extended by the Government of Canada, shall expire only on the day fixed by the said Government), and to the conditions hereinafter stated in respect to the construction of said compensating or remedial works of said applicant, its successors, or assigns, and subject also to such conditions and rules as hereinafter stated and authorized in respect to the control and operation of said works, the obstruction, diversion, and use of the waters of said river on the Canadian side of the international boundary for power purposes, as applied for as aforesaid, together with the plans therefor as finally approved by the Governor General in council, March 5, 1914, and submitted upon the final hearing, be and the same are all hereby, approved upon the conditions following as to their construction, maintenance, and operation, and as to their control, which conditions with the said remedial, protective, or compensating works the commission deems to be and requires as suitable and adequate conditions for the protection and indemnity of all interests on both sides of the international boundary, and which conditions are hereby made a part of this order of approval.

CONDITIONS AS TO CONSTRUCTION.

1. The works to be built in St. Marys River at Sault Ste. Marie, in the Province of Ontario, shall consist of certain Stoney sluice gates running parallel to the international bridge and about 150 feet therefrom on its upstream side and extending from the existing Stoney sluice gates of the applicant southerly to the international boundary, each gate to be about 52 feet in the clear, the details as shown on plans Nos. 953 and 954 approved by the order of the Governor General in council hereinabove mentioned.

2. The sills of all Stoney sluice gates on the Canadian side shall not be higher than 590.2 feet above said mean tide, and the river bed both upstream and downstream from the works so to be built, to a

distance to be determined by the Board of Control, shall be excavated at least one-half foot lower than the intervening sills.

3. All the detail plans of the works shall be approved by the Governor General in council or such officer as he may designate.

4. The order in which the works are to be proceeded with, subject to the approval of the Governor General in council or such officer as he may designate shall be—

(*a*) The removal by the applicant within 60 days or within such further time not exceeding 30 days as the Board of Control hereinafter authorized may direct of the dike, cofferdam, and all works appertaining to the temporary structures used in connection with the construction of the existing four sluice gates. The gates shall thereafter be tested and put in effective working order. Should it be found that in order to secure the effective working of the sluices rock will have to be removed from the bed of the river, the applicant shall forthwith remove such rock as may be necessary to render the discharge of the sluices effective.

(*b*) The necessary enlargement of the applicant's power canal so as to provide for the carrying of 30,000 second-feet of water at level 602.1 above said mean tide.

(*c*) The channel of the stream not to be closed at any time by more than one cofferdam of a sufficient size for the construction of a set of four Stoney sluice gates.

(*d*) The order of construction of the works thereafter to be determined by the Board of Control, with the approval of the Governor General in council.

5. The Governor General in council or any officer duly designated by him for that purpose may guard against undue rise of Lake Superior during the construction of the compensating works of the applicant by requiring said applicant to do such things for said purpose as in his judgment may be deemed necessary.

CONDITIONS AS TO CONTROL AND OPERATION

Ordered further, that as additional conditions of approval of said application, the said compensating works, power canal, head gates, and by-passes of the applicant, the Algoma Steel Corporation (Ltd.), its successors or assigns, shall be maintained, operated, and controlled, whether op-

erated independently or in connection with the works of the said Michigan Northern Power Co., its successors or assigns, or in connection with any other works in said river in accordance with the following provisions, viz:

6. All compensating works heretofore built and all such works built under this order of approval and all power canals, including their head gates and by-passes, shall be so operated as to maintain the level of Lake Superior as nearly as may be between the levels 602.1 and 603.6 above said mean tide, and in such manner as not to interfere with navigation. The operation of all the said works, canals, head gates; and by-passes for the above purposes shall be under the direct control of the board hereinafter authorized, which board shall be known as "The board of control."

7. The mean elevation of Lake Superior shall be ascertained by taking the mean of the readings of at least four automatic gauges, half the number to be maintained by the United States and half by Canada; these gauges to be located so that their combined readings will indicate as nearly as may be the mean or average condition of the whole lake. The records of these gauges shall be furnished to the board charged with the control of the compensating works referred to at such intervals as it may require.

8. The officer of the Corps of Engineers charged with the improvement of the Falls of the St. Marys River on the American side and an officer appointed by the Canadian Government shall form said board, whose duty it shall be to formulate rules under which the compensating works and power canals and their head gates and by-passes shall be operated so as to secure as nearly as may be the regulation of Lake Superior as set forth herein. It shall be the further duty of said board to see that any rules or regulations now or hereafter made by proper authority for the control of said works are duly obeyed: *Provided,* That said

board shall consist of the same persons who will be appointed under the order of approval of the works of the said Michigan Northern Power Co., and their powers and duties hereunder may be exercised jointly over the compensating and other works on either or both sides of the international boundary.

9. To guard against unduly high stages of water in Lake Superior the rules formulated by said board, when tested by physical conditions which existed during any year of recorded high water in Lake Superior, when the monthly mean elevation of the lake exceeded 603.6 above said mean tide, shall give no monthly mean level of the lake greater than the maximum monthly mean actually experienced in said year.

10. To guard against unduly high stages of water in the lower St. Marys River, the excess discharge at any time over and above that which would have occurred at a like stage of Lake Superior prior to 1887 shall be restricted so that the elevation of the water surface immediately below the locks shall not be greater than 584.5 above said mean tide.

(Amendment adopted Feb. 4, 1915, and filed with both Governments.)

10a. Each power company shall keep continuous records satisfactory to said board which will show the quantity of water used by it, and shall furnish to the board when required full information from said records.

11. At all times said board shall determine the amount of water available for power purposes. Said board will cause the amount of water so used to be reduced whenever, in its opinion, such reductions are necessary in order to prevent unduly low stages of water in Lake Superior, and will fix the amounts of such reductions; provided, that whenever the monthly mean level of the lake is less than 602.1 above said mean tide, the total discharge permitted shall

be no greater than that which it would have been at the prevailing stage and under the discharge conditions which obtained prior to 1887; provided further, before any flow of primary water on either side of the river is reduced, the use of all secondary water shall be discontinued.

12. If the compensating works constructed in accordance with the plans hereby approved, together with those already constructed, and the power canals, head gates, and by-passes can not be operated independently or in conjunction with similar works in the St. Marys River on the American side of the international boundary so as to secure the regulation of the level of Lake Superior as provided herein, they may be altered so as to provide for a greater flow, and in a manner to be determined by the International Joint Commission upon the application of either or both Governments, or upon the application of any person or corporation, either public or private, transmitted to said commission through his or its Government; and any change or alterations in said works or in the discharge cross-section area in said river at the outlet of Lake Superior ordered by this commission on such application shall be made in accordance with said order by either or both of the owners of the compensating works in said river, their successors or assigns, as a further condition of approval herein. Whenever it is required that the said works shall be altered, any greater flow desired shall be secured in equal parts on each side of the boundary line, and the cost of securing such total greater flow shall be borne equally by the owners of the two parts of the said works, or the commission may, on like application, make such other order as it may deem necessary.

13. Should ice interfere with navigation, due to the presence of the compensating works, the board shall take measures to obviate this difficulty, and may call upon the owners of said works to do any work necessary for this purpose.

14. Should currents which unduly interefere with navigation be developed by the operation of the power works on either side of the river, the power company operating said works shall alter them or construct such other works as its Government may deem necessary to remedy this condition and in a manner approved by such Government.

15. The cost of maintaining all parts of the compensating works shall be borne by the respective owners thereof, and this work of maintenance shall be done in a manner satisfactory to said board. The rules to be adopted by said board for the operation of the compensating works shall be framed so as to equalize the cost of maintenance between the owners of the component parts of the entire system as nearly as may be in proportion to the amount of primary water used for power development on each side of the international boundary.

16. Should the Government of the Dominion of Canada or any corporation or municipality acquire title to the said power canal, head gates, by-passes, and compensating works of the Algoma Steel Corporation (Ltd.) already constructed, or the compensating works by this order approved, the approval of the construction and maintenance of all said works hereby given shall, subject to the conditions herein provided, inure to the benefit of such government or corporation, and all the powers, duties, and obligations hereby conferred or imposed upon the Algoma Steel Corporation (Ltd.) shall apply to and are hereby conferred and imposed upon its successors or assigns.

17. In the event of a disagreement between the members of said board, in respect to anything required of said board herein or in respect to the duties or powers of said board or as to the exercise of such duties or powers, the question at issue shall upon the application of either Government be referred to this commission for its decision.

18. The approval herein granted is subject to all rights of navigation in the St. Marys River now or hereafter existing.

19. Until the compensating works of the said Michigan Northern Power Co., or any other compensating works of the like character and extent, are constructed in said river on the American side thereof the conditions herein not reasonably applicable to the control and operation of the compensating works and power works of the Algoma Steel Corporation (Ltd.), its successors or assigns, or that can not be complied with independently of said compensating works on the American side of said river, shall not be operative, but as to such conditions they shall become operative when said works on the American side of the boundary are constructed and in operation: *Provided, however,* That this shall not be construed so as to render inoperative the conditions that said compensating works of said applicant, its successors or assigns, are to be operated under international joint control as herein provided and subject to any rules hereafter prescribed by said Board of Control for their operation.

20. "Primary water" as used herein shall be understood to mean the amount of water which is continually available for use for power purposes. "Secondary water" shall be understood to mean an amount of water, over and above that designated as primary water, which is intermittently available for use for power purposes.

Dated at New York City, N. Y., this 27th day of May, 1914.

JAMES A. TAWNEY.
TH. CHASE CASGRAIN.
OBADIAH GARDNER.
HENRY A. POWELL.
ROBERT B. GLENN.
CHARLES A. MAGRATH.

INTERNATIONAL JOINT COMMISSION.

APPLICATION OF ALGOMA STEEL CORPORATION (LTD.) FOR THE APPROVAL OF COMPENSATING WORKS AND PLANS THEREFOR IN THE ST. MARYS RIVER.

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## OPINION.

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This application was filed under the provisions of Article III of the treaty, the first paragraph of which reads as follows:

> It is agreed that, in addition to the uses, obstructions, and diversions heretofore permitted or hereafter provided for by special agreement between the parties hereto, no further or other uses or obstructions or diversions, whether temporary or permanent, of boundary waters on either side of the line, affecting the natural level or flow of boundary waters on the other side of the line, shall be made except by authority of the United States or the Dominion of Canada within their respective jurisdictions and with the approval, as hereinafter provided, of a joint commission, to be known as the International Joint Commission.

Reference will also be had to paragraphs 6 and 7 of Article VIII of the treaty, which are in the following words:

> The commission in its discretion may make its approval in any case conditional upon the construction of remedial or protective works to compensate so far as possible for the particular use or diversion proposed, and in such cases may require that suitable and adequate provision, approved by the commission, be made for the protection and indemnity against injury of any interests on either side of the boundary.
>
> In cases involving the elevation of the natural level of waters on either side of the line as a result of the construction or maintenance on the other side of remedial or protective works or dams or other obstructions in boundary waters or in waters flowing therefrom or in waters below the boundary in rivers flowing across the boundary the commission shall require, as a condition of its approval

thereof, that suitable and adequate provision, approved by it, be made for the protection and indemnity of all interests on the other side of the line which may be injured thereby.

The applicant is a corporation incorporated by letters patent of the Province of Ontario, and is the successor in title to several other corporations, which seem either to have gone out of existence or to have transferred to the applicant certain rights, powers, and properties heretofore belonging to them. It is the owner of certain compensating works in the bed of the St. Marys River, consisting of a crib and rock-and-earth-filled dam above the tenth span of the international bridge across the St. Marys River at Sault Ste. Marie, Ontario, and four steel sluice gates operated between piers above the ninth span of said bridge. These works are located on the Canadian side of the river. As they were constructed and in place before the treaty was passed, they have nothing to do with the subject matter of the present application, which is for the approval of certain "additional compensating works in the bed of St. Marys River, extending southerly from the present works practically to the international boundary, of similar construction to those above described."

These works are shown on two plans, Nos. 953 and 954, which are filed with the application, and which were approved by order of his royal highness the Governor General in council, of the 5th March, 1914. Several conditions were imposed by the approving order in council, as follows:

1. That the company shall furnish legal evidence that it has the right to use the site of the said works.

2. Full control of the works and the discharges on the Canadian side of the boundary line is to be vested in the department of public works, or as directed by the International Joint Commission, and all expenses for upkeep of the works are to be borne by the company.

3. That the works shall be completed on the Canadian side of the boundary line within three years from the date of the approval of the plans.

4. That the Government of the Dominion of Canada may take over the works on the Canadian side of the boundary line, at any

time, on terms to be arranged between the company and the Government, or by expropriation.

5. That the provincial government of Ontario may, at any time, make such alterations and additions to the works on the Canadian side of the boundary line, at its own cost, as may be called for in connection with the development of power, as shown on the plan submitted with the statement in response, on behalf of the Province of Ontario, dated November 3, 1913, which was filed with the International Joint Commission when the matter was before the commission.

The only statement in response was filed by the Michigan Northern Power Co., an applicant for compensation works on the other side of the river, which does not object to the building of the works, but which prays that if the application be granted, it be granted on the following conditions:

(*a*) That the proposed compensating works and the existing compensating works on the Canadian side at Sault Ste. Marie, Ontario, shall be maintained and operated in accordance with the same rules and regulations and under the same method of joint control that may from time to time be applicable to the maintenance and operation of the compensating works proposed to be built on the American side of the international boundary at Sault Ste. Marie, Mich., under the said application of the respondent to your honorable commission.

(*b*) That the proposed compensating works and the existing compensating works on the Canadian side of the boundary shall be maintained in such manner that there will be no impairment in their discharge capacity for regulating purposes.

(*c*) That in the event that any conditions be imposed by your honorable commission as to the maintenance of lake levels, or of levels and flow of St. Marys River, which will require any modification of the plans of the proposed compensating works filed with the said application of the respondent to your honorable commission, corresponding modifications or additions be required to be made in or to the compensating works proposed to be built on the Canadian side, by which the proper Canadian interests would bear their respective and appropriate share in meeting the burden of such conditions.

(*d*) That the construction of the proposed compensating works be proceeded with as soon as any further diversion of water for power purposes be made on the Canadian side, at Sault Ste. Marie, Ontario, and completed as soon as compliance with any rules or regulations that may become effective respecting the maintenance of lake levels, or of levels and flow of St. Marys River, may render such construction and completion necessary.

(*e*) That in the event that the proposed compensating works, together with the compensating works proposed to be built on the American side of the boundary in St. Marys River, should fail to maintain lake levels or levels and flow of St. Marys River, in accordance with any rules and regulations that may be established by your honorable commission, such alterations in or additions to the proposed compensating works on the Canadian side be required to be made as will equitably divide the burden of such maintenance of levels and river flow between the interests on the Canadian side and the interests on the American side of the international boundary.

The United States Government filed no statement in response, but there is in the record a letter from the Department of State, dated March 16 last, transmitting to the commission a memorandum by the Department of War, dated March 5, in which that department says—

This department sees no reason for objecting to the Canadian application being received and considered at the hearing on the 9th instant (March) in conjunction with the American application, and with the sanction of your department, counsel for this Government will be instructed to consent to the reception of the application and to waive any technical objection which might be raised on account of the time or manner of its filing.

At the same time the commission is called upon to consider an application by the Michigan Northern Power Co. for the approval of certain plans and compensating works on the American side similar in nature and construction to the works, the approval of which is sought by the present applicant. The two corporations are absolutely distinct. The works are distinct and separate. It may be that when they are completed they will be joined somewhere near the international boundary, but it is only a mere coincidence that both applications come at the same time for considera-

tion before the commission; in fact, Col. Patrick, of the Corps of Engineers of the United States Army, in charge of the district covering the St. Marys River, has stated on several occasions throughout his testimony that the application of the Michigan Northern Power Co. should stand on its own merits, and that if nothing further were done on the Canadian side, or, in other words, if the application of the Algoma Steel Corporation were not before the commission and the works sought to be approved were not preceeded [sic] with, the scheme of the Michigan Northern Power Co. could still be carried out and the remedial or compensating works proposed by it would be amply sufficient to protect any interests which might be affected by the putting into operation of the proposed plan.

As I understand the situation developed by the application of the Michigan Northern Power Co. and the Algoma Steel Corporation (Ltd.), it is as follows:

Besides the ship canals on both sides of the river and the power plant on the American side, known as the Chandler-Dunbar plant, there is, on the latter side, a power canal, which is either owned by or will be leased to the Michigan Northern Power Co., while, on the Canadian side, the Algoma Steel Corporation (Ltd.) owns a power canal which was constructed some years ago. It is the intention of both applicants to maintain their canals at a sufficient width and depth to carry 30,000 second-feet of water taken from the St. Marys River at some point above the rapids and restored lower down. In order to compensate for the water thus borrowed from the river and to regulate the level of Lake Superior, it is proposed by the American company to build compensating works to a point at or near the international boundary with eight sluice gates; likewise the Canadian company proposes to build, as already stated, compensating works from the Canadian shore southerly to a point at or near the international boundary, which will also have eight openings or sluice gates. The effect of these compensating works would be, if they were not subject to proper operation and control, to back up the

water of the St. Marys River and to raise the level of Lake Superior, thereby endangering the owners of property on the opposite shores of the river and of the lake. Even if the works contemplated were never joined together, there is no doubt that the effect of placing such an obstruction by one of the companies in the river would have the effect of backing the water up and raising the levels of Lake Superior, to the detriment of the inhabitants of the shores of the lake. Likewise, if compensating and regulation works were not built, the very important and paramount interests of navigation might be interfered with. It will thus be seen that the matter falls under Article III of the treaty, which provides that no such obstruction or diversion affecting the natural level or flow of the water shall be made except with the approval of the commission.

The original application is somewhat peculiar in that it does not ask for the approval of any diversion of water, but simply for the approval of plans of certain compensating works which are supposed to be necessary in case the applicant increases the capacity of its canal, which is now from ten to fifteen thousand second-feet, to 30,000 second-feet. The natural and logical method of putting the matter before the commission would probably have been to seek an approval of the diversion and, as a consequence, of certain remedial works rendered necessary by such diversion; but as the matter was first presented to the commission, it was simply for the approval of certain obstructions in the St. Marys River, which obstructions we are told are for the purpose of regulating or compensating for the diversion which it is proposed to make by way of the canal in question. The application was subsequently amended, in the course of the hearing, so that the approval of the commission was asked for the diversion of 30,000 cubic second-feet.

Both applications have been before the commission for some time. The hearing was fixed for the 9th of March last, at Detroit, which is the headquarters of the United States Corps of Engineers who have charge of these partic-

ular waters, and which is also at a convenient distance from the territory affected by the contemplated works. At this session of the commission, besides the representatives of the interested companies, there were present representatives of the chief cities situated on both sides of Lake Superior, of different railway companies, boards of trade, and other public and private corporations whose rights might be affected by the raising of the levels of Lake Superior. The Michigan Northern Power Co. laid its case before the commission, heard its engineers, and sought to establish by the testimony of the latter and also by the testimony of Col. Patrick and of Mr. W. J. Stewart, the engineer representing the Dominion Government, that no damage, or no serious damage, would result to the different interests on the lake by reason of the construction and the maintaining of the works, the approval of which they sought to obtain.

The Algoma Steel Corporation, through its counsel, Mr. Thomas Gibson, declared that it would rely upon the evidence adduced by the other applicant, and asked that such evidence be made part of its case, which prayer was granted.

When the companies had thus presented their case to the commission, the divers interests affected by the construction of the works suggested that in order to permit them to study the case as presented, with all the figures, calculations, and possible effect of the raising of the levels of the lake, an adjournment of the hearing should be had. This request seemed just and reasonable and the hearing was thereupon adjourned to the regular semiannual session of the commission, at Washington, on the first Tuesday of April, viz, the 7th. In the meantime a series of rules for the control and regulation of the works contemplated was suggested, and the Government engineers, with the engineers representing the applicants, met, for the purpose of considering and discussing the suggestions, and the following were agreed upon:

(1) The works to be built in the St. Marys River by the Michigan Northern Power Co., its successors or assigns, shall consist of a dike about 200 feet long and eight Stoney sluice gates and their appurtenances, each gate to be about 50 feet in the clear, and between the northern terminus of this gate system and the system of four gates now in place in Canadian waters, there shall be left an interval sufficient to be filled by four Stoney sluice gates, each of the same size as those above mentioned.

(2) The works to be built in the St. Marys River by the Algoma Steel Corporation (Ltd.), its successors or assigns, shall consist of four Stoney sluice gates and their appurtenances, each gate to be about 50 feet in the clear, and this gate system is to connect with the system of four gates already in place in Canada, and with the gate system which the Michigan Northern Power Co. is to build under condition (1) above.

(3) The sills of all Stoney gates on both sides of the international boundary shall not be higher than 591.2 above mean tide at New York, according to the system of levels established by the United States in 1903, and the river bed both upstream and downstream from the works to be built shall be excavated to elevation 590.7 or lower.

(4) All the detailed plans for the structures to be built by the Michigan Northern Power Co., its successors or assigns, and the order in which they are to be built shall be subject to the approval of the Secretary of War of the United States, or an officer duly designated by him.

(5) All the detailed plans for the works to be built by the Algoma Steel Corporation (Ltd.), its successors or assigns, and the order in which they are to be constructed shall be subject to the approval of the Governor General in council of the Dominion of Canada or an officer duly designated by him.

(6) The dike now in place above the four sluices already built and owned by said Algoma Steel Corporation (Ltd.) shall be removed forthwith by said Algoma Steel Corporation (Ltd.), its successors or assigns, and the said gates shall be put in service.

(7) All compensating works heretofore built and all such works built under this order of approval and all power canals, including their head gates and by-passes, shall be so operated as to maintain the level of Lake Superior as nearly as may be between levels 602.1 and 603.6 above mean tide at New York, according to the system

of levels established by the United States Government in 1903, and in such a manner as not to interfere with navigation. The operation of all the said works, canals, head gates, and by-passes for the above purpose shall be under the direct control of the board hereinafter designated.

(8) The mean elevation of Lake Superior shall be ascertained by taking the mean of the readings of at least four automatic gauges, half the number to be maintained by the United States, half by Canada; these gauges to be located so that their combined readings will indicate as nearly as may be the mean, or average condition of the whole lake. The records of these gauges shall be furnished to the board charged with the control of the operation of the compensating works and hereinafter referred to at such intervals as it may require.

(9) The officer of the Corps of Engineers charged with the improvement of the falls of the St. Marys River on the American side, and an officer duly appointed by the Canadian Government, shall form a board whose duty it shall be to formulate rules under which the compensating works and power canals and their head gates and by-passes shall be operated to secure as nearly as may be the regulation of Lake Superior as set forth herein. It shall be the further duty of this board to see that any rules or regulations now or hereafter made by proper authority are duly obeyed.

(10) To guard against unduly high stages of water in Lake Superior, the rules formulated by the said board, when tested by the physical conditions which existed during any year of recorded high water in Lake Superior, when the monthly mean elevation of Lake Superior exceeded 603.6 shall give no monthly mean level of the lake greater than the maximum monthly mean actually experienced in said year.

(1) [sic] To guard against unduly high stages of water in the lower St. Marys River, the excess discharge at any time, over and above that which would have occurred at a like lake state of Lake Superior prior to 1887, shall be restricted so that the elevation of the water surface immediately below the locks shall not be greater than 584.5.

(12) Each power company shall keep continuous records, satisfactory to the board, which will show the quantity of water used by it and shall furnish to the board when required full information from said records.

(13) At all times the board will determine the amount of water available for power purposes. It will cause the amount of water so used to be reduced whenever in its opinion such reductions are necessary in order to prevent unduly low stages of water in Lake Superior and will fix the amounts of such reductions; provided, that whenever the monthly mean level of the lake is less than 602.1 the total discharge permitted shall be no greater than that which it would have been at the prevailing stage and under the discharge conditions which obtained in 1887; provided further, before any flow of primary water on either side of the river is reduced the use of all secondary water shall be discontinued.

(14) If the compensating works constructed in accordance with the plans hereby approved, together with those already constructed, can not be operated so as to secure the regulation of the level of Lake Superior as provided herein they shall be altered so as to provide for a greater flow, and in a manner satisfactory to the two Governments. Whenever it is required that the said works shall be so altered the greater flow desired shall be secured in equal parts on each side of the boundary line, or the cost of securing the total greater flow shall be borne equally by the owners of the two parts of the said works.

(15) The board herein constituted shall guard against any undue rise of Lake Superior, during the construction of the compensating works, by requiring the power companies to pass through their respective canals quantities of water up to their maximum capacities, or in such other manner as may be suitable to accomplish this purpose.

(16) Should ice interfere with navigation, due to the presence of the compensating works, the board shall take measures to obviate this difficulty, and may call upon the owners of the said works to do any work necessary for this purpose.

(17) Should currents which unduly interfere with navigation be developed by the operation of the power works on either side of the river, the power company operating said works shall alter them or construct such other works as its Government may deem necessary to remedy this evil and in a manner approved by such Government.

(18) It is recommended that the cost of maintaining all parts of the compensating works shall be borne by the respective owners thereof, and that this work of maintenance shall be done in a manner satisfactory to both Governments. It is also recommended that the rules devised by the board for the operation of the compensating

works shall be framed so as to divide this burden between the owners of the component parts of the entire system as nearly as may be in proportion to the amount of primary water used for power development on each side of the international boundary.

(19) Should either or both Governments acquire title to the compensating works built in their respective territories, the approval of the construction and maintenance of these compensating works by the applicants, shall inure to the benefit of their respective Government successors.

(20) In the event of a disagreement between the members of the board herein constituted with respect to the interpretation of the conditions attached to this order of approval or to the duties and powers of said board or to the details of the operation of the compensating works, the question at issue, upon the application of either Government, shall be referred to this commission for its recommendation.

(21) "Primary water" as used herein shall be understood to mean the amount of water which is continuously available for use for power purposes. "Secondary water" shall be understood to mean an amount of water over and above that designated as primary water which is intermittently available for use for power purposes.

Copies of these suggested rules were sent to all the parties who had appeared before the commission and to certain others whose interests were likely to be affected.

At the session held at Washington, besides the public announcement of the adjournment at the Detroit meeting, special notices had been sent out and not a few of the original objectors appeared; the suggested rules for the operation and control of the works were explained, examined, and discussed in detail by the engineers representing both Governments. The fullest opportunity was given to all concerned to criticize the rules, to make any suggestions, and to bring to bear upon the important questions submitted to the commission all the light which study, knowledge, and experience could possibly produce.

On the 4th and 5th of May instant, several members of the commission, with the Government engineers and the engineers representing the applicants, visited Sault Ste. Marie and the site of the works on both sides of the river.

The commission was perfectly alive to the magnitude of the problem which it had before it. One of the engineers representing the cities of Duluth and Superior and the commercial interests of these cities, Mr. Hoyt, states in his testimony that—

> The body of water sought to be controlled in Lake Superior with its area of between thirty-one and thirty-two thousand square miles is a project which has never been taken hold of by man before. While we have confidence in the figures and plans as laid out to produce the control that they (the engineers) expect to get and keep within reasonable ranges, in my opinion, it is going to be very hard to tell until they have had some experience as to what the actual results are going to be.

In a state of nature this immense body of water flows into Lake Huron though a narrow outlet. A serious situation, and a great menace to property, would be brought about by diminishing the space through which the outflow takes place, and it is to guard against such danger, resulting either from the building and the maintaining of the compensating works or their operation, and also to safeguard the navigation interests, that the commission has bent its best efforts.

The question which presents itself to the commission is not whether the latter is ready to give to a power company leave to divert the water of the St. Marys River and build obstructions in the river, which may seriously affect the levels of Lake Superior. However important may be the industrial interests which are dependent upon the supply of water which is asked for, the problem which the commission is called upon to solve is whether the natural outflow of this great international body of water can be interfered with for the purpose of borrowing power from it without prejudice to the enormous public interests which are dependent upon a continuous and uninterrupted flow.

There is no doubt that considerable benefit will result from the establishment and operation of the works of the Algoma Steel Corporation, and in this age of progress and advancement such enterprises should be encouraged, but,

on the other hand, apart from the great shipping interests, the inhabitants who live on the opposite side of the St. Marys River and Lake Superior have vested interests which can not be disturbed without compensation, and the question is whether the remedial or compensating works proposed are sufficient to protect the owners of property, both public and private, and navigation against any damages or danger which might result from the construction and operation of the works as contemplated.

The evidence shows that a great deal of care and attention has been given to this problem, but, as Mr. Hoyt says, it will be very difficult to foresee what will happen; actual experience only, in dealing with such a huge question, will be able to enlighten us.

As was remarked during the course of the hearing, the proposed remedial works seem to be sufficient and to be so constructed as to carry out the intention of those who designed them, but the principal object to be attained is the flexibility of the works in order that, in their operation, the waters may be so controlled as to meet any ordinary and natural emergency. Upon this consideration I place my belief that no set rules or regulations should be definitely adopted for the operation of the works in question, but that tentative rules should be drafted, giving those intrusted with their execution such discretion as will allow, within certain limits, of their amendment so as to meet the requirements and exigencies of the moment.

Leaving aside the very able disquisitions of the engineers employed by the companies, I have, for obvious reasons, paid particular attention to the testimony of Col. Patrick and Mr. Stewart, who have appeared on several previous occasions before the commission, and who I have always found have been most helpful to our deliberations.

From observations taken during 54 years the range between high water and low water under natural conditions has been a little over 3½ feet. At Port Arthur the mean monthly level has been as follows:

| | Feet |
|---|---|
| Between 1860 and 1912 | 602.27 |
| Between 1892 and 1907 | 602.58 |
| Between 1892 and 1912 | 602.44 |

In the opinion of Mr. Stewart, the new works will raise the level 2 inches above the latter mean; it will practically not raise it above the mean between 1892 and 1907. The object and result of the works, according to the two engineers, will be to maintain the level between 602.1 and 603.6. This range has been before the public since 1903, when it was fixed by the War Department in respect of a permit issued to the Michigan & Lake Superior Power Co. It was adopted in 1906 by the International Waterways Commission. Both Government engineers assert that it will be possible to maintain a range or oscillation of 2½ feet.

Mr. Hoyt, who represents interests in opposition to the power companies, declares that the important feature is the mean range. He says:

> So you can see the vital importance of the increase in the mean level of the lake. I wanted to bring that out particularly to the commission, because it seems to me sometimes that we lose sight, in taking the top and bottom elevations, of the fact that the important feature to the interests around the lake is the average level or the mean level.

Col. Patrick expressed the opinion that if the works were properly carried out and controlled, the conditions in respect of navigation and of proprietary rights at the head of the lake would be improved. He endeavored to impress upon us the idea that the construction of the works, if operated according to well-devised regulations, would present no danger for the interests involved. Mr. Stewart is not quite so positive, and he maintained very strenuously that in order to give full protection it would be necessary, at all events, as soon as the works of the Michigan Northern Power Co. were commenced, to put in commission the four gates on the Canadian side and to open them according to circumstances. As a matter of course the cofferdam

in front of the gates would have to be removed. At pages 189 and 190 he gives his reason for this opinion. In view of what Mr. Hoyt said, I would hesitate to refuse to agree with Mr. Stewart. It is true that at page 205 of his testimony Mr. Hoyt says:

> As I stated yesterday, if the control were kept within those limits (viz. 602.1 and 603.6), it would raise our mean at the head of the lake probably from 2 to 3 inches, and I think if the conditions are controlled within those limits we would have no cause for serious complaint.

Mr. Lyon, who represented the Northern Pacific Railway Co. and the Great Northern Railway Co., also declares, at page 155, "that the purpose of these works and the result of these works, if the intentions of the Government engineers are carried out, will be to improve conditions rather than to make them worse."

But I have constantly before me the fact that we are dealing with an immense body of water, and that the problem which we have to solve is untried. We are acting upon the advice of eminent engineers who have given us the benefit of their investigations and their experience, but where the interests involved are as considerable as in the present case we must proceed with the greatest caution and take every possible means of avoiding any risk. I am, therefore, constrained to take the view put forward by Mr. Stewart.

Moreover, I am of the opinion that no approval of the works in the stream should be given to the plans of the Algoma Steel Corporation, unless the latter, concurrently with the construction of these works, enlarges its canal so as to carry 30,000 second-feet of water instead of 10,000, as at present.

The following question was put by Mr. Magrath to Mr. Gibson, representing the Algoma Steel Corporation (Ltd.):

> Do your plans contemplate the enlargement of your canal from 10,000 to 30,000 cubic feet per second?

Mr. Gibson answered:

Yes, sir. At one time it was thought that we might build an extra canal, but our engineers now tell us that the more economical way to develop would be by enlarging and widening and deepening the existing canal. There is no doubt of that.

MR. MAGRATH. So that it would be a factor in the control of the water or in carrying off the surplus water?

MR. GIBSON. Exactly. That is exactly in line with all the negotiations that have been going on between the engineers of the two Governments, Col. Patrick on the one hand and Mr. Stewart on the other, all predicating on a diversion of water through the canal.

Some question was raised during the argument as to the right of this applicant, in view of the position taken by the Ontario Government, to take the water which belongs to the Province and build upon the land which is also in the provincial domain. With that question we have nothing to do. The applicant comes before us with plans approved by the Government of the Dominion and asks us under the treaty to approve of the diversion and obstruction which it contemplates. Section 132 of the British North America act enacts as follows:

The Parliament and Government of Canada shall have all powers necessary or proper for performing the obligations of Canada or of any Province thereof, as part of the British Empire, toward foreign countries, arising under treaties between the Empire and such foreign countries.

By the act, 1 George V, Chapter 28, section 1, the treaty and protocol "in the schedule of this act are hereby confirmed and sanctioned," and by section 2 it is declared:

The laws of Canada and of the several Provinces thereof are hereby amended and altered so as to permit, authorize, and sanction the performance of the obligations undertaken by His Majesty in and under the said treaty, and so as to sanction, confer, and impose the various rights, duties, and disabilities intended by the said treaty to be conferred or imposed or to exist within Canada.

This does not mean, however, that a party may appear before the commission and by obtaining an order of ap-

proval of its plans, in the case of a diversion or obstruction, take the land of another without conforming to the common law of the country. So in the present instance, before the applicant can use the approval which it obtains from this commission, it will, if the necessity of the case arise, be obliged to treat and settle with those whose property rights it encroaches upon.

By this I do not intend to say that an individual or even a Province could step in and prevent the order of the commission being carried out; but the applicant would have to put himself in the position of being able to fulfill the conditions imposed by the order, otherwise he could not avail himself of the permission granted.

On the whole, I am of opinion that the commission should grant the application of the Algoma Steel Corporation (Ltd.) and approve of the plans submitted by it, under reservation of the conditions imposed by the order-in-council of the 5th of March, 1914, and subject to the regulations which have been adopted by the commission.

While upon this subject of the regulations, and before closing, I wish to say a word upon a question which was raised at the hearing.

One of the regulations submitted to us, No. 14, reads as follows:

> If the compensating works constructed in accordance with the plans hereby approved, together with those already constructed, can not be operated so as to secure the regulation of the level of Lake Superior, as provided herein, they shall be altered so as to provide for a greater flow and in a manner satisfactory to the two Governments.

I wish to refer here to paragraph 6 of Article VIII of the treaty. The suitable and adequate provision which is to be made for the protection against injury of any interests on either side of the boundary must be approved by the commission. The regulations formulated are the result of the thought, research, science, and experience of eminent engineers, but we are led to believe that they are more or

less of an experiment. The engineers are not absolutely certain that the works contemplated will be sufficient under all circumstances to protect the interests involved, and the very fact that this regulation 14 is suggested, bears out the impression which I have in my mind that it may become necessary in the light of further experience, either to alter the works or to alter the regulations. In the view that I take of the above-cited paragraph of Article VIII, I am of opinion that our functions in such a case as the present one do not cease with the decision to be rendered by us. If it were so, the services which we are called upon to render to both countries might be nugatory and without practical effect. The commission is in existence, and if denounced can only be terminated at the expiry of one year from the date on which it is denounced. Even taking the extraordinary view that the treaty might be denounced, the high contracting parties, according to its terms, would have one year within which they could come to some understanding to replace the machinery settled upon by the commission in the course of its decisions, but we must adjudicate upon these questions which come before us with the treaty under our eyes, as an existing fact, leaving to the high contracting parties the responsibility, in case of necessity, of providing other means by which the decisions or findings of the commission may be carried out to the advantage of both. There is nothing in the treaty which says that once we have approved of remedial or protective works, the commission, in respect of these works, is *functus officio*. The matter having been submitted to us, having been studied with all the care and attention which it requires, and the particular means provided by the treaty to ascertain the true state of facts and the exact condition of things having been taken, it is for the commission to say whether it approves, once for all, what provisions shall be taken for the protection of the interests involved, or whether this provision, from the nature of things, having proved unsuitable and inadequate, the parties may not be at liberty to return

before the commission, point out the inadequacy or insufficiency of the means employed, and obtain a further order, if necessary.

The provision, according to the treaty, must be suitable and adequate. Who but the commission is the judge of suitability and adequacy of the provision? If, in the judgment of the commission, it is necessary that the provision be tried before it has been definitely adopted, I see nothing to prevent us giving our approval temporarily to certain works and declaring that if after a certain time or under certain circumstances it appears that they do not constitute a suitable and adequate protection, other works to meet the requirements of the case shall be constructed.

Once the parties are before the commission, under the treaty the matter is referred to a body to which both the high contracting parties have delegated the powers necessary and sufficient to settle and adjust any dispute or question which might hereinafter arise.

For convenience sake and for the preservation of the friendly relations which should exist between two neighboring nations this treaty was passed and the commission appointed. When the matter is brought before the tribunal constituted for the purpose of settling questions, if, after having engaged the attention of the commission and having been adjudicated upon, it is necessary to refer back to the Governments of the high contracting parties, the question is not settled, but the cause of trouble or friction or dispute has only been shifted.

For these reasons I would make the regulations a part of the order and amend the regulations proposed so that, in case either the regulations themselves or the works approved did not prove to be a suitable and adequate provision for the protection of the interests involved, either of the Governments or any interested party could apply directly to the commission for a change in the regulations or in the works. This application could be made and disposed of summarily.

Opinion by Mr. Casgrain.

## Canadian Aide Memoire of January 6, 1958

BETWEEN THE U. S. GOVERNMENT AND THE CANADIAN GOVERNMENT ON INCREASED DIVERSIONS OF WATER FROM LAKE MICHIGAN AT CHICAGO

AIDE MEMOIRE

Useful conversations between United States and Canadian officials were held in Ottawa on July 9, 1957, on the subject of the sanitation problems which gave rise to proposed legislation for a 3-year temporary diversion of 1,000 cubic feet of water per second from the Great Lakes system at Chicago to the Mississippi system, and on the subject of studies to be carried out under the proposed legislation.

The Canadian Government understands that, if such legislation is enacted, these sanitation studies will not be limited to evaluating the effects of dilution, but will also include consideration of all possible measures for dealing with waste-disposal facilities at Chicago. Such measures would include:

(*a*) complete separation of storm sewers from the domestic sewerage system, or expansion of the existing treatment facilities to serve a total combined flow;

(*b*) treatment of organic wastes in industrial plants before discharging these effluents into the sewerage systems;

(*c*) chlorination of effluent before discharge into the Illinois Waterway; and,

(*d*) artificial aeration of the waterway.

The treatment of sewage in the Chicago area is, of course, a matter entirely within the jurisdiction of the competent legislative bodies within the United States. It is

understood that present treatment of waste represents a vast improvement over conditions which existed in former years and that, under the present-day uses of the water, the waste is more a nuisance than a menace to the public health in the area.

In considering the economics of alternative methods of improved waste disposal, it is assumed that full consideration will be given to the economic harm which may be done to navigation and hydroelectric generation in both countries by extended use of dilution methods.

It is not possible to give a firm undertaking to provide flows of a particular volume through the existing Long Lac and Ogoki diversions to the Great Lakes Basin during the 3-year period envisaged by proposed United States legislation. However, if it were possible to offset part of the effects of the Chicago diversion by inflows from the Albany Basin in Canada, it would be equitable that an equivalent amount of water should remain available for use in hydroelectric power generation by the Ontario interests at St. Marys Falls, Niagara Falls, and in the international section of the St. Lawrence River until the effects of the proposed temporary diversion will have ceased to be felt in the Great Lakes system.

All rights under the provisions of the boundary waters treaty of 1909 are specifically reserved.

THE CANADIAN EMBASSY, *A. E. R.*
*Washington, D. C., January 6, 1958.*

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## Canadian Aide Memoire of February 20, 1959

*February 20, 1959*

On a number of occasions in the past, the Canadian Government has expressed its objections to proposals envisaging increased diversions of water for Lake Michigan at Chicago. Once again, and at the invitation of the Government of the United States through the U.S. Embassy's aide memoire of February 9, 1959, the Government of

Canada is anxious to make known its views on legislative proposals now before Congress such as bill H.R. 1, which are intended to authorize an increased diversion of water from the Great Lakes Basin into the Illinois Waterway.

While recognizing that the use of Lake Michigan water is a matter within the jurisdiction of the United States of America, it is the considered opinion of the Canadian Government that any authorization for an additional diversion would be incompatible with the arrangements for the St. Lawrence Seaway and power development, and with the Niagara Treaty of 1950, and would be prejudicial to navigation and power development which these mutual arrangements were designed to improve and facilitate.

The point has been made repeatedly by Canada that every withdrawal of water from the basin means less depth available for shipping in harbors and in channels. Additional withdrawals would have adverse effects on the hydroelectric generation potential on both sides of the border at Niagara Falls and in the international section of the St. Lawrence River, as well as in the province of Quebec, and would inflict hardship on communities and industries on both sides of the border.

The Government of Canada therefore protests against the implementation of proposals contained in H. R. 1.

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## Canadian Note No. 184 of April 9, 1959

HON. CHRISTIAN A. HERTER,
*Acting Secretary of State, Department of State,*
*Washington, D. C.:*

I have the honour on instructions from my Government to refer to proposals for legislation in the United States concerning an increase in the diversion of water from Lake Michigan through Chicago Drainage Canal. It is noted that

one proposal to this effect has been approved by the House of Representatives and will shortly be considered by the Senate.

During a period of many years there have been numerous occasions on which the Government of Canada has made representations to the Government of the United States of America with respect to proposals concerning the diversion of water from Lake Michigan out of the Great Lakes watershed at Chicago.

Many of these representations have been directed toward particular proposals then under discussion by U. S. authorities. Because of the importance of the question, the Government of Canada believes it timely to reexamine the considerations which it regards as most important concerning any proposals for additional diversion of water from the Great Lakes watershed. Accordingly, in order that there may be no misunderstanding as to the views of the Government of Canada, I have been instructed to bring the following considerations to your attention.

Every diversion of water from the Great Lakes watershed at Chicago inevitably decreases the volume of water remaining in the basin for all purposes. The Government of Canada is opposed to any action which will have the effect of reducing the volume of water in the Great Lakes Basin. Careful inquiry has failed to reveal any sources of water in Canada which could be added to the present supplies of the basin to compensate for further withdrawals in the United States.

The Government of Canada considers that many agreements and understandings between the United States and Canada would be broken if unilateral action were taken to divert additional water from the Great Lakes watershed at Chicago and directs attention to provisions of two treaties in particular:

(*a*) The Boundary Waters Treaty of 1909—The applicability of either article II, paragraph 2, or article III of

this treaty depends upon the interpretation of physical facts.

If Lake Michigan physically flows into the boundary water Lake Huron, article II preserves to Canada the right to object to such a diversion which would be productive of material injury to the navigation interests in Canadian waters.

If, as has been asserted by eminent U. S. jurists, article III of the treaty applies, no further diversion shall be made except with the approval of the International Joint Commission.

(*b*) Niagara Treaty of 1950—This treaty allocates water for scenic and power purposes. The amount of water which shall be available for these purposes is the total outflow from Lake Erie. The specific inclusion of certain added waters in article III of the treaty emphasizes the underlying assumption that existing supplies will continue unabated.

In addition to these treaty provisions, there is a further agreement of far-reaching importance. Power development in the Provinces of Ontario and Quebec is predicated upon agreed criteria for regulation of the flows of the St. Lawrence River. The order of approval of the International Joint Commission of October 29, 1952, as supplemented on July 2, 1956, and accepted by both our Governments, forms the basis for the construction and operation of the hydroelectric power installations in the international section of the St. Lawrence River. Criterion (*a*) of this order approval assumes a continuous diversion out of the Great Lakes Basin limited to the present 3,100 cubic feet per second at Chicago.

Navigation and commercial interests depend upon the maintenance of the basis upon which channel enlargements have been designed in order that vessels of deep draught may proceed with full load to and from ports of the upper Great Lakes. In this connection I would refer to the following matters:

(*a*) The construction of the St. Lawrence Seaway—Legislation in the two countries and the several exchanges of notes concerning the construction and operation of the seaway now just completed are based on the assumption and understanding that there will not be unilateral action repugnant to the purposes of the legislation. Withdrawal of water from the Great Lakes Basin would materially affect the operation of the St. Lawrence Seaway:

(*b*) Dredging—By agreement contained in the various exchanges of notes between the two countries, profiles have been prepared for the excavation which has taken place or is about to take place in the international rapids section of the river, in the Amherstburg Channel and in the St. Clair River. These agreements are based or [sic] the implied understanding that material changes would not be made in the volume of water available for navigation;

(*c*) New channel—In an exchange of notes dated February 28, 1959, it has been agreed that a new channel should be constructed to eliminate the so-called southeast bend of the St. Clair River. The agreement by the Government of Canada to this proposal was based on the understanding that there would be no artificial interference with the present supplies of water.

Because of the importance attached by the United States and Canada to the honouring of international undertakings in letter and in spirit, the Government of Canada views with serious concern any possible impairment of agreements and undertakings relating to the Great Lakes Basin. Furthermore, the alarms created by repeated proposals for diversion which inevitably disturb the people and industry of Canada are a source of profound irritation to the relations between our two countries which we can ill afford.

I am instructed, therefore, to express the hope of the Government of Canada that the United States will view this matter with equal concern and will be able to give satisfac-

tory assurances that unilateral action will not be taken which would imperil the present regime of the waters in the Great Lakes Basin and the status of the agreements and understandings to which I have referred.

Please accept, Sir, the renewed assurances of my highest consideration.

(*S*) A. D. P. HEENEY.

WASHINGTON, D. C., *April 9, 1959.*

## U. S. Ex. 5A

[CANADIAN NOTE OF NOVEMBER 2, 1961]

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CANADIAN EMBASSY

Washington, D. C.
November 2, 1961

No. 782

SIR,

On instructions from my Government, I have the honour to refer to cases now before the Supreme Court of the United States, October term 1959, Nos. 2, 3 and 4 between the States of Wisconsin, Minnesota, Ohio, Pennsylvania, Michigan and New York as complainants and the State of Illinois and the Sanitary District of Chicago as defendants; and case No. 12 original between the State of Illinois as complainant and the States of Michigan, Ohio, Pennsylvania, New York and Wisconsin as defendants.

It is noted that in cases Nos. 2, 3 and 4, the complainants ask that the defendants be restrained from discharging any of the treated effluents emanating from the Sanitary District's sewage and industrial treatment facilities into the Chicago Sanitary and Ship Canal, and that the said defendants be required to return all of said effluent to the Great Lakes Basin from which it originally came in the form of "domestic pumpage"; and alternatively that a Permanent Master be appointed for the purpose of determining whether measures other than the return to Lake Michigan of the Chicago domestic pumpage effluent can be put into effect so that such measures will either reduce the direct diversion or limit the Chicago domestic pumpage, to the end that the total amount of diversion from the Great Lakes at Chicago will be reduced or restricted.

It is further noted that in case No. 12 original the complainant asks the Court to declare that the State of Illinois and its instrumentality, the Elmhurst-Villa Park-Lombard Water Commission, are entitled to proceed with a programme for the construction of a water supply sys-

tem and the withdrawal of water from Lake Michigan, and further asks the Court to restrain the defendants from interfering with such construction and withdrawal.

It is a matter of satisfaction to my Government that the United States of America, in applying for Leave to Intervene in cases 2, 3, 4 and 12 original in order to protect its interests, included among those interests the "maintenance of friendly relations with Canada." It will be recalled that representations have been made to the Government of the United States of America on numerous occasions during a period of many years with respect to a variety of proposals concerning the diversion of water from Lake Michigan out of the Great Lakes watershed at Chicago; that the Canadian Government has never consented to any such diversion; and that it has repeatedly expressed its unalterable opposition to such unilateral diversions which, in its view, are in violation of Canada's rights under many agreements and understandings between the United States of America and Canada. Because of the importance to Canada of the questions under consideration in the cases referred to above, the Government of Canada, while fully reserving its rights, believes that it is timely to re-examine the considerations which it regards as relevant and material to any proposals involving diversions of water out of the Great Lakes watershed.

Furthermore, the Government of Canada, while not submitting in any way or for any purposes to the jurisdiction of the Supreme Court of the United States in these cases, considers that its views should be reiterated at this time so as to avoid any possible misunderstanding as to the nature and extent of Canada's rights and interests in the outcome of the cases referred to above. I have accordingly been instructed to bring the following considerations to your attention.

Every diversion of water out of the Great Lakes watershed at Chicago inevitably decreases the volume of water remaining in the Great Lakes Basin for all purposes.

Any lowering of the water levels has measurably adverse effects upon Canadian navigation in the Great Lakes and the St. Lawrence River. Similarly, any decrease in the outflow of Lake Erie and Lake Ontario causes a proportionate reduction of the power potential of the Niagara and St. Lawrence Rivers. Consequently, diversions such as that under consideration in Case No. 12 original would impair Canada's legitimate interests. Conversely, any restriction upon presently existing diversions not previously consented to by Canada such as is under consideration in Cases No. 2, 3 and 4 would be consistent with Canada's legitimate interests.

The causal relationship between diversions out of the Great Lakes Basin and the resultant adverse effects upon Canadian and United States of American navigation and/or power interests is recognized in the following treaties and agreements:

Treaty between Canada and the United States of America relating to uses of waters of the Niagara River, signed at Washington, February 27, 1950. CTS 1950/3;

Treaty between Great Britain and the United States of America relating to Boundary Waters and Questions arising along the boundary between Canada and the United States, signed at Washington, January 11, 1909. CUS 1927/312;

Exchange of Notes between Canada and the United States of America concerning the construction of the St. Lawrence Seaway, signed at Washington, June 30, 1952 and January 11, 1952, CTS 1952/30;

Exchange of Notes between Canada and the United States of America modifying the Exchange of Notes of June 30, 1952 concerning the construction of the St. Lawrence Seaway, signed at Ottawa, August 17, 1954. CTS 1954/14;

Exchange of Notes between Canada and the United States of America relating to the Great Lakes-St. Lawrence Basin (Niagara Falls-Long Lac Ogoki Works-Albany River Basin), signed at Washington, October 14 and 31 and November 7, 1940. CTS 1940/11.

In accordance with the aforementioned treaties and agreements, various hydro-electric power installations and navigation channels, including those of the St. Lawrence Seaway, have been constructed. Such projects would be jeopardized by diversions of the kind under consideration in Case No. 12 original. Moreover, apart from damage immediately attributable thereto, such a diversion would establish an extremely undesirable precedent with serious implications for Canada.

For the foregoing reasons, and bearing in mind the importance attached by the United States of America and Canada to the honouring of international undertakings in letter and in spirit, I have been instructed to convey the Government of Canada's serious concern at the prospect of any action being taken which would impair the legitimate interests of Canada, including Canada's rights under agreements and undertakings between our two countries relating to the Great Lakes Basin, and would constitute an irritant to good relations between Canada and the United States of America.

Accept, Sir, the renewed assurances of my highest consideration.

A. D. P. HEENEY

THE HONOURABLE DEAN RUSK,
*Secretary of State of the United States*
Washington, D. C.

## U. S. Ex. 5F

[CANADIAN NOTE OF JUNE 10, 1964]

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No. 288

Washington, D. C.
June 10, 1964

Sir,

I have the honour to refer to note No. 782 of November 2, 1961, from the Canadian Ambassador, concerning cases now before the Supreme Court of the United States in connection with the diversion of water from the Great Lakes at Chicago.

The Canadian Government wishes to reaffirm its position as stated therein, and, in particular, to draw to your attention a statement by the Prime Minister in the House of Commons on April 17, when he reiterated the Government's opposition to such unilateral diversions.

I should be grateful if you would convey the contents of this note in an appropriate manner to the Special Master appointed by the United States Supreme Court to hear evidence concerning this matter.

Please accept, Sir, the renewed assurances of my highest consideration.

C. S. A. RITCHIE

The Honourable
Dean Rusk,
The Secretary of State,
Washington, D. C.

## Earlier Canadian Notes Referred to in Finding II-38

[NOTE OF APRIL 22, 1921]

*Correspondence Relating to Diversion of the Waters of the Great Lakes by the Sanitary District of Chicago, from March 27, 1912 to October 17, 1927* (Ottawa, F. A. Acland, printer), p. 21.

Note 285. The British Ambassador [Geddes] to the Secretary of State.

"I have the honour to inform you that my attention has been drawn by the Canadian government to statements recently made public to the effect that the authorities of the city of Chicago are about to approach Congress with a view to obtaining legislative authority to increase the diversion of water from Lake Michigan for the use of the Chicago Sanitary Canal up to, and even possibly beyond, a rate of 10,000 cubic feet per second.

"For convenience of reference I may perhaps be permitted to recall the earlier correspondence that has taken place on this subject; in a note dated 17 March 1913 His Majesty's ambassador made known to the Secretary of State the attitude of steadfast opposition which Canada has consistently adopted to the policy involved in the proposed diversion. Mr. Bryce took the opportunity to point to the serious prejudice caused to Canadian navigation interests by the diversion of waters from Lake Michigan and the consequent lowering of the levels of the Great Lakes, even when such diversion had been made from a reserve that had accumulated in years of plenty. He further represented that any diversion of water from Lake Michigan which prejudicially affected the navigation of the Great Lakes constituted an infringement of the treaty rights secured to Canada by the Ashburton-Webster Treaty of 1842 in so far as concerned the channels of the rivers St. Lawrence and Detroit and other channels and passages mentioned in Article 7 of that treaty. It was pointed out that such diversion was also an infringement of those

rights of navigation in boundary waters and in Lake Michigan to which the Dominion is entitled under the Boundary Waters Treaty of 1909.

"In drawing attention again to the above representation, I should like to lay stress upon the fact, quoted by Mr. Bryce, that, apart from the question raised by these specific treaty stipulations, the recognized principles of international law do not confer either upon the federal authorities of the United States or upon any individual state of the union the right to divert from Lake Michigan, by any means or for any purpose, such an amount of water as will prejudicially affect the navigation of boundary waters in which both Canada and the United States are interested.

"The existing diversion of water has not been acquiesced in by the Canadian government and is, in fact, greatly in excess of the amount authorized by the Secretary of War in December 1901. It has already done considerable harm and the waterpower interests throughout all the Great Lakes and the St. Lawrence system, from Lake Huron to tidewater, look upon the present situation with apprehension—an apprehension which is shared by the Canadian government.

"The United States government will, I think, agree that no solution of the area question is likely to be permanently sound or satisfactory unless it is based upon a recognition of the principle, established by international practice, that no permanent diversion should be permitted to another watershed from any watershed naturally tributary to waters forming the boundary between two countries.

"In drawing your attention to the attitude consistently taken by the Canadian government upon this question, I venture to express the confident hope that the United States government will not give their approval to the application of the Chicago authorities or take any steps in this matter which so closely affects Canadian interests without in the first instance arranging for a discussion of the matter with the Canadian government."

[NOTE OF FEBRUARY 24, 1925]

*Papers Relating to the Foreign Relations of the United States, 1925, Vol. I,* pp. 559-561

"The British Ambassador [Howard] to the Secretary of State

"No. 198 Washington, February 24, 1925.

"SIR: I have the honor to refer to your note of the 13th instant, and to inform you that the Government of Canada have observed that public hearings have recently been held by the War Department in Washington on an application made by the Sanitary District of Chicago for permission to increase the quantity of water which that District is now permitted to divert from Lake Michigan under authority of the Secretary of War and that the question whether, in accordance with the recommendation of the Chief Engineer, the amount permitted to be diverted should, under certain conditions, be increased to 8,500 cubic feet per second instead of 4,167 cubic feet per second, to which the Sanitary District is limited under a recent judgment of the Supreme Court of the United States, was also considered.

"The Dominion Government now desire me to state that, while they would not wish to oppose any interim measure which may be necessary to protect the health of the inhabitants of the city of Chicago, they feel compelled to reiterate the protest they have already made against the abstraction of water from the St. Lawrence basin [12] and, in order that there may be no misunderstanding, I desire to take this opportunity of making it clear that the Government of Canada do not surrender any claims that might be put forward for consequential losses already suffered or which may possibly be suffered in the future on this account. The Dominion Government are of opinion that it is impossible to lose sight of the fact that the effect of the present increase in permitted diversion of water will

[12] See despatch No. 144, Feb. 13, 1924, from the British Charge, *Foreign Relations,* 1924, vol. I, p. 350.

be to postpone the relief for which the navigation and other interests injuriously affected by the attitude of the Chicago Sanitary District have been waiting already too long, and which, subject only to the paramount necessity of safeguarding public health, these interests are now entitled to receive.

"I feel sure that you will readily appreciate that the injury to Canadian interests by any lowering of the natural level of the Great Lakes connecting waters and the St. Lawrence River by the diminution of their natural water supply is of constantly increasing importance not only on account of navigation on the Great Lakes and lower St. Lawrence River but also on account of power development. The Government of Canada have not failed to recognize that United States interests are likewise substantially affected by this question.

"The Government of Canada feel confident that the Government of the United States is fully alive to the advisability of restricting within the narrowest possible limit the amount of water to be diverted from Lake Michigan for use by the Sanitary District of Chicago, and in this connection, they feel certain that no permit will be granted for the diversion of any water not essential to safeguarding the health of the population of that city, and, further, that the period during which such diversion must on this account continue, will be made as short as circumstances permit.

"I should be most grateful if you would be so good as to communicate the contents of this note to the interested authorities of the United States Government.

"I have [etc.]

ESME HOWARD"

[NOTE OF SEPTEMBER 15, 1925]

*Papers Relating to the Foreign Relations of the United States, 1925, Vol. I*, pp. 565-567.

"The British Charge [Chilton] to the Secretary of State

"No. 813 Manchester, Mass., September 15, 1925.

[Received September 17.]

"SIR: At the request of the Governor General of Canada I have the honour to inform you that the Government of Canada has carefully considered your note of June the 15th last on the subject of the interpretation of the permit granted by the United States Secretary of War on the 3rd of March, 1925, for the diversion of water from Lake Michigan by the Sanitary District of Chicago.

"The Government of Canada is constrained to point out that despite repeated protests against the diversion of water from Lake Michigan, the above-mentioned permit of March 3rd, 1925, authorizes a diversion in amount over twice that stipulated in any previous permits.

"In this connection I have the honour to state that the Canadian Government also views with apprehension the interpretation which has been placed upon the permit in your note under reference. As set forth in the note which I had the honour to address to you on this subject on May the 7th last, the Government of Canada believed that the present permit, as in the case of previous permits, would limit the amount of the total diversion and be applicable to all waters passing Lockport. The interpretation of the permit of the 3rd March, 1925, as contained in your note under reference, would indicate, however, that the point of measurement is changed from Lockport to the intake works of the Sanitary District and through such change the permit recognizes an actual diversion much in excess of the stipulated amount of 8,500 second feet set forth in the permit. In other words, it is clearly stated that the permit does not embrace water diverted by the City of Chicago's pumping stations which at the present rate of pumping amounts to some 1,200 second feet thereby increasing the

authorized diversion from 8,500 second feet to 9,700 second feet.

"In addition, it would appear that if measurement be made at the intake from Lake Michigan the result would be to exclude from the operations of the permit the intercepted flow of the Chicago and Little Calumet Rivers, which varies in amount but is equal, it is understood, to an annual average of about 1,300 second feet. In these circumstances it would appear that the effect of the permit of the 3rd March would not merely authorize an average annual diversion of 9,700 second feet as above noted, but would recognize and permit of a total diversion passing Lockport of 11,000 second feet.

"While it is understood from your note of June the 15th that the Government of the United States anticipates that at the expiry of a five year period the annual diversion may be reduced between 1,750 and 3,000 second feet, this is far from reassuring since even if the larger suggested reduction becomes effective, the diversion at the beginning of 1930 will still be almost double that authorized by the Secretary of War of the United States when action for an injunction against the Sanitary District of Chicago was commenced in 1908.

"Furthermore, the Government of Canada would point out that works dependent on the levels and flow of the Great Lakes System cannot be confidently projected or economically carried out if diversions from the watershed are permitted without mutual assent thereto. Moreover, in this connection the continued and increasing impairment of the natural levels and discharge of the Great Lakes System, due to the diversion from Lake Michigan, raises the question as to the extent to which the Canadian Government would be warranted in giving consideration to any further improvements therein until there is an assurance of definite curtailment of such diversion.

"In connection with this matter the attention of the Canadian Government has been called to a permit dated the 30th April, 1925, from the United States Acting Secre-

tary of War, authorizing the Sanitary District of Chicago to carry out certain dredging work in the Calumet river system, which it is understood will involve an expenditure of $1,500,000 and enable the Calumet-Sag Channel to by-pass 2,000 second feet into the main drainage canal. If the report of this large expenditure is correct, it would appear to indicate that the Sanitary District is proceeding in expectation of continued diversion.

"The Canadian Government is therefore compelled to conclude that despite repeated protests no immediate or definite reduction has been provided and, furthermore, that if the above interpretation of the permit of 3rd March, 1925, is confirmed, the effect will actually be to authorize a greater diversion than is now being made.

"I accordingly have the honour to request that you will be so good as to communicate the above consideration to the competent authorities of the United States Government and to enquire whether it is not their intention to take measures to ensure immediate as well as more definite and more substantial future curtailment in the amount of water which is being diverted with such serious results from the Great Lakes and St. Lawrence System.

"I have [etc.]

H. G. CHILTON"

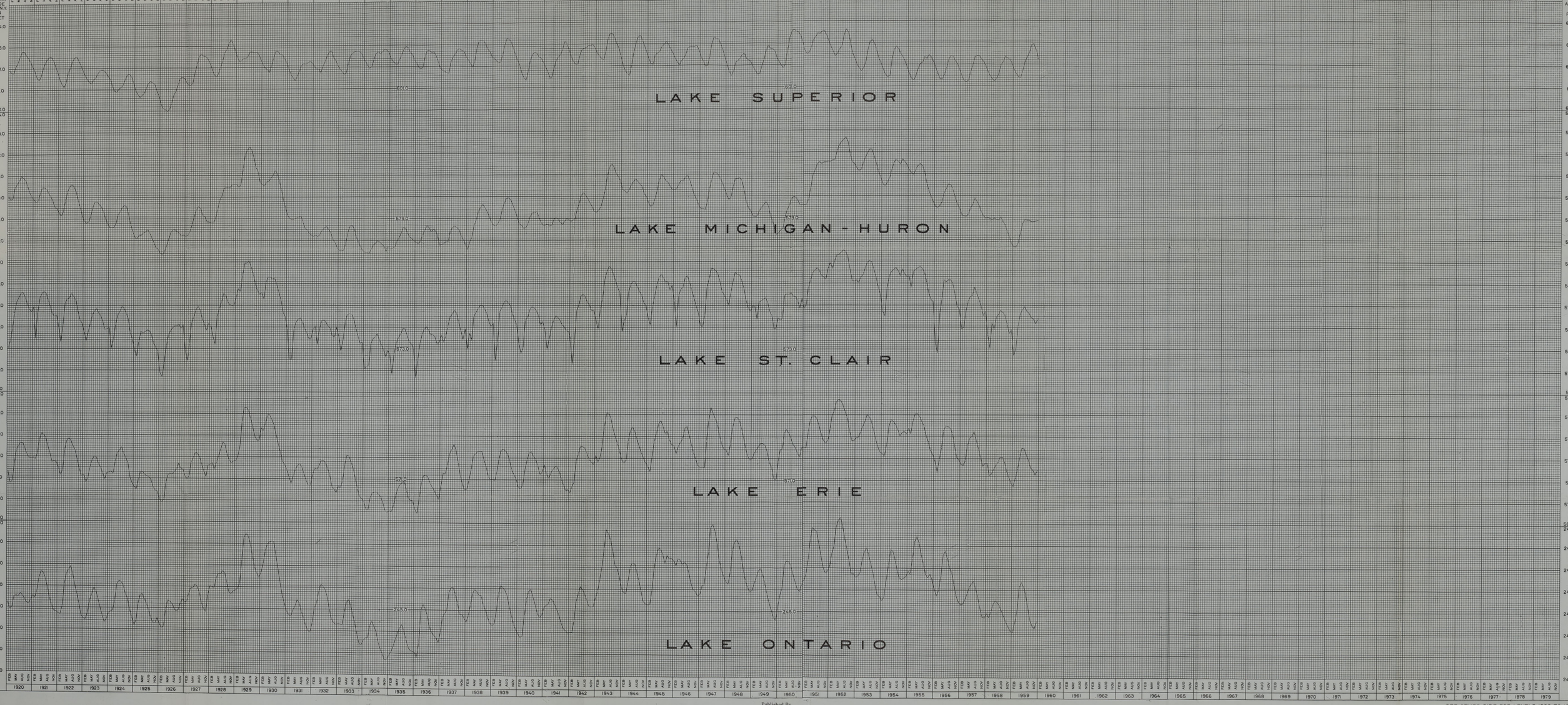
# L. S. Ex. 19G

## Hydrograph of Great Lakes Levels

CORPS OF ENGINEERS, U. S. ARMY

# HYDROGRAPH OF MONTHLY MEAN LEVELS OF THE GREAT LAKES

UNITED STATES LAKE SURVEY





Published By
U. S. LAKE SURVEY
630 Federal Building, Detroit 26, Michigan.

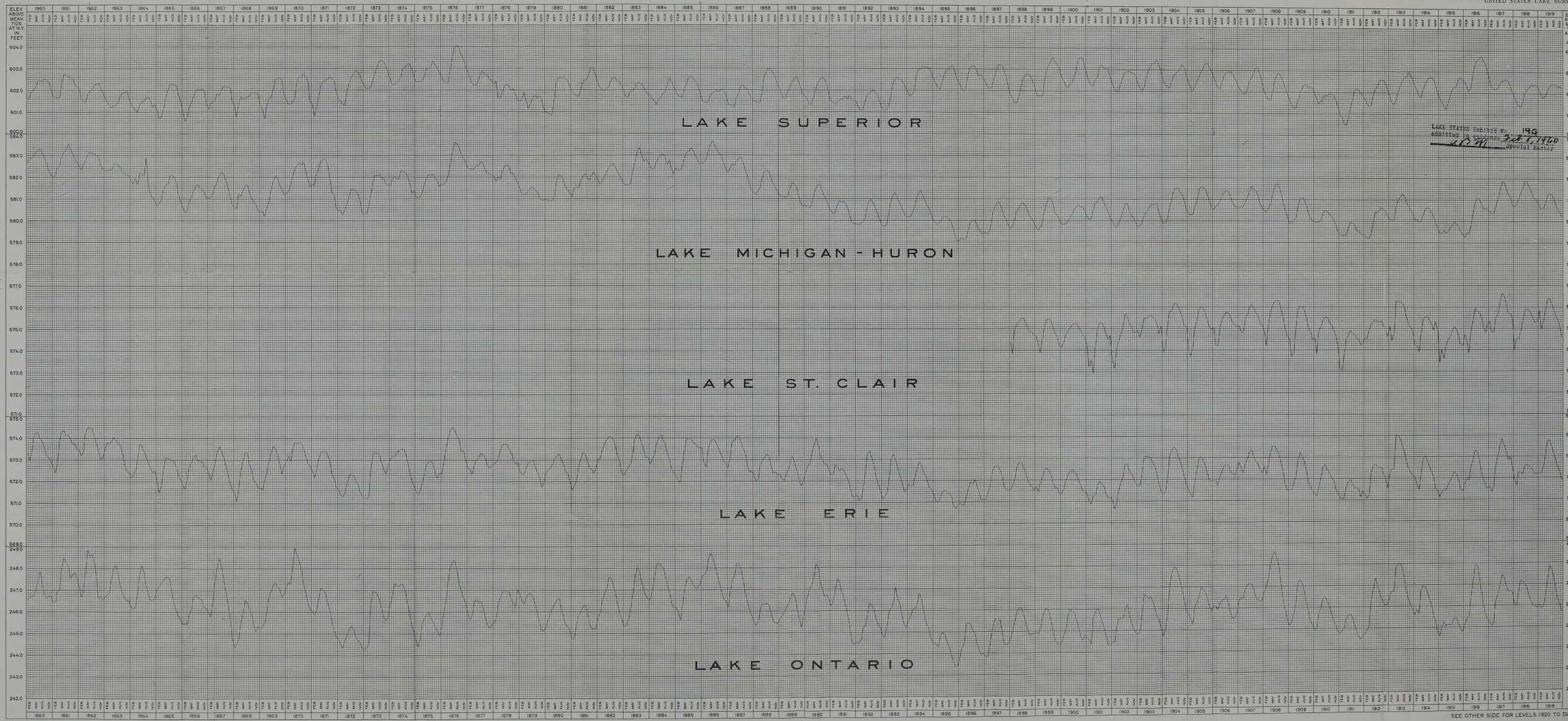

SEE OTHER SIDE FOR LEVELS 1860 TO 1919

CORPS OF ENGINEERS, U. S. ARMY

# MONTHLY MEAN WATER LEVELS

From Official Records, 1860 to 1919.

UNITED STATES LAKE SURVEY




LAKE STAGE RATING No. 199
ADOPTED IN ORDER DATED SEP 5 1920
Official Matter

SEE OTHER SIDE FOR LEVELS, 1920 TO DATE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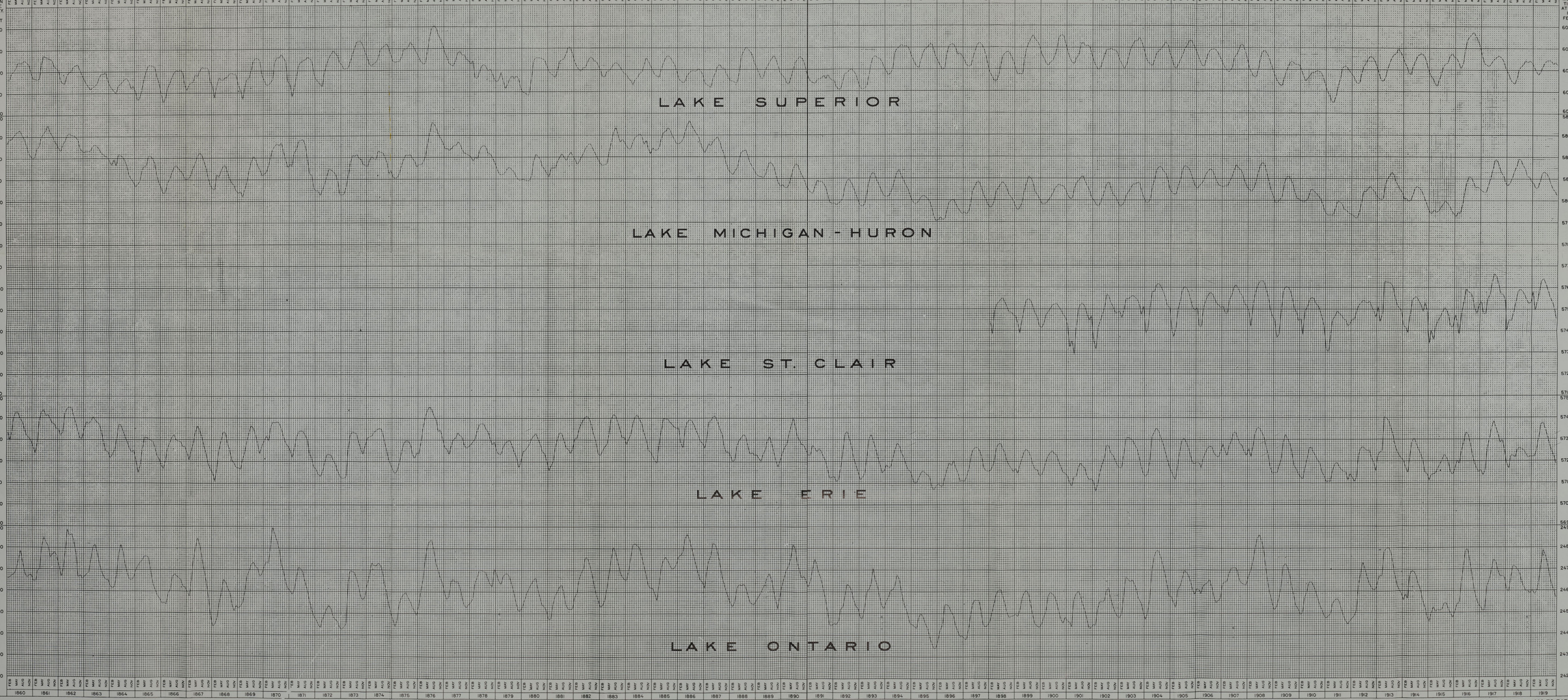
## L. S. Ex. 19G (Supplementary)

HYDROGRAPH OF GREAT LAKES LEVELS

HYDROGRAPH
OF
MONTHLY MEAN LEVELS OF THE GREAT LAKES
Referred to Mean Tide at New York; 1935 Datum

CORPS OF ENGINEERS, U. S. ARMY

UNITED STATES LAKE SURVEY

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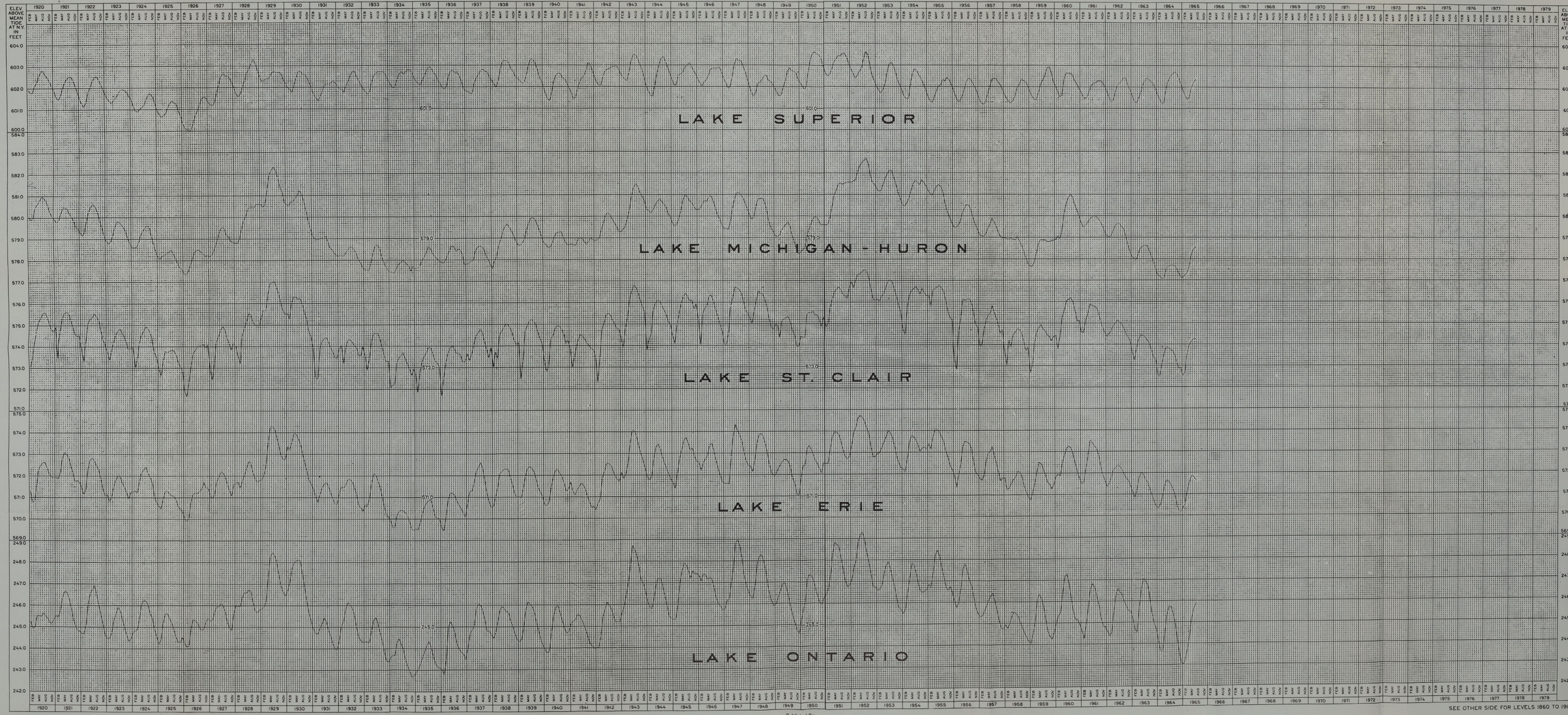
SEE OTHER SIDE FOR LEVELS 1920 TO DATE

HYDROGRAPH
OF
MONTHLY MEAN LEVELS OF THE GREAT LAKES
Referred to Mean Tide at New York; 1935 Datum

CORPS OF ENGINEERS, U. S. ARMY

UNITED STATES LAKE SURVEY




Published By
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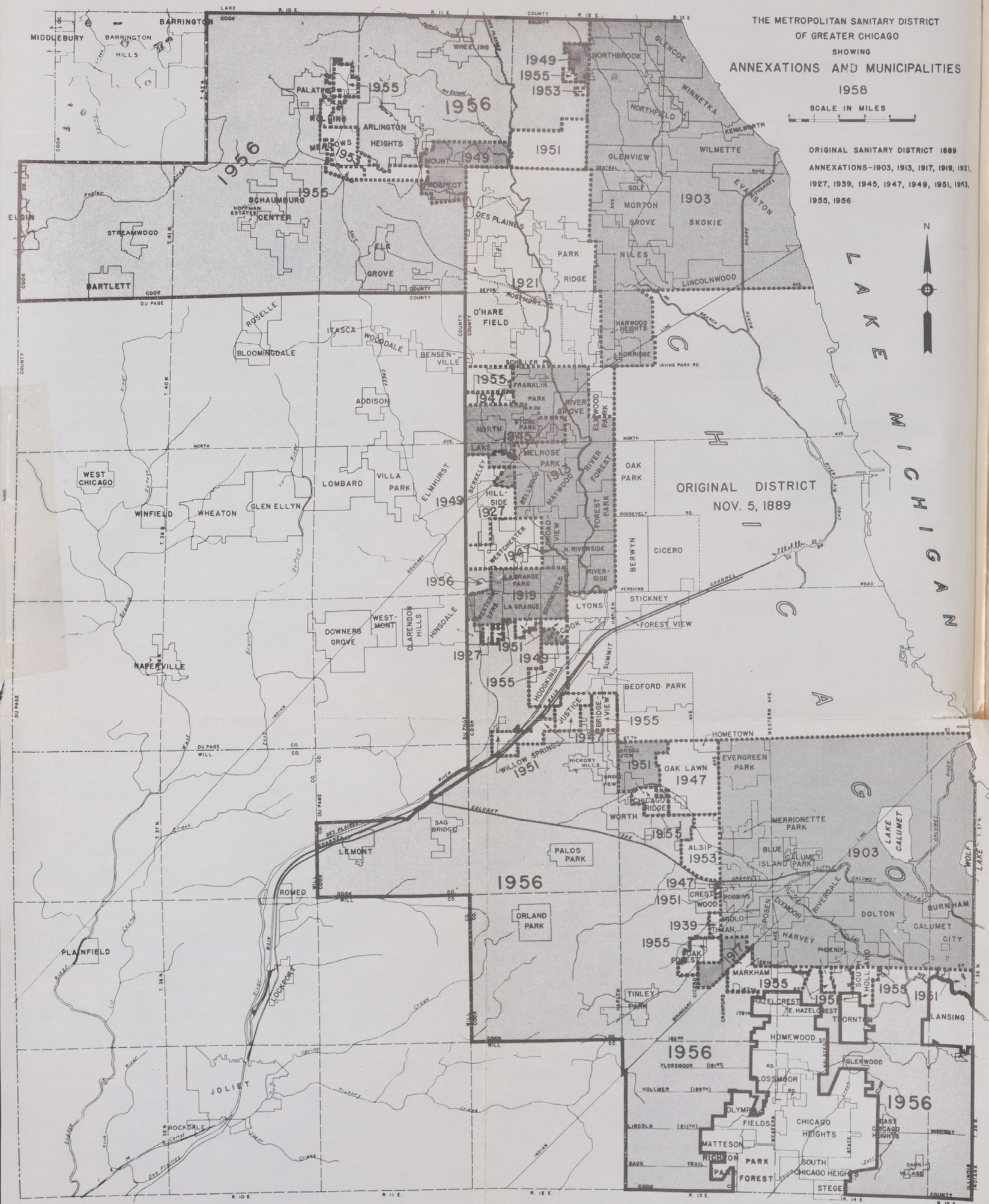
SEE OTHER SIDE FOR LEVELS 1860 TO 1919

## L. S. Ex. 500

MAP, METROPOLITAN SANITARY DISTRICT
SHOWING ANNEXATIONS

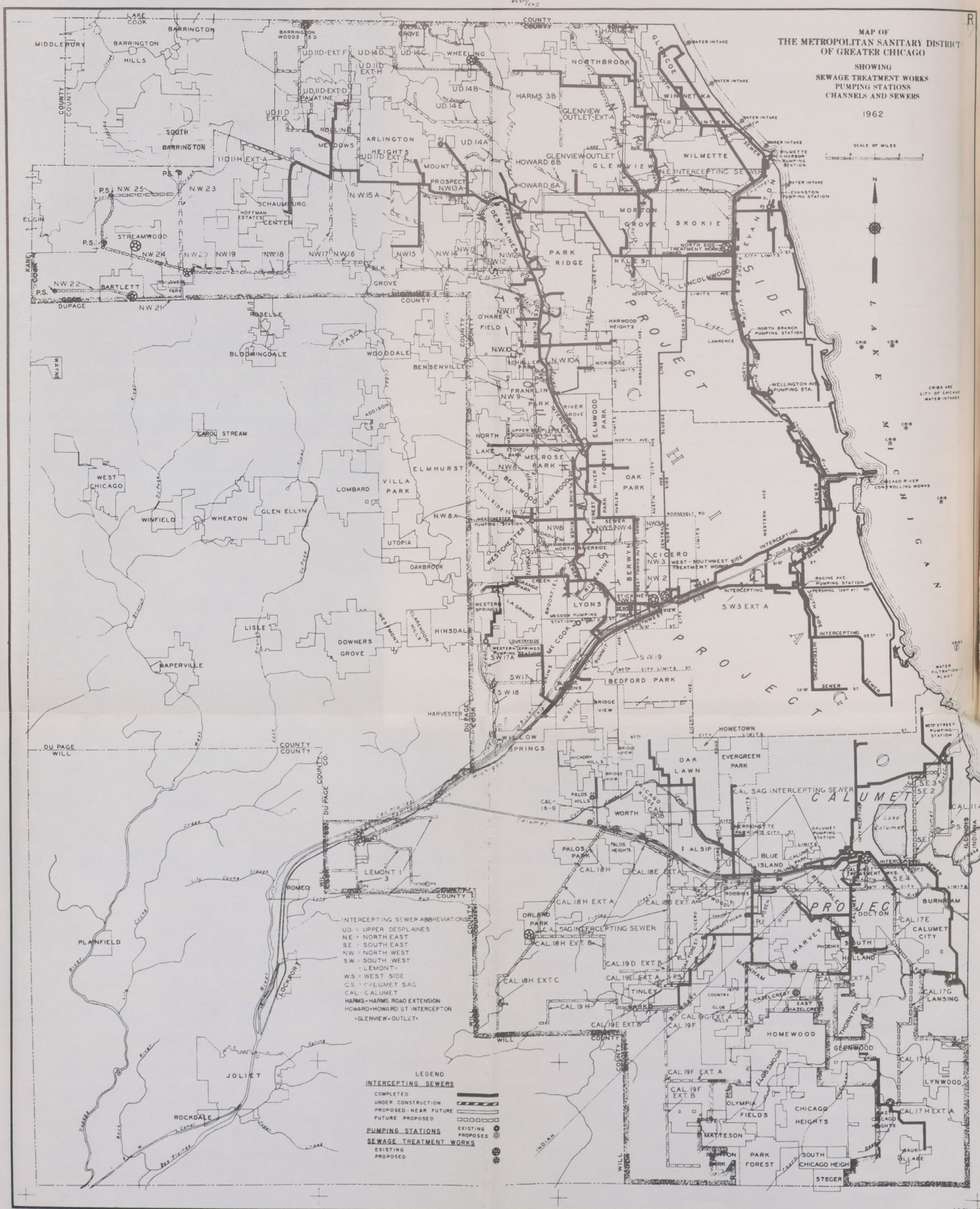
LAKE STATES Exhibit No. U.S. 500
admitted in evidence 3/2/1961
Special Master



## Ill. Ex. 719

MAP, METROPOLITAN SANITARY DISTRICT, SHOWING CANALS AND WORKS

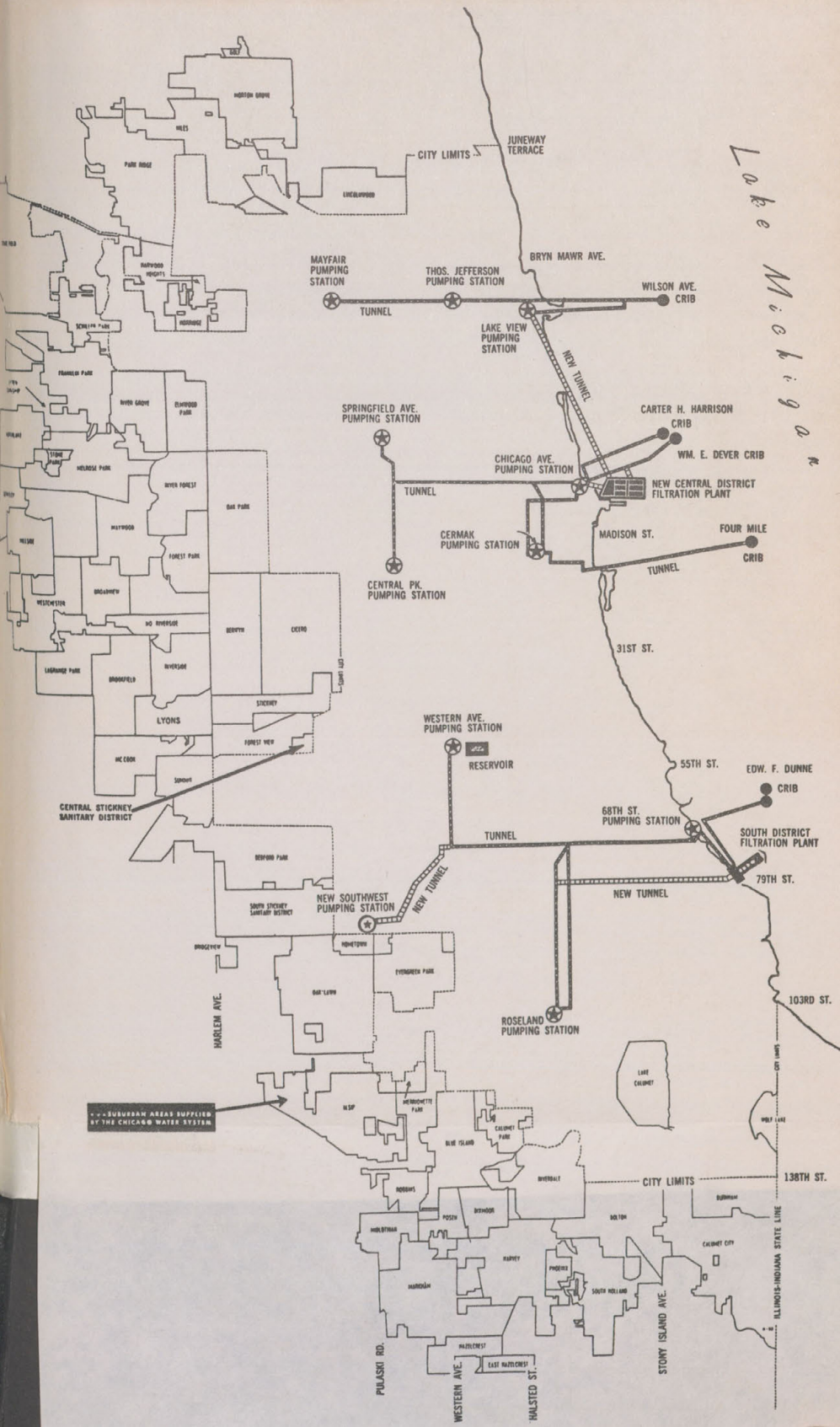
ILLINOIS ... NO. 719
admitted in evidence Dec. 12, 1962
Special Master




Revised Nov 1960
Revised Nov 30 1962

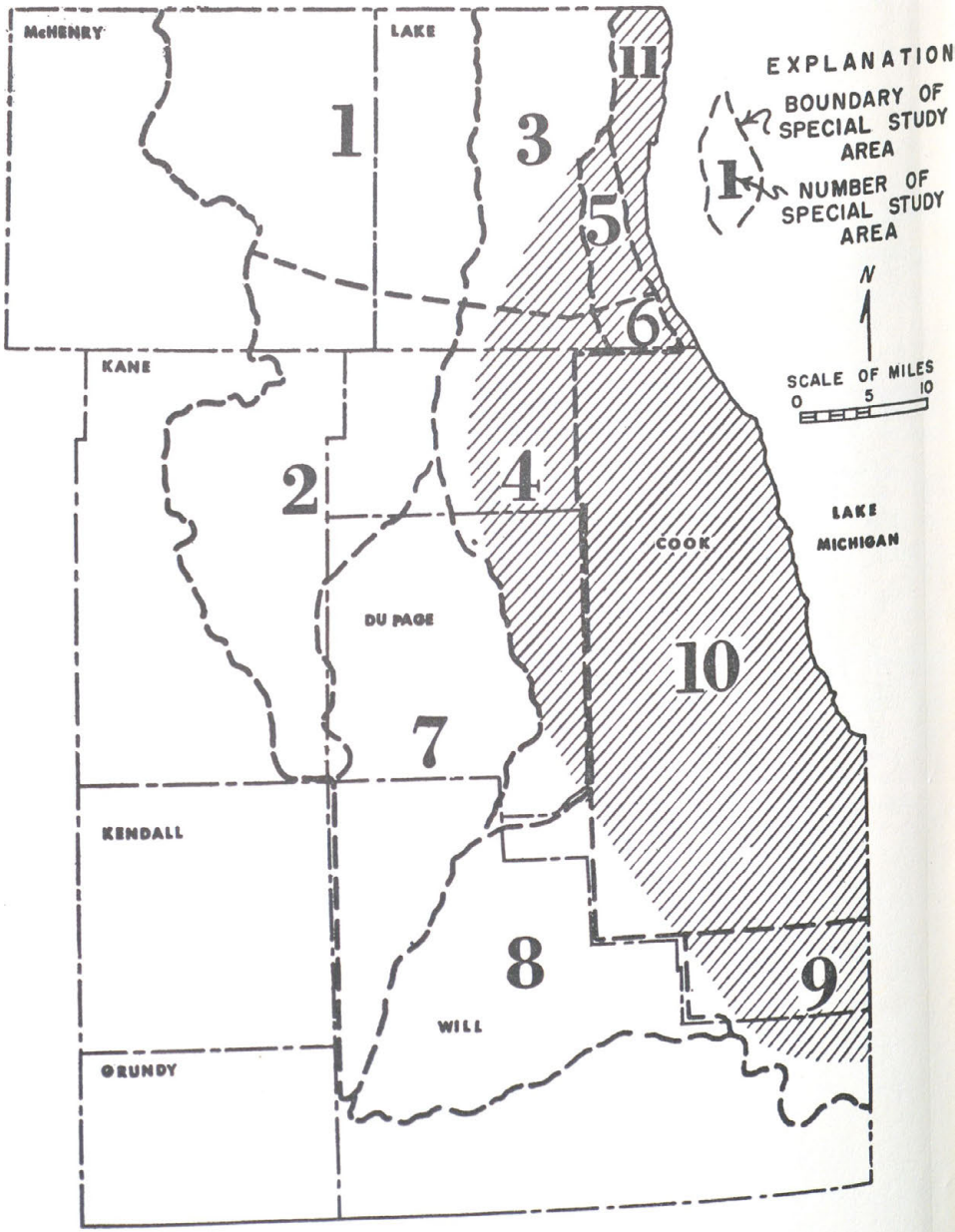
# Ill. Ex. 618, p. 17

## Map, Chicago Water System



## Ill. Ex. 654

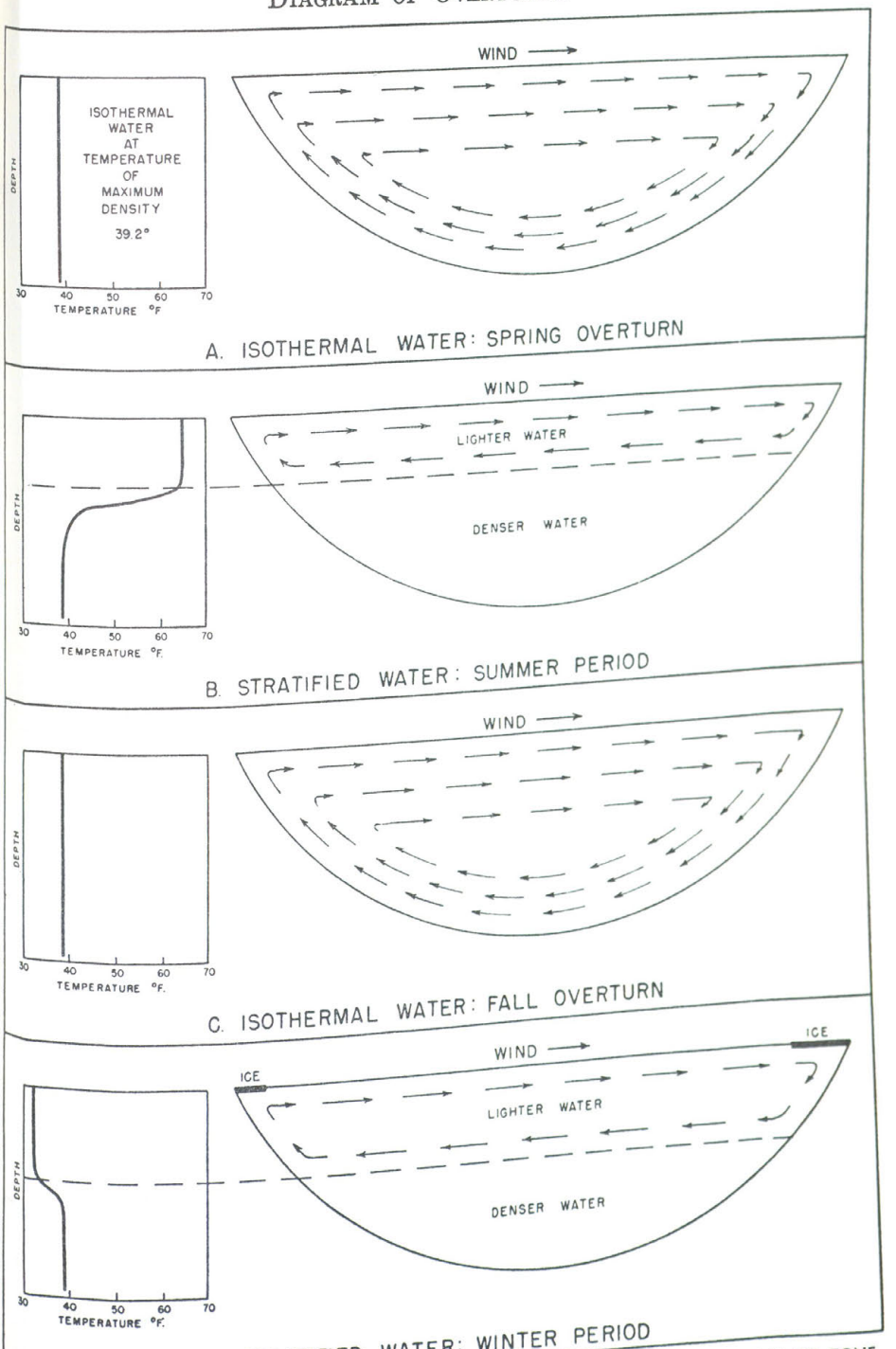
### Map, Study Areas, Northeastern Illinois Metropolitan Region




Special Study Areas in the Chicago Region

# Ill. Ex. 649

## Diagram of Overturns




TYPICAL ANNUAL CYCLE OF LARGE FRESHWATER LAKES OF THE NORTH TEMPERATE CLIMATE ZONE.

# U. S. Ex. 10C, Fig. II-2

MAP, SUBDRAINAGE AREAS OF ILLINOIS RIVER BASIN

## Ill. Ex. 500E

[WAR DEPARTMENT PERMIT, JUNE 26, 1930]

### WAR DEPARTMENT

NOTE.—It is to be understood that this instrument does not give any property rights either in real estate or material, or any exclusive privileges; and that it does not authorize any injury to private property or invasion of private rights, or any infringement of Federal, State, or local laws or regulations, nor does it obviate the necessity of obtaining *State assent* to the work authorized. It MERELY EXPRESSES THE ASSENT OF THE FEDERAL GOVERNMENT SO FAR AS CONCERNS THE PUBLIC RIGHTS OF NAVIGATION. (See *Cummings v. Chicago*, 188 U. S., 410.)

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### PERMIT

WHEREAS, By Section 10 of an act of Congress approved March 3, 1899, entitled "An Act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," it is provided that it shall not be lawful to build or commence the building of any wharf, pier, dolphin, boom, weir, breakwater, bulkhead, jetty, or other structures in any port, roadstead, haven, harbor, canal, navigable river, or other water of the United States, outside established harbor lines or where no harbor lines have been established, except on plans recommended by the Chief of Engineers and authorized by the Secretary of War; and it shall not be lawful to excavate or fill, or in any manner to alter or modify the course, location, condition or capacity of any port, roadstead, haven, harbor, canal, lake, harbor of refuge, or inclosure within the limits of any breakwater, or of the channel of any navigable water of the United States, unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of War prior to beginning the same;

AND WHEREAS, The SANITARY DISTRICT OF CHICAGO, ILLINOIS, was granted authority by the Secretary of War by an instrument dated December 31, 1929, to divert water through its main drainage canal and auxiliary channels from Lake Michigan, the said authority if not previously revoked or specifically extended to cease and be null and void on the effective date of the decree to be entered by the Supreme Court of the United States in the case of the State of Wisconsin, et al. versus the State of Illinois and Sanitary District of Chicago;

AND WHEREAS, On April 21, 1930, the Supreme Court of the United States entered a decree enjoining the State of Illinois and the Sanitary District of Chicago from diverting any of the waters of the Great Lakes—St. Lawrence System or Watershed excepting as specified in the said decree, a copy of which is hereto attached and made a part of this instrument;

AND WHEREAS, The said Sanitary District has applied for a continuation of authority to divert water from Lake Michigan;

NOW THEREFORE, this is to certify that upon the recommendation of the Chief of Engineers, the Secretary of War under the provisions of the aforesaid statute, and subject to the following conditions, hereby authorizes the said Sanitary District of Chicago to divert through its main drainage canal and auxiliary channels, waters from Lake Michigan, as specified in the said decree.

The conditions to which the said diversions shall be subject are as follows:

1. That there shall be no unreasonable interference with navigation by the work herein authorized.

2. That if inspections or any other operations by the United States are necessary in the interests of navigation, all expenses connected therewith shall be borne by the permittee.

3. That no attempt shall be made by the said permittee to forbid the full and free use by the public of any navigable waters of the United States.

4. That action taken by the said Sanitary District for the reduction of sewage discharge into the said Chicago River shall be under the supervision of the United States District Engineer at Chicago, and the said diversion of water from Lake Michigan hereby authorized, shall also be under his supervision, and under his direct control in times of flood on the Illinois and Des Plaines rivers.

5. That this permit is revocable at the will of the Secretary of War, and is subject to such action as may be taken by Congress. ———————————————————

Witness my hand this—25th—day of—June —, 1930.

/s/ LYTLE BROWN,
*Major General,*
*Chief of Engineers.*

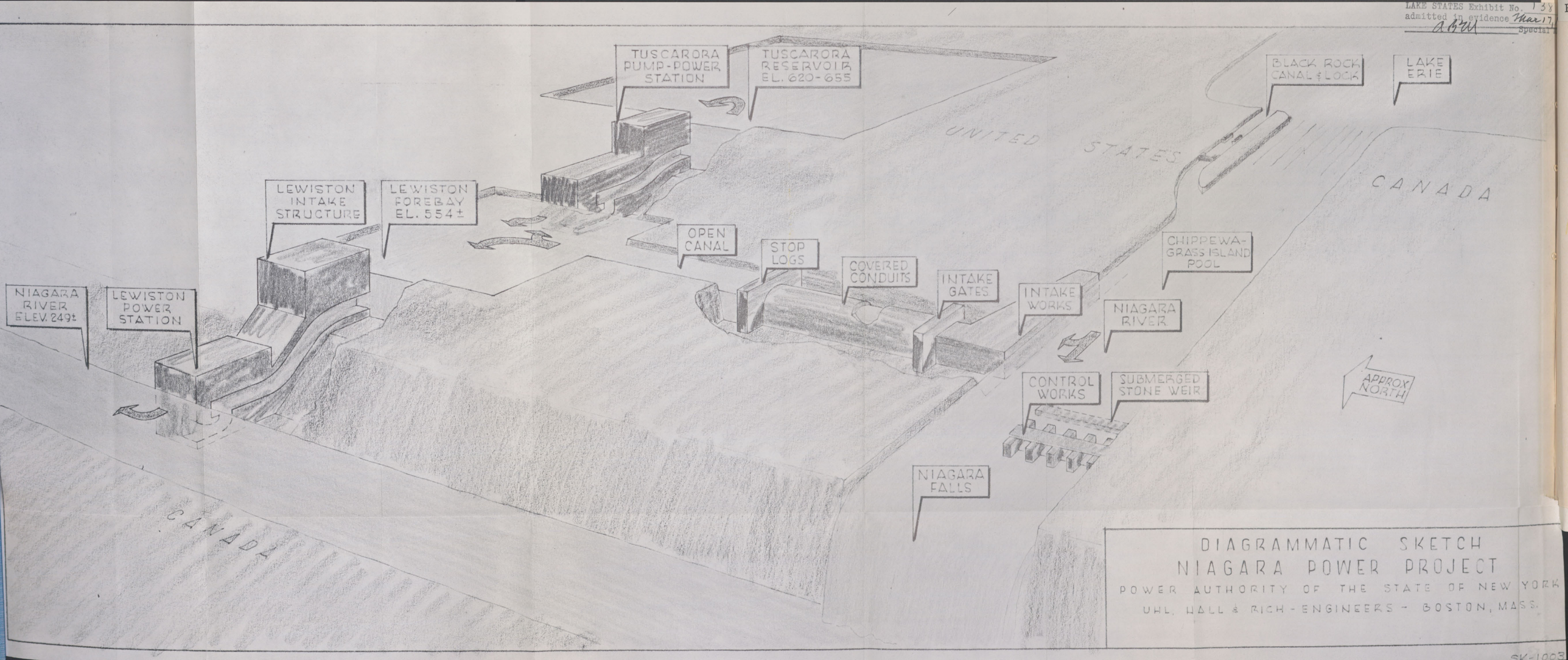
Witness my hand this 26th day of—June—, 1930.

/s/ PATRICK J. HURLEY
*Secretary of War.*

# L. S. Ex. 138

SCHEMATIC DRAWING OF NIAGARA POWER PLANT

LAKE STATES Exhibit No. 138
admitted in evidence Mar 17
Special




# DIAGRAMMATIC SKETCH
# NIAGARA POWER PROJECT

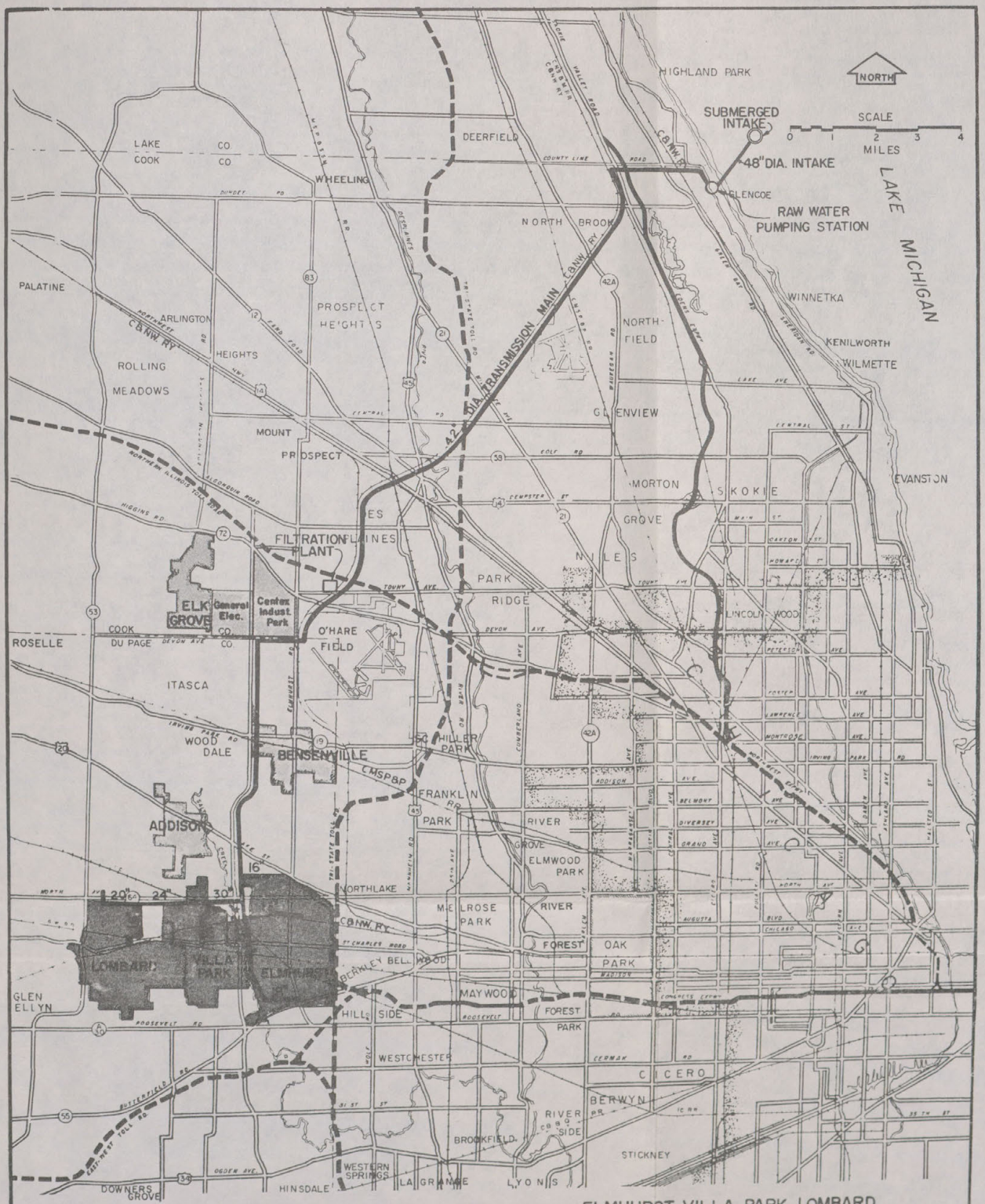
POWER AUTHORITY OF THE STATE OF NEW YORK

UHL, HALL & RICH - ENGINEERS - BOSTON, MASS.

SK-1003

## Ill. Ex. 7

GENERAL LOCATION MAP
ELMHURST—VILLA PARK—LOMBARD WATER COMMISSION




ELMHURST, VILLA PARK, LOMBARD
WATER COMMISSION

# GENERAL LOCATION MAP

LEGEND

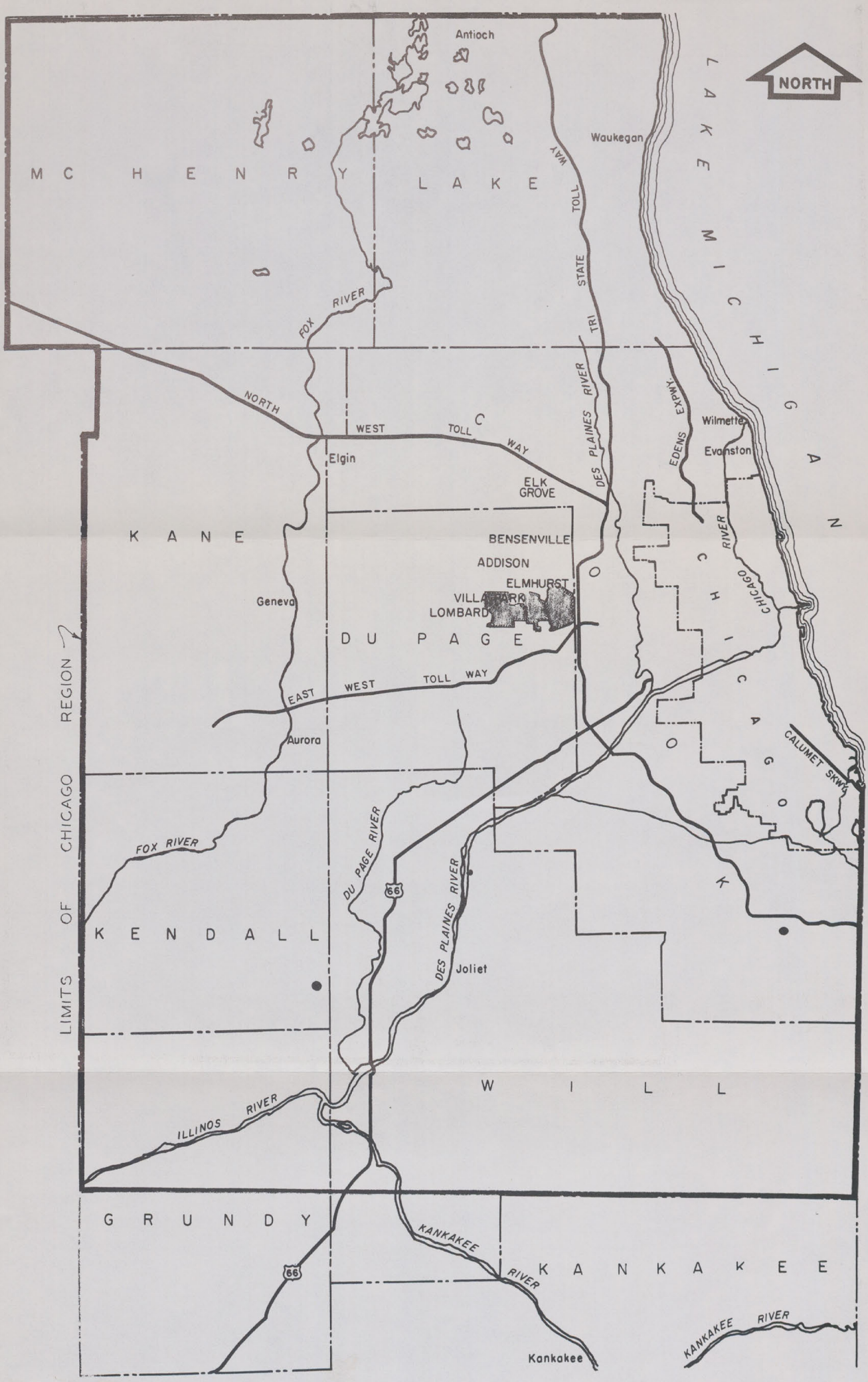
- WATER COMMISSION MEMBERS
- WATER COMMISSION CUSTOMERS

DE LEUW, CATHER & COMPANY  CONSOER TOWNSEND & ASSOCIATES

Consulting Engineers - Chicago

## Ill. Ex. 8

GENERAL MAP, CHICAGO REGION




ILLINOIS Exhibit No. 8
admitted in evidence Oct 21, 1959
Special Master

ELMHURST, VILLA PARK, LOMBARD
WATER COMMISSION

# GENERAL MAP CHICAGO REGION

DE LEUW, CATHER & COMPANY CONSOER TOWNSEND & ASSOCIATES
Consulting Engineers — Chicago