REPORT

GREAT LAKES BASIN FRAMEWORK STUDY

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Great Lakes Basin Framework Study

REPORT

prepared by

GREAT LAKES BASIN COMMISSION

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The *Report* of the *Great Lakes Basin Framework Study* was prepared by the Great Lakes Basin Commission. The recommendations of the Great Lakes Basin Commission are included in this volume.

OUTLINE

(Sponsoring agency for each appendix is listed after the appendix title.)

SPECIAL ACKNOWLEDGMENT

The Commission member agencies, non-member agencies, private individuals, institutions, and organizations that contributed their labor and support to the completion of the Great Lakes Basin Framework Study are too numerous to list without risk of inadvertently omitting some.

The cost of publishing the appendixes was met in part by funds from some of the Federal agencies that sponsored the various appendixes. The remaining funds for printing the study were to be obtained through the Great Lakes Basin Commission budget.

However, during the 7½ year period of study, the cost of publishing more than doubled. Without additional funds some of the volumes might not have been published in their entirety nor made available to the public at reasonable cost. Some sponsoring agencies provided additional funds for printing appendixes: the Department of Agriculture provided additional funds for Appendix 13, *Land Use and Management*, Appendix 15, *Irrigation*, Appendix 16, *Drainage*, and Appendix 18, *Erosion and Sedimentation*; the Environmental Protection Agency provided additional funds for Appendix 6, *Water Supply*, Appendix 7, *Water Quality*, and Appendix 23, *Health Aspects*. The Department of Transportation, which had not sponsored an appendix, provided funds for publishing Appendix C9, *Commercial Navigation*.

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INTRODUCTION

The *Great Lakes Basin Framework Study* was begun in 1967 to develop an information base and to prepare components for a future comprehensive, coordinated, joint plan (CCJP). This plan will guide the conservation, use, and development of water and land resources in the Great Lakes area through the year 2020.

The Water Resources Council's July 22, 1970, policy statement (presented below) explains that the purpose of a Level A framework study is to make a general survey of resources, identify problems, and determine future needs. This Level A framework study for the Great Lakes Basin encompasses a large geographic area and is conducted on a very broad basis to evaluate the needs of the Region's people. It does not include detailed data collection or planning. Detailed study of and planning for problem areas identified in the Level A Framework Study are carried out in further studies called Level B and Level C studies.

Laws and Policies Underlying the Framework Study

Excerpts from Public Law 89–80 and from a Water Resources Council policy statement issued in July, 1970, are reproduced here. These excerpts are the basis for the Framework Study. The terms defined in these excerpts, such as "Comprehensive Coordinated Joint Plan (CCJP)," "Level A Study," "Level B Study," and "Level C Study," must be understood to comprehend the relationship of the Framework Study to other planning efforts.

Public Law 89–80. Duties of the Commissions, Sec. 204 (Excerpt)

Each river basin commission shall—

. . . (3) submit to the [U.S. Water Resources] Council for transmission to the President and by him to the Congress, and the Governors and the legislatures of the participating States a comprehensive, coordinated, joint plan, or any major portion thereof or necessary revisions thereof, for water and related land resources development in the area, river basin, or group of river basins for which such commission was established.

(4) submit to the Council at the time of submitting such plan, any recommendations it may have for continuing the functions of the commission and for implementing the plan, including means of keeping the plan up to date.

A Policy Statement, Water and Related Resources Planning, U.S. Water Resources Council, Washington, D.C. July 22, 1970 (Excerpt)

. . . II. Objectives of Planning

Broadly, the objectives are to provide a guide for Federal, State and local interests to conserve, develop and utilize their water and related land resources in an efficient and timely manner. Further, such planning should provide a sound basis for rational, well considered decisions among alternative or competing uses of these resources . . . .

III. Planning Method

. . . The method described herein continues implementation of directions to the Water Resources Council in the Water Resources Planning Act (P.L. 89–80) through the preparation of plans for major regions of the country; maintaining a continuing study and preparing a framework or an assessment of the adequacy of supplies of water necessary to meet the water requirements in each water resource region; maintaining a continuing study of the relation of regional or river basin plans and programs to the requirements of large regions of the Nation. . . .

A. Framework Studies and Assessments [Level A Studies]

Framework studies and assessments are merged into the first and broadest level planning. They are the evaluation or appraisal on a broad basis of the needs and desires of people for the conservation, development and utilization of water and related land resources, and will identify regions (hydrologic, political, economic, etc.) with complex problems which require more detailed investigations and analyses, and may recommend specific implementation plans and programs in areas not requiring further study. They will consider Federal, State and local means and will be multiobjective in nature. These studies will not involve basic data collection, cost estimating, or detailed plan formulation. . . .

B. Regional or River Basin Plans [Level B Studies]

A regional (political, economic, etc.) or river basin plan (hydrologic region) is a preliminary or reconnaissance level water and related land plan for a selected area. These are prepared to resolve complex long-range problems identified by framework studies and the National Assessment and will therefore vary widely in scope and detail; will focus on middle term (15 to 25 years) needs and desires; will involve Federal, State and local interests in plan development; and will identify and recommend action plans and programs to be pursued by individual Federal, State and local entities.

They will be programmed only where problems are interdisciplinary and of such complexity that an intermediate planning step is needed between framework and implementation level studies.

Regional or river basin plans may be developed through Federal-State water and related land studies involving interested State and Federal agencies and through cooperative, comprehensive studies between individual State and Federal agencies. Such plans will be prepared by River Basin Commissions in their areas of jurisdiction. The size and limits of the region will depend on such considerations as the interrelationship of problems, and the possibilities for effective plan implementation. Appropriate regions include river basins, subbasins; one or more States or political subdivisions thereof; economic regions; demographically significant areas; etc. . . .

C. Implementation Studies [Level C Studies]

Implementation studies are program or project feasibility studies generally undertaken by a single Federal, State or local entity for the purpose of authorization or development of plan implementation. These studies are conducted under normal Federal, State or local agency responsibilities and authorities, and implement findings, conclusions and recommendations of assessments and regional plans found needed in the next 10 to 15 years.

Implementation studies encompass the broad spectrum from preservation to full development, and lead to administrative, legal, or other non-development action programs, to structural meeting of needs and desires, and combinations thereof. . . .

General Information Concerning This Study

The Framework Study *Report*, 25 appendix volumes and an environmental impact statement, present a portion of the Great Lakes Basin Commission's work toward guiding conservation, use, and development of water and land resources in the Great Lakes area through the year 2020.

Based on available information, the volumes of the Framework Study contain descriptive materials, both tabular and textual, on what the problems are, what solutions should be explored, and what kinds of development the residents of the Great Lakes area prefer. These volumes identify and rank the sections of the Basin that have special problems requiring closer scrutiny both now and in the future. In addition, they give the estimated costs of dealing with resource problems and recommend courses of action that should be taken to ensure wise use of the resources.

Twenty-four of the 25 appendixes to this report contain data and information on specific resource uses and types of problems. Each of these appendixes deals with one area such as economics, demography, water supply, flood plains, commercial navigation, and shore use and erosion. These appendixes were used in the plan formulation process that culminated in Appendix 1, *Alternative Frameworks.*

The frameworks described in Appendix 1 contain projections of resource use rates that are likely to occur and describe resource management practices that will be necessary under either of two conditions:

(1) Normal—based on furthering national economic development consistent with trends that occurred in the Great Lakes area through 1970

(2) Proposed—based on choices regarding encouraging or discouraging development, or maintaining development, as requested by residents in various parts of the Basin.

The Proposed Framework is that determined by the members of the Great Lakes Basin Commission through their assessment and through public interactions to be the best course for attaining and maintaining the Basin's economic and environmental health. The members include the States of Illinois, Indiana, Michigan, Minnesota, Ohio, New York, Wisconsin, and the Commonwealth of Pennsylvania. Federal members are the U.S. Departments of Agriculture; Army; Commerce; Health, Education and Welfare; Housing and Urban Development; Interior; Justice; State; and Transportation; the Environmental Protection Agency; the Energy Research and Development Administration; and the Federal Power Commission. The Great Lakes Commission, an interstate organization, is also represented. Canadian representatives participate as observers. If adopted, the Proposed Framework will serve as a guide for planning future development and growth in the Basin. It remains for Commission members and the public to provide or withhold government and private funds to ensure eventual wise implementation under the guideline.

This report is organized so that conclusions and recommendations of the study are presented first (Section 1). Following in order are study methodology and assumptions (Section 2), physical and demographic data and resource problem information for reader reference (Section 3), information on the Proposed Framework and projected costs (Section 4), and a discussion of benefits that may accrue from coordinating effective Great Lakes water and land resource plans (Section 5).

In addition to the 25 appendixes, an environmental impact statement prepared in response to interpretations of the National Environmental Policy Act of 1969, Public Law 91–190, completes the set of volumes associated with this report. The environmental impacts associated with the programs addressed in the Framework Study are presented in the environmental impact statement. The environmental impacts associated with each project under those programs are to be analyzed in accordance with legal requirements by prospective implementers before specific decisions are made regarding these projects.

When the term "Basin" is used without qualification in this report, it refers to the geographic area within the jurisdiction of the Great Lakes Basin Commission. This area includes the United States portion of the Great Lakes drainage basin and the basins of streams draining into the St. Lawrence River to the point where it ceases to be the international boundary (Figure 1).

The hydrologic basins, the drainage areas of the five Great Lakes, are referred to individually as Lake basins. Of necessity, however, much of the

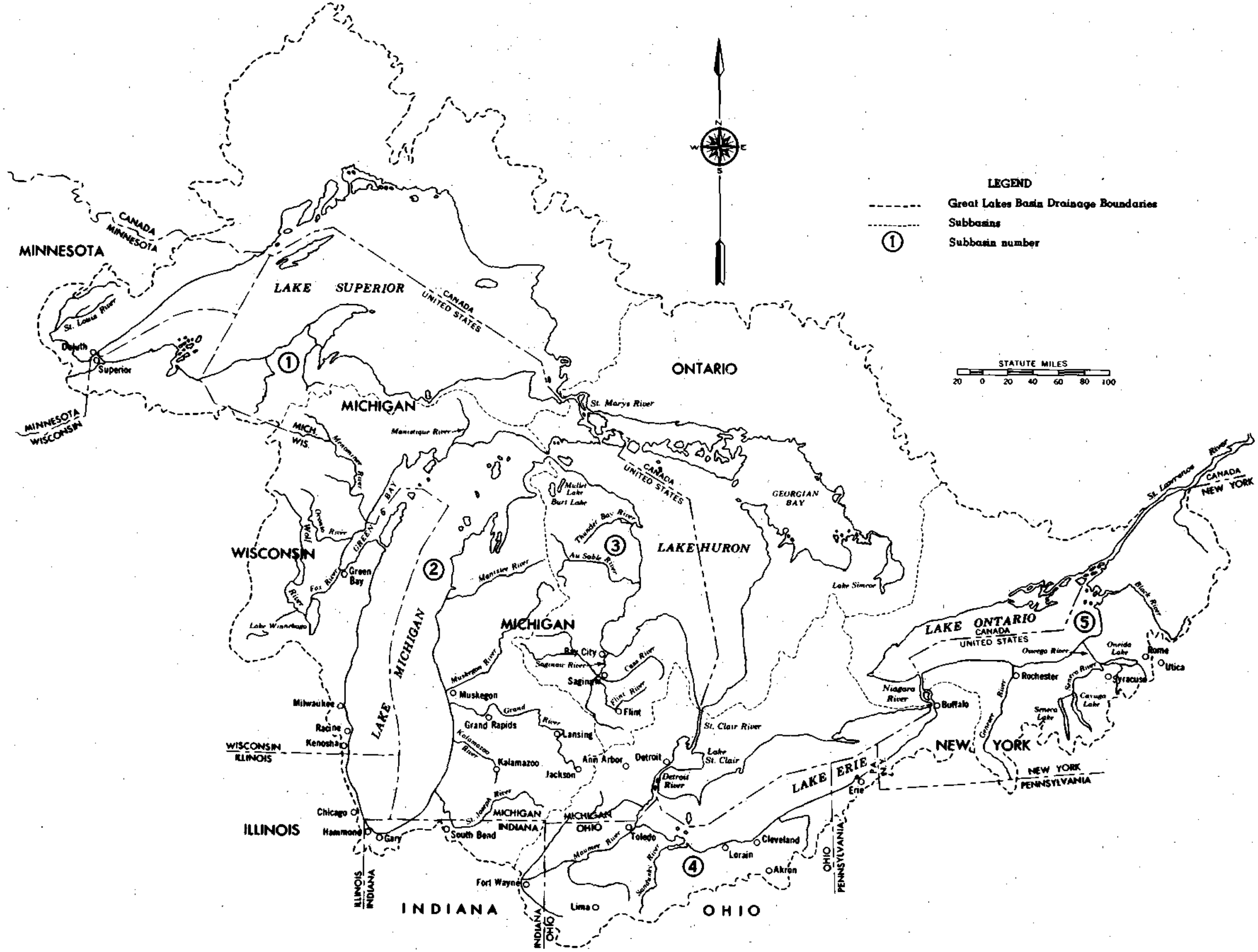


FIGURE 1 Great Lakes Basin Subbasins

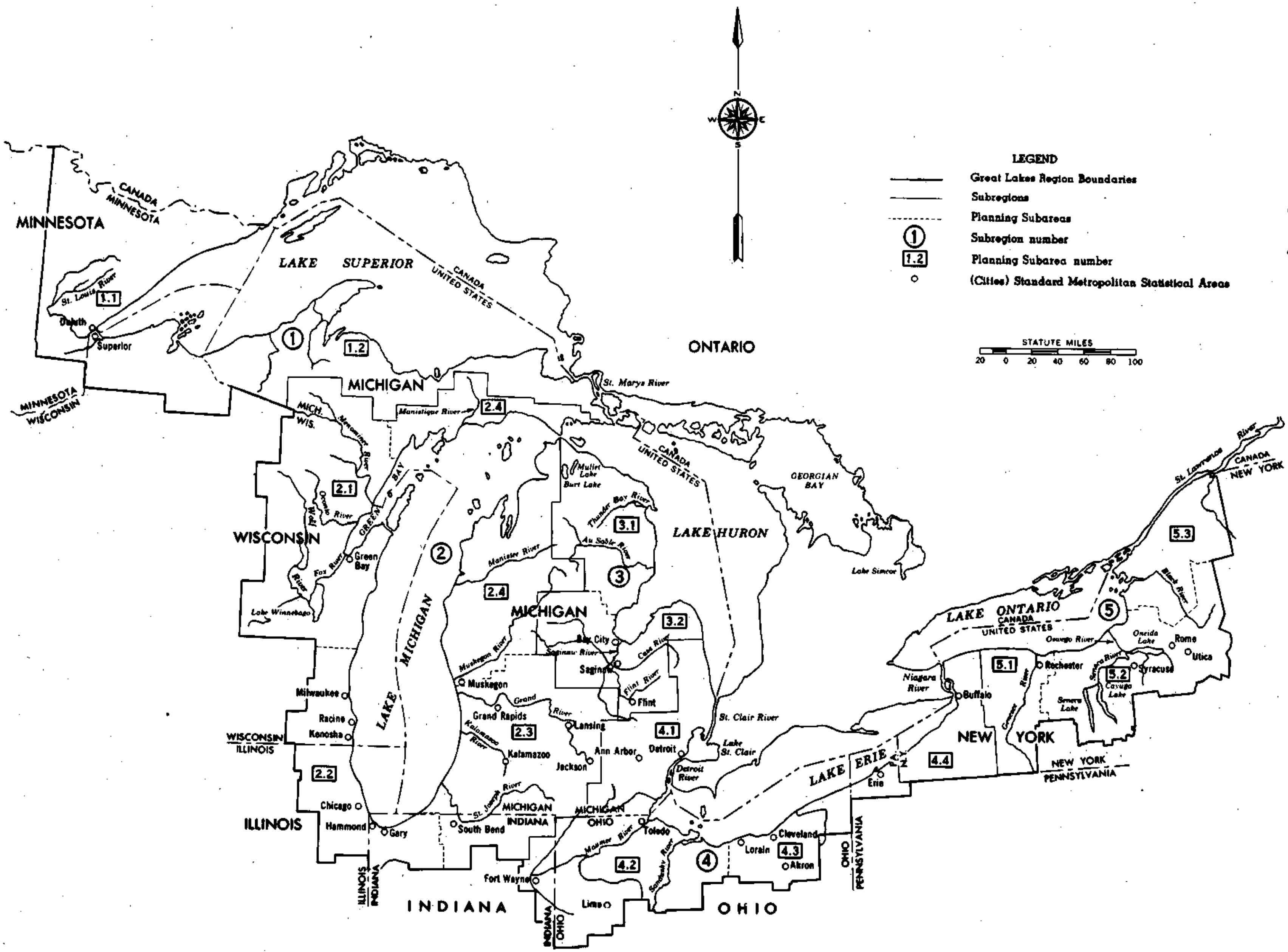


FIGURE 2 Great Lakes Region Planning Subareas

information in this report was collected according to county or political boundaries rather than hydrologic basins, so the term "Great Lakes Region" is used to denote the political area that approximates the Basin (Figure 2). The five Lake basins have regional counterparts, known here as plan areas (subregions). The plan areas are further divided into planning subareas. For convenience in referring to them, the five Lake basins and five plan areas are numbered similarly from west to east in the direction of flow: 1, Superior; 2, Michigan; 3, Huron; 4, Erie; and 5, Ontario.

Section 1

RECOMMENDATIONS AND THEIR IMPLEMENTATION

Recommendations

The Great Lakes Basin Commission recommends to the President and the Congress and to the Governors and the Legislatures of the participating States that they support the following actions proposed to ensure the conservation and wise use of water and related land resources in the Basin.

These recommendations include those (I) concerning the Great Lakes Basin Proposed Framework, (II) proposed for action under the auspices of the Great Lakes Basin Commission, and (III) concerning specific resource subjects.

It is the Commission's intention that the agencies normally responsible for specific actions contained in the recommendations will take the lead in the implementation thereof.

I. Recommendation Concerning the Great Lakes Basin Proposed Framework

Follow the Proposed Framework as an initial guide to the development of the water and related land resources of the Basin.

The Proposed Framework encompasses the features believed necessary to develop the water and related land resources of the Basin in an optimum manner. It builds on the situation which existed in 1970, the base year. Costs were estimated for most of the elements and indicate a capital investment of $25 billion, about one-half of which is Federal (Table 1), and an expenditure for operation, maintenance, and replacement of $47 billion, about 80 percent of which is public non-Federal (Table 2), in the 50 years from 1970 to 2020. This translates into a per capita capital cost of $30 in the early 1970s and $8.50 in 2020 and an operation, maintenance, and replacement cost of $16 in the early 1970s and $30 in 2020. In view of the central importance of a high level of water quality to the future of the Basin, the water quality management program represents the largest single investment at $10 billion, or 40%, for municipal wastewater treatment facilities in order to meet the requirements of P.L. 92–500, the Federal Water Pollution Control Act as amended. Nearly one-half of this expenditure is in the first 10 years, to build new facilities and bring existing facilities up to current standards. This results in the high per capita costs shown for the early period.

Within the concept of the Proposed Framework, the following specific recommendations are adopted as initial action items of the Comprehensive Coordinated Joint Plan for Great Lakes Basin. The recommendations of the Proposed Framework are subject to change during the development of the CCJP.

II. Recommendations Concerning the U.S. Great Lakes Basin for Action under the Auspices of the Great Lakes Basin Commission

A. Accelerate the development of the next portion of the Comprehensive Coordinated Joint Plan to ensure its completion by 1980 through (1) utilizing to the maximum practicable extent national assessments of water problems and needs, and other Federal, State, interstate, regional, local, and non-governmental plans in a continuous planning process, and (2) adequately funding more detailed studies conducted by the Commission, including the following in order of recommended priority for Federal funding and early action by the Commission:

	Studies	Cost ($1,000)	Start (F.Y.)	Length (Years)
(1)	Fox-Wolf River Basin Level B Study	830	1977	2
(2)	Great Lakes Regional Water and Energy Study	875	1978	2
(3)	Great Lakes Environmental Planning Study	2,100	1978	3

B. Coordinate and support expanded data collection and research programs necessary for improved management of the water and related land resources of the Basin.

C. Foster and support a comprehensive study of transportation needs and opportunities in the Great Lakes Basin and their implication for water resources in the Great Lakes Basin.

D. Foster or undertake appropriate additional studies to provide the details necessary for development of the Comprehensive Coordinated Joint Plan, and for authorization and construction of projects.

TABLE 1 Identified Proposed Framework Capital Costs, Great Lakes Basin, ($1,000,000) (1970 Prices)[1]

RESOURCE USE CATEGORY[2]	1971-1980				1981-2000				2001-2020				
	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	125.6	293.0	0	418.6	204.0	476.0	0	680.0	274.8	641.1	0	915.9	2014.5
SELF-SUPPLIED INDUSTRIAL	0	0	57.5	57.5	0	0	232.7	232.7	0	0	391.5	391.5	681.7
RURAL DOMESTIC & LIVESTOCK	0.3	0	2.3	2.6	0.5	0	4.1	4.6	0.4	0	3.4	3.8	11.0
IRRIGATION	0	0	20.1	20.1	0	0	17.0	17.0	0	0	21.4	21.4	58.5
MINING	0	0	6.2	6.2	0	0	11.6	11.6	0	0	20.7	20.7	38.5
THERMAL POWER COOLING[3]	0	14.4	272.7	287.1	0	54.2	1032.1	1086.3	0	101.1	1921.4	2022.5	3395.9
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES[4]	3588.0	1196.0	0	4784.0	2186.2	728.8	0	2915.0	1970.2	656.8	0	2627.0	10326.0
SPORT FISHING	26.7	45.3	0	72.0	19.1	22.1	0	41.2	28.6	33.7	0	62.3	175.5
RECREATIONAL BOATING	95.4	95.4	81.2	272.0	142.8	142.9	122.3	408.0	122.0	121.9	104.5	348.4	1028.4
COMMERCIAL NAVIGATION	295.6	0	0	295.6	1386.6	0	0	1386.6	0	0	0	0	1682.2
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	40.9	0	105.3	146.2	76.9	0	197.6	274.5	46.7	0	120.0	166.7	587.4
-CROPLAND DRAINAGE	36.2	0	84.4	120.6	60.8	0	141.9	202.7	39.0	0	91.0	130.0	453.3
FOREST LAND-TREATMENT	150.4	9.4	28.2	188.0	301.6	18.9	56.5	377.0	300.0	18.8	56.2	375.0	940.0
SHORELAND EROSION	5.7	0	22.1	27.8	9.2	0	36.7	45.9	9.2	0	36.8	46.0	119.7
STREAMBANK EROSION	5.3	0	13.9	19.2	16.3	0	41.4	57.7	26.9	0	69.4	96.3	173.2
FLOOD PLAINS-URBAN[5]	410.7	0	136.7	547.4	297.3	0	98.8	396.1	84.8	0	28.4	113.2	1056.7
WILDLIFE MANAGEMENT	12.1	109.1	0	121.2	22.5	202.1	0	224.6	21.2	190.7	0	211.9	557.7
OUTDOOR RECREATION-INTENSIVE	252.8	469.6	0	722.4	297.0	551.5	0	848.5	253.9	471.5	0	725.4	2296.3
TOTAL	5045.7	2232.2	830.6	8108.5	5020.8	2196.5	1992.7	9210.0	3177.7	2235.6	2864.7	8278.0	25596.5

[1] Some of these costs are presently being incurred through expenditures for programs now underway; notably the programs for water quality management accelerated under P.L. 92-500. The Federal obligations for this purpose in FY 1974 were estimated to be $488 million.

[2] Costs were not estimated for all the elements considered and evaluated in the Framework. The text should be consulted for details.

[3] Water withdrawal costs only. Does not include secondary cooling facilities, etc.

[4] Does not include private costs for industry treatment of water for reuse or discharge.

[5] Some of these costs are associated with alleviating rural flood damages; however these are a relatively small part of the total cost, and the basic cost data did not permit distinguishing between urban and rural.

TABLE 2 Identified Proposed Framework Operation, Maintenance, and Replacement Costs, Great Lakes Basin, ($1,000,000) (1970 Prices)[1]

RESOURCE USE CATEGORY	1971-1980				1981-2000				2001-2020				
	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	0	192.0	0	192.0	0	1,224.3	0	1,224.3	0	2,713.9	0	2,713.9	4,130.2
SELF–SUPPLIED INDUSTRIAL	0	0	53.5	53.5	0	0	704.7	704.7	0	0	2,015.3	2,015.3	2,773.5
RURAL DOMESTIC & LIVESTOCK	0	0	8.3	8.3	0	0	56.9	56.9	0	0	103.9	103.9	169.1
IRRIGATION	0	0	2.9	2.9	0	0	16.3	16.3	0	0	26.6	26.6	45.8
MINING	0	0	7.8	7.8	0	0	61.4	61.4	0	0	139.2	139.2	208.4
THERMAL POWER COOLING	0	3.7	70.1	73.8	0	42.1	800.6	842.7	0	121.6	2,309.8	2,431.4	3,347.9
NON–WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	0	4,108.7	0	4,108.7	0	9,955.0	0	9,955.0	0	16,223.9	0	16,223.9	30,287.6
SPORT FISHING	9.4	12.6	0	22.0	21.0	33.2	0	54.2	29.0	42.4	0	71.4	147.6
RECREATIONAL BOATING	0	0	62.9	62.9	0	0	432.0	432.0	0	0	772.5	772.5	1,267.4
COMMERCIAL NAVIGATION	36.0	0	0	36.0	438.2	0	0	438.2	732.4	0	0	732.4	1,206.6
RELATED LAND USES & PROBLEMS													
AGRIC. LAND–TREATMENT	0	0	3.4	3.4	0	0	31.9	31.9	0	0	50.7	50.7	86.0
–CROPLAND DRAINAGE	0	0	3.1	3.1	0	0	25.2	25.2	0	0	38.7	38.7	67.0
FOREST LAND–TREATMENT	0.5	1.0	3.3	4.8	4.3	8.6	30.1	43.0	7.0	14.1	49.3	70.4	118.2
SHORELAND EROSION	0.5	0	2.2	2.7	4.0	0	16.3	20.3	7.8	0	31.0	38.8	61.8
STREAMBANK EROSION	0	0	1.8	1.8	0	0	17.8	17.8	0	0	49.8	49.8	69.4
FLOOD PLAINS–URBAN	0.1	1.1	0	1.2	0.5	8.9	0	9.4	0.6	11.6	0	12.2	22.8
WILDLIFE MANAGEMENT	0	6.0	0	6.0	0	11.2	0	11.2	0	11.2	0	11.2	28.4
OUTDOOR RECREATION–INTENSIVE	29.5	117.7	0	147.2	203.3	813.1	0	1,016.4	357.6	1,429.4	0	1,787.0	2,950.6
TOTAL	76.0	4,442.8	219.3	4,738.1	671.3	12,096.4	2,193.2	14,960.9	1,134.4	20,568.1	5,586.8	27,289.3	46,988.3

[1] These costs include the operation, maintenance, and replacement costs of plant constructed by the capital costs shown in Table 1. They do not include OM&R costs of existing facilities, for example the present navigation facilities, or for facilities for which capital costs were not estimated.

III. Recommendations Concerning Specific Resource Subjects

A. Energy

(1) Support studies by State and Federal agencies and other power interests of hydroelectric power projects and other alternative sources of energy, including their economic, environmental, and social impacts and costs.

(2) Develop policies to reduce energy problems through proper management of water and related land resources, including the early accomplishment of the Great Lakes Regional Water and Energy Study (recommendation II.A.2.).

(3) Foster energy conservation as a basic policy for the reduction of energy problems.

B. Navigation

(1) Continue the Great Lakes-St. Lawrence Seaway Navigation Season Extension Demonstration Project until the technical, economic, and environmental feasibility, or lack thereof, of season extension, has been determined for all parts of the system, and investigate related programs having significant impacts on navigation.

(2) Modify and deepen navigation harbors, consistent with findings of need and with the current 27-foot depth navigation system, considering environmental quality and economic efficiency.

C. Lake Levels

(1) Foster or undertake Great Lakes level studies and lake level control studies through the International Joint Commission, giving emphasis to State and local involvement and considering benefits, costs, and environmental effects of: (a) the proposed plan to regulate Lakes Superior, Erie, and Ontario (SEO-17P) employing existing works and additional controlled outflow capacity provided through the Black Rock Canal to the Niagara River, using a new objective for regulating the levels of Lake Superior; (b) constraints on lake regulation downstream from Lake Ontario in the St. Lawrence River; and (c) alternative means by which such constraints can be met or modified.

D. Mineral Deposits

(1) Determine locations, extents, and values of mineral deposits in the Basin. These determinations are especially important in areas of rapid growth where access to essential minerals may be lost, recovery of mineral deposits impeded, or implementation of community plans later encumbered by higher priority need for minerals.

(2) Identify locations, extents, and values of mineral deposits in the beds of the Great Lakes in States where approval has been granted.

(3) Support reclamation of mined lands to abate pollution from them and to provide the opportunity for as many varied future land uses as possible. High priority consideration should be given to the opportunities of using mined lands for future recreation and open space use.

E. Coastal Zone Management

(1) Continue studies for coastal zone management, implement suitable management programs, and coordinate activities of an interstate nature within the context of Federal and State laws.

F. Recreation

(1) Give high priority to development of land-based, water-oriented outdoor recreation facilities in and near large urban concentrations.

(2) Encourage additional public access to private land for recreational purposes, especially in the southern half of the Basin, through incentive programs, education of users and private landowners, and other methods.

(3) Provide recreational boating harbors and harbors of refuge where determined necessary and agreed to in the Great Lakes.

(4) Encourage development of public facilities for recreation by demonstrating the potential for recreation and fishing. To support such development, foster one or more Federally funded research and development projects on small watersheds in or near urban areas where water quality conditions are being restored.

G. Water Quality

(1) Continue to implement the planning and management aspects of the water pollution control program for meeting the goals of and standards developed pursuant to the Federal Water Pollution Control Act as amended in 1972 and the Great Lakes Water Quality Agreement.

(2) Maintain: (a) a level of Federal and State funding for construction grants for wastewater

treatment facilities adequate to meet national and international commitments, and (b) assurances of funding continuity.

(3) Foster methods of reducing non-point source pollution. This includes increased support for development and implementation of areawide waste treatment management plans (Section 208 of P.L. 92–500).

(4) Accelerate those aspects of implementation of P.L. 92–500, in addition to those above, and State programs which facilitate the improvement of the quality of water of the Great Lakes. This includes additional funding for research, demonstration, water quality surveillance and monitoring, implementation, and legislative amendments.

(5) Undertake the Great Lakes Environmental Planning Study, recommended in the preceding section II.A.3., to provide for a major study of water quality aspects in the Great Lakes.

(6) Foster studies of environmentally hazardous substances such as organic contaminants, mercury, and other heavy metals, to assess their effects and persistence and to determine methods of eliminating their introduction and reducing their concentration in the lakes.

(7) Support legislation for immediate ban of non-essential uses of polychlorinated biphenyls (PCBs), and a complete ban as soon as substitutes for essential uses are found.

H. Waste Management

(1) Continue study of all aspects of waste disposal, including solid and liquid wastes, and accelerate studies on the recovery of useful materials therefrom.

I. Agricultural and Forest Land Treatment

(1) Complete or update detailed soil surveys within the U.S. Great Lakes Basin, particularly in the Lake Erie basin.

(2) Accelerate soil and water conservation treatment programs including those to reduce sedimentation for land now in agricultural use in the Lake Erie Basin and also in the northeastern Lake Michigan basin. These programs should include when appropriate Federal cost sharing and other incentives to private land owners.

(3) Accelerate forest land treatment programs to maintain high quality forest, sustain continuous timber production, continue multiple use, control surface and streambank erosion, and promote reforestation which will affect runoff, groundwater, organic loadings, and water temperatures, with emphasis in the northwestern and northeastern Lake Michigan basins, northern Lake Huron basin, and eastern Lake Ontario basin.

(4) Accelerate assistance to improve soil drainage of active cropland, consistent with preserving wetland, primarily in the Saginaw and Maumee basins and in the northwestern and southwestern Lake Michigan basins.

J. Fish and Wildlife

(1) Accelerate protection and management of all wetlands that are valuable for wildlife and fishery habitat and other unique and critical wildlife habitat in the Basin through appropriate State and Federal legislation.

(2) Expand wildlife management extension services, cost sharing, and other incentives to private landowners to encourage game habitat development and maintenance.

(3) Provide increased Federal and State support for fish population research, assessment, and analysis so that interstate and international Great Lakes programs will have a stronger data base for cooperative decisions on species introductions, fish stocking, available harvest, and commercial and sport fishery regulations.

(4) Insure that Great Lakes fishery management decisions are designed for maximum public benefit.

(5) Increase international efforts to develop comprehensive alternative programs of sea lamprey control to reduce dependence on the selective toxicant TFM as the primary control method in order that the value of the Great Lakes fishery (hundreds of millions of dollars in revenue annually) is not solely dependent on this control method.

(6) Support the formulation and implementation of an accelerated fish restocking program for the Great Lakes, closely coordinated among U.S. Federal and State agencies and with the Canadian government, to attain an optimum yield based on the productive capacity of the lakes.

(7) Continue Federal support of Great Lakes public access and harbor of refuge programs to provide access to the fishery resources.

K. Shoreline and Streambank Erosion

(1) Support the preparation of a cooperative assessment of shore damages due to high water levels of the 1970's, that will provide a base of information for evaluating the economic justification of damage reduction options.

(2) Continue study for early authorization of the breakwater at Presque Isle, Pennsylvania, recommended for beach protection by the Chief of Engineers.

(3) Support ongoing State and Federal shore erosion studies and coastal zone management programs that provide information on both structural and nonstructural methods of reducing shore erosion problems on the Great Lakes.

(4) Institute nonstructural methods of reducing shore erosion damage in undeveloped areas—e.g., zoning and setback requirements—until suitable methods for structural protection have been demonstrated.

(5) Develop a technical assistance program coordinated among appropriate agencies to stabilize severe streambank erosion areas.

L. Flooding

(1) Accelerate flood plain delineation and flood elevation determination studies in emerging urban areas.

(2) Institute flood damage reduction using both structural and nonstructural measures.

(3) Encourage nonstructural flood plain measures, such as purchase (including less than fee simple and purchase with lease backs) or zoning of shoreland and flood plain areas, as priority measures for resolution of flood problems whenever feasible.

Implementation

The implementation of the recommendations of this report will require deliberate effort at many levels of government and in the private sector, as well as the commitment of time, money, and other resources. Implementation will not occur automatically.

The framework is not a plan in the usual sense of the word. Rather, the framework is an outline of various kinds of programs which, if adopted, will lead to the conservation, development, and use of the water and related land resources of the Basin in a way that will meet the needs and desires of the people of the Basin, and at the same time supply those materials, products, and functions which the Great Lakes Basin can best provide for the nation. Therefore, implementation does not mean simply constructing a number of projects, passing a number of laws, or providing for the needs of people. It means exploring ways in which to build upon the general outline or framework; adopting programs out of which will come specific structures, projects, laws, and other devices for meeting the needs; conducting basic research to determine the effects of certain actions; collecting data to provide background information for research and planning; and planning locally in the degree of detail that will lead to the best use of resources in the locality.

The framework includes some structural and nonstructural measures. However, it recognizes that more detailed studies are needed, and that the suggestions of a particular program carries with it the reservation that additional planning may show some other alternative to be preferable. Recognizing these limitations, and with the understanding that conditions, attitudes, and future study results may change, the Great Lakes Basin Commission recommends in general that all necessary steps be taken to implement the structural and nonstructural programs in the framework during the periods indicated in Section 4.

Some of the studies will be undertaken by the Commission itself, coordinating work by Federal and State agencies. Others will be undertaken by the States with assistance from other agencies. Specific feasibility studies will be performed by the responsible agency, local, State, or Federal, or by industry.

The local unit of government may well be the critical element in implementation. This will vary somwhat by State. An aggressive city, county, or improvement district backed by an informed public will be most effective in accomplishing planning and completing projects.

Implementation of the framework programs may require changes in existing public law and policy. The historical patterns of funding limitations on research, data collection, planning, and implementation may have to change to meet the challenges the Framework Study has identified.

Data collection and analysis and research are generally the responsibility of specific Federal or State agencies, sometimes with local cooperation. The recommendations of this report include continuation and expansion of these activities, under the coordination of the Commission to ensure against deficiencies and unwarranted duplication. The Commission cannot itself undertake the work or finance it. The Commission can provide support and create a climate in which the public, through its legislators, will provide the authority and funds to get the job done.

Public acceptance of the Framework Study and the *Report* as a basis for cooperation and coordination, and public insistence on future construction, studies, legislation, research, and data collection are necessary to ensure that the study findings are used and the Recommendations are implemented.

The Framework Study is just the beginning of a continuous planning process designed to produce the Comprehensive Coordinated Joint Plan (CCJP). In addition to the more detailed studies (Level B and/or Level C) that are recommended in this report (Recommendation II, A, Section 1) and elsewhere, information obtained from the National Assessment and other elements of the CCJP will be used as appropriate to supersede the earlier data found in the Framework Study.

The CCJP was defined by the Basin Commission on February 26, 1975, as follows:

> The Comprehensive Coordinated Joint Plan (CCJP) is a specific document composed of elements approved and adopted by the Great Lakes Basin Commission, identifying those water and related structural and non-structural projects, programs, and other measures designed to enhance the economic, environmental, and social conditions of the area, and will include the Level A Study (Framework Study) and revisions through the National Assessments; Level B Studies and revisions to reflect changed conditions; and the results of appropriate Commission, Federal, State, regional, interstate, local, and non-governmental planning studies. The CCJP will be developed through a continuous, dynamic procedure, may be prepared in stages, and will be kept current.

Development of the CCJP will also include the participation of private economic, environmental, and social institutions, and individuals. Broad participation is essential to make the CCJP consider the needs and demands of the residents in the Great Lakes Basin and national goals and policies, and to effectively maintain its continued development and updating. Through the use of citizen advisory groups and other means, it is expected that wide public participation can be achieved.

So that the CCJP may fulfill its purpose of continuous planning for the future use of the Basin's resources, an evaluative methodology is being established for analyzing how well proposed plans, programs, and projects meet national goals and objectives and regional priorities. This methodology will determine the present situation, project future conditions, and recommend appropriate actions.

The methodology will include three major steps. The first step, or baseline, will be the synthesis of all available information from the Framework Study and other existing plans and programs, at all levels of detail, and will include a listing of all existing projects, ongoing nonstructural programs, and projects under construction by both the public and private sectors. Information gaps and problems or conflicting demands will be identified. This information will provide a basis for evaluating plans and proposed structural and nonstructural programs.

The second step, or direction for the future, will be an assessment of the direction in which Great Lakes Basin activities are likely to go in the future, and what procedural and data-related problems may occur. Possible alternative procedures and gaps in the data that should be filled by additional studies will be identified. The direction for the future will point the way to preserving and enhancing our resource capabilities.

The third or next step will be an assessment of proposed plans, projects, and programs in light of how well they meet the anticipated needs and problems determined by step two, and how well they coincide with national goals and objectives. From this assessment will come a concise statement of recommended short- and mid-term actions.

These three steps will be developed for each of the 15 river basin groups and interrelated with issues and problems throughout the Basin.

As the baseline information is utilized to assess the short- and long-term economic and environmental impacts of plans and proposed programs, a series of alternative futures will be developed. These alternatives will then be weighed against current national, regional, and local goals and objectives. This process will enable the decisionmaker to judiciously select or advocate a course of action with some understanding of the expected consequences.

As local projects are completed, they will be catalogued and stored in the baseline. Projects and programs having more widespread effects will be subject to Commission approval before inclusion in the baseline and designation as elements of the CCJP. In this manner, the baseline information will continue to be modified. Proposed programs will be analyzed and evaluated in relation to this changing baseline.

It is clear that the CCJP must constantly evolve because new information is always being acquired, planning is continuously taking place in one area or another, and national, State, and local priorities and goals change. The need for plan evolution is exemplified by energy concerns. Recently, energy resources and consumption have received national attention due to world events. Similarly, issues such as PCB and toxic metal pollution have received recent national attention due to our expanded knowledge of environmental impacts. Because of this changing state of national goals and priorities, the CCJP cannot be a fixed plan, but rather must be

Courtesy of National Aeronautics and Space Administration

Part of the Great Lakes Basin may be seen in this satellite photograph of northern Lake Michigan, eastern Lake Superior, and Lake Huron.

an evolving document that aids and encourages yearly analysis and evaluation of how the host of plans, programs, and projects under way in the Great Lakes Basin will meet national goals and priorities and how their cumulative effects may influence the water resources in the Great Lakes Basin.

In summary, the CCJP will provide for identification and analysis of alternatives and enable a wise choice of solutions. The CCJP will determine which of the multitude of programs being recommended by Federal, State, and local agencies meet the identified goals and objectives and national priorities and should be given top priority. The CCJP will provide the means for charting the current course and projecting where we are headed in the future, thus enabling us to conserve and protect water resources for future generations.

Section 2

METHODOLOGY: HOW THE STUDY WAS PERFORMED

The Framework Study

The Great Lakes Basin Commission began work on the *Great Lakes Basin Framework Study* shortly after the Commission was organized in 1967. Planning conferences in 1968 initiated the cooperative effort that continued through 1972. After that time the work largely entailed preparing the appendixes for publication, completing the plan formulation studies, compiling Appendix 1, *Alternative Frameworks*, and developing the *Report* and the *Environmental Impact Statement*.

The Framework Study is one of several studies begun in the United States during the 1960s in various regions to determine the adequacy of water supplies. These studies were also intended to define the steps that should be taken to ensure that water supplies and related land resources are available for use and that adjustments are made to keep growth within the capability of water and land to support such growth. The quality of water was considered in all questions regarding water supply and use. Finally, these studies provide overall information for assessing the water supply situation for the entire country.

The Basin Commission, acting through subcommittees and the Commission staff, coordinated the 7½ year effort. Funds were provided to the Federal agencies either through their own appropriation processes or through the Corps of Engineers and to the Basin Commission through the U.S. Water Resources Council. The States provided personnel specifically for the Framework Study and also provided available information. Commission staff activities were supported by Federal and State financing of the Great Lakes Basin Commission as provided for in the Water Resources Planning Act of 1965, P.L. 89–80.

Objectives

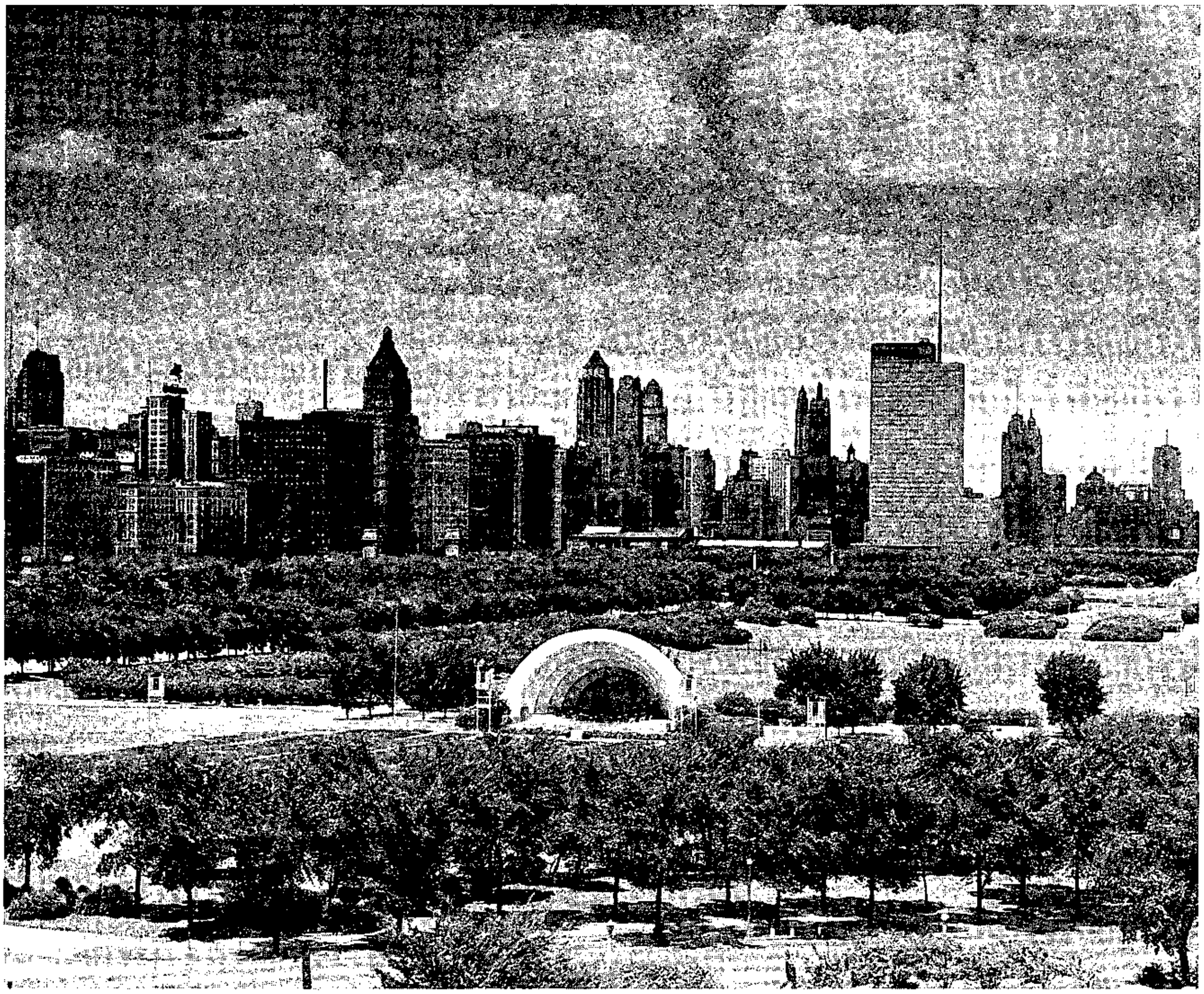
The purpose of the Framework Study was to develop a framework, a skeletal plan, that would outline how the needs for water can be met in the future. This framework would allow planning and development in the Great Lakes Region to move ahead with the assurance that no serious conflicts of use or water supply would develop.

To prepare the framework it was necessary to find out what the residents and governments of the Basin wanted. A wide range of views exists about what consitutes a high quality of life, and this makes it impossible to select a single objective for planning. However, the emphasis of the objectives influences the direction of planning for development, and thus the Framework Study is an example of multi-objective planning.

From time to time the U.S. Congress and U.S. Water Resources Council have suggested objectives for water resources planning. These objectives have varied. The desires of the public and the viewpoints of different levels of government influence the objectives and their relative importance.

The Framework Study was initiated under guidelines the Water Resources Council issued in October 1967. These guidelines did not define specific objectives, but they did implicitly require analysis under the national economic development objective. Section 201(b)(2) of P.L. 89–80 also provides, "That the plan shall include an evaluation of all reasonable alternative means of achieving optimum development of water and related land resources. . . ." During the course of the study, four objectives (national economic development, regional development, environmental quality, and social well-being) were proposed by the Council. Later, the national economic development and environmental quality objectives were included in the Principles and Standards of September 10, 1973, with the other two to be considered in analysis and formulation.

The national economic development objective (NED) aims to enhance national economic development and improve national economic efficiency. The objective assumes the continuation of past trends as modified by present conditions. Regional development (RD) occurs when a unit of government introduces forces—economic, financial, regulatory, or other—that increase the rate of local or regional development faster than the area's normal share of the national economy would warrant. Regional development is fostered by the Federal government when it is in the national interest to do so, as is the case with the economy of the upper Great Lakes area. Sometimes the regional development fostered by a State or local government is a deliberate



Source unknown

Waterfront park in Chicago, Illinois. A peaceful green park in the midst of urban development and activity adds to the social well-being of the Basin's citizens.

attempt to favor a smaller area that has assumed increasing importance.

The environmental quality objective (EQ) emphasizes the environmental aspects of proposals and assesses the desirability of an action in terms of its impacts upon the environment. The objective became increasingly important during the development of the Framework Study.

Social well-being (SWB) or quality of life is an overriding objective that influences the other three while retaining some characteristics of its own. Sometimes this objective is considered within, or as a mix of the other objectives. For example, safety measures preventing loss of life in time of flood are, for the most part, considered to be social well-being objectives.

These four objectives were taken into account as the study progressed. However, because objectives are used to guide the analysis of benefits and costs and because the Framework Study does not quantify benefits, it was impossible to rigorously consider the four objectives. As a result, the Commission decided to not make explicit evaluations of the way in which each objective might be met.

The normal growth objective, representing national economic development, was the basic objective considered. Projections made for the NED objective formed a baseline, and projections for extreme ranges of accelerated growth and limited growth, which have characteristics of regional development and environmental quality respectively, were compared with the baseline. The comparision led to acceptance of the NED projections, or baseline, for both the Normal and Proposed Frameworks, with programs for the latter selected to provide optimum quality of life, i.e., programs that tend to recognize different desired growth rates in various areas of the Basin.

The Proposed Framework recommended by the Commission is a modification of the Normal Framework. It recognizes some developmental and environmental effects and reflects certain costs of the accelerated and limited growth objectives.

While the Commission recognized that a rate of growth cannot be equated with environmental quality, this equation was implicit in the definition of the study, partly because lesser growth rates impose less stress on the resources and thus tend to preserve existing qualities.

Assumptions

The assumptions implicit in the general specifications adopted for all framework studies determined the scope of this study. However, in almost every stage of this study, it was necessary to make a number of additional assumptions, either with respect to data or to methodology. Some assumptions affecting only a limited subject area were made on an ad hoc basis. Those that affected the entire study were made after more extensive consideration.

The Data

The study is based almost exclusively on data either existing in 1968 or generated for other primary purposes during the Framework Study. No studies were undertaken to obtain new information. Although data were available from Federal and State agencies, much work had to be done to prepare the information for use.

To make the framework studies in various parts of the United States comparable, the U.S. Water Resources Council determined that similar projections should be used for each framework study. To establish these projections, the Council entered into a contract with the U.S. Department of Commerce, Office of Business Economics (later named the Bureau of Economic Analysis), and the U.S. Department of Agriculture, Economic Research Service. These two agencies prepared projections of various parameters for use in projecting water and related land requirements in the framework studies. Known as the OBERS projections, these projections were made on a national basis using the Bureau of Census Series C population and economic projections prepared in 1967. The projections were disaggregated to economic areas and water resource areas and finally compiled according to the planning subareas used in each framework study. For the *Great Lakes Basin Framework Study* there were 15 planning subareas, described later in this section. Because much of the Framework Study data was presented according to economic or political boundaries (PSAs), the public has been somewhat concerned about areas that fall into one hydrological region but are placed in another economic or demographic region (e.g. Niagara County, New York). However, framework formulation was based on river basin groups (hydrologic regions), and the reporting in Appendix 1 and the *Report* is on this basis.

During the 1960s, the OBERS Series C projections were considered the basic series for normal anticipated population growth in the United States. However, the 1970 population census revealed that because of a declining birth rate, there was disparity between the actual population count and the projected 1970 population. It appears that some lower population estimate, perhaps the Series E projections, may now be more appropriate. Nevertheless, the Series C was used in this study because of the low probability that the currently lower birthrate will continue to 2020. Furthermore, the difference is small between the two series in the early term forecasts for 1980 and 2000. Additionally, a basic planning goal is to anticipate when resources will be taxed to their limits. Because projections based on Series C indicate greater requirements, they provide timely warning.

Population relationships are shown in Table 3. It is apparent that the potential work force, measured by population over age 21, is only slightly less under Series E than under Series C projections up to year 2000. Because a large proportion of the work force for the year 2000 was already born in 1970, reduction in the growth rate will not have much effect on employment in the projected years.

Of the 22 resource uses considered (Section 4 tables), needs are based on population in seven instances, and reflect economic conditions in four others. In the case of the remaining eleven categories, the relationships to population or the economy are tenuous or slight.

Needs were fully met for three of the seven resource uses for which needs are related to population (municipal water supply, rural domestic and livestock water supply, and municipal waste treatment). Needs for these resource uses would be reduced if Series E population projections were used.

The other four resource uses for which needs are related to population (water-oriented outdoor recreation, sport fishing, recreational boating, and wildlife management) all have projected needs

TABLE 3 Comparison of Series E and Series C Population Projections

Year	Total Population 1972 E Series as a Percent of 1967 C Series	Population Age 21+ 1972 E Series as a Percent of 1967 C Series
1975	97.5	100.0
1980	95.3	100.0
1990	91.1	99.6
2000	85.9	94.7
2020	(74.4)	(83.8)

( ) indicate projection prepared for 1967 C Series by Bureau of Economic Analysis.

SOURCE: 1972 OBERS Projections, Series E Population, Vol. 1, U.S. Water Resources Council.

greater than can be met by the available resource. The magnitude of these implies that they could not have been met even under the reduced population projections.

Economic development projections influence the projection of needs in four cases, self-supplied industrial water supply, mining water supply, industrial waste treatment, and thermal power cooling water. In each of these cases other factors and assumptions have a greater influence on needs than do the economic projections. For the first three cases, the requirements of P.L. 92–500 caused sharp modifications of the assumptions used in the Framework Study. This law was passed after the base year of the study, and after the appendixes dealing with these resources had been completed, so its effects could not be considered when determining needs. In fact the magnitude of its influence is only now being assessed in connection with the National Assessment.

P.L. 92–500 has affected resource use because of its mandatory restrictions on pollutant discharges, and the high order of required waste treatment. To reduce pollutant discharges, many industries have improved their internal waste treatment to the point where water can be recycled after treatment. Many industries are redesigning their production processes to minimize effluent discharge by maximizing the reuse of water. The result in these industries is that requirements for new water input will decline and consumptive water use will increase. Although the law sets time limits on compliance, the actual rate of compliance is influenced by administrative studies, technological development, competition, the state of the economy, availability of funds for compliance, and public acceptance or rejection of the higher product prices. These factors can result in modifications of legislation, compliance orders, or enforcement.

Projections of water needed for thermal power plant cooling are subject to many assumptions regarding power plant siting, the mix of flow-through and supplemental cooling systems, and the types of supplemental cooling systems. The Framework Study was based on explicit cooling systems assumptions that future studies may modify if different decisions are made with respect to siting criteria, the local and lake-wide effects of thermal pollution, and the types of acceptable supplemental cooling.

Much concern has been expressed over the Framework Study projections regarding energy production. The projections were based on the most current available data in 1970 together with the judgment of energy planners.

Much has transpired in the energy field since the projections were made. The latest projection for energy production in the Great Lakes Basin for the year 2000 is 20 percent below that used in the Framework Study. The need for water and related land resources can be satisfied under the Framework Study power projections, so the lower projections indicate delaying the need for a period of years. To illustrate, if the power requirements grew at a 4.5 percent growth rate (the 1975 National Assessment Modified Central Case projection, which utilizes the Series E population projections and considers the effects of conservation) rather than the 5.4 percent used in the Framework Study, in the year 2020 the requirements would be about 65 percent of that projected in the Framework Study. However, within ten more years the requirements would be at the same level projected for 2020.

The exact amount of reduction in electric energy consumption through conservation can only be estimated. Assuming that the power requirements in the year 2000 would be reduced 35 percent through conservation efforts, this would only delay for ten years the time when the requirements would be the same as they were projected to be in 2000. Therefore, conservation, while desirable, would not solve the long-term problem of inadequate energy supplies, and additional power plants will be built as required to supply the needs of the Basin as they actually develop.

Water withdrawal projections used in the Framework Study vary from more recent projections that reflect greater water reuse, which is consistent with the higher water quality requirements of current law. An example of this problem is the projections as derived for the Commonwealth of Pennsylvania in their State Water Plan (Table 4). These projections are probably more accurate as they are based on more specific local assumptions.

The importance of updating information with more refined studies is implicit in the entire planning process. The Framework Study is only a first step based on information existing at the time of its compilation, and it presents projections on a con-

TABLE 4 Comparison of Proposed Framework and Pennsylvania State Water Plan (SWP) Water Withdrawals

Use Category[1]	1970 Supply PRO[1]	SWP	Diff.	1980 Needs PRO[1]	SWP	Diff.	1990 Needs SWP[2]	2000 Needs PRO[1]
Municipally supplied	55	47.6	7.3	8.3	0.8	7.5	4.09	24.7
Self-supplied industrial	35	36.1	1.1	17.0	-15.7	32.7	-16.8	68.0
Rural dom. & livestock	3	2.4	0.6	0	0.24	0.24	0.7	1.]
Irrigation	3.3	2.8	0.5	3.1	3.5	0.4	4.0	7.8
Mining	1.8	0.02	1.8	0.5	000.5	0.5	0.01	1.8
Thermal power cooling	144	127	17	0	0	0	0	0

[1]Table 81

[2]Incremental differences of total water use in each category

sistent basis for the entire Basin and for all purposes.

During the formulation of programs for this study, estimates prepared by the States and other agencies were examined, and in some cases were found to differ from those of the OBERS projections. Some were higher for certain years and other estimates indicated the States anticipated taking actions that would increase the population growth rate in particular areas over the long term.

When the 1970 census revealed the difference in the actual population and the OBERS projections, the Basin Commission analyzed the differences and their potential significance. OBERS Series C projections continued to be used for future years and as a basis for some 1970 estimates, but corrected data for 1970 were generally used.

Where practicable, resource use data were adjusted from the date of record to the year 1970, the base year for the study.

Constraints

The international character of the Great Lakes Basin makes it difficult for one country to plan for the effective use of the waters of the Basin. The Great Lakes Basin Commission minimized this problem as much as possible by establishing and maintaining informal contact with Canadian planners.

Although P.L. 89–80 and the Executive Orders that established the Commission restrict its jurisdiction to the U.S. portion of the Basin, they also provide for the exchange of information with Canadians through official channels. In addition, there was continuous informal discussion of matters relating to the problems of the Lakes.

An additional constraint prevented the Framework Study from planning or recommending diversions of waters into or out of the Great Lakes Basin (as restricted under P.L. 89–80). Existing diversions were recognized as part of the "existing situation." Also recognized were adjustments of uses within the limitation of 3,200 cubic feet per second total diversion in Illinois, prescribed by U.S. Supreme Court decree.

To some extent, the fact that no studies to acquire new information could be undertaken in the Framework Study posed a constraint on the consistency of the information. This relatively minor problem was overcome by adjusting information to a common base year, 1970.

Planning efforts previous to and during the Framework Study differed widely among the State and the Federal agencies. They did not have equal financing to carry out their work, nor were they likely to be equally affected by the outcome of the study. Consequently, the input to the study was not consistent for the entire Basin. Among the States there was great disparity in available personnel to work on the study.

Federal Legislative Changes During the Study

During the course of the study, there were changes in law, international agreements, institutional arrangements in State and Federal agencies, administrative policies, and public attitudes. While the Framework Study was being developed, more substantive legislation was passed involving water and related resources than ever before in the United States during the same number of years. Additionally, this legislation made more funds available for water and related land resources than ever before. Much of the legislation greatly affects Great Lakes Basin resources, but is not adequately reflected in the Framework Study. These recent legislative changes and their effects will be incorporated into the comprehensive coordinated joint plan.

The most important Federal legislation affecting Great Lakes Basin resources enacted between 1970 and 1976 is discussed below.

(1) Resource Recovery Act

In 1970, Congress passed the Resource Recovery Act (P.L. 91–512), which amended the Solid Waste Disposal Act of 1965 (42 U.S.C. 3251–3259, see *Great Lakes Basin Framework Study,* Appendix F20, *Federal Laws, Policies and Institutional Arrangements,* 1975, p. 37). The purpose of this act is to encourage and assist research, development, and adoption of new techniques of waste reuse and disposal. The amended act substantially increases the level of funding for these purposes. It authorizes grants and support for State and interstate waste disposal plans. After a State plan is approved by the Administrator of the Environmental Protection Agency, the State is eligible for grants for the construction of modern waste disposal facilities. Grants are also available for research and training projects.

The Administrator is to provide technical assistance by conducting studies relating to resource recovery from and disposal of solid wastes, by collecting and making available the results of research, and by cooperating with public and private agencies and organizations in the preparation and conduct of research and related activities. Also, the Administrator is to investigate how Federal participation can be more effective in dealing with the problems of solid waste.

Other provisions of the act require the Administrator to provide guidelines for solid waste recovery and disposal systems and recommend model ordinances and statutes. Additionally, the Administrator must submit a plan for the disposal of hazardous wastes.

(2) Great Lakes Water Quality Agreement

Although the Great Lakes Water Quality Agreement between the United States and Canada is not Federal legislation, it is included in this summary because of its significance for the Great Lakes area. The Agreement, signed on April 15, 1972, sets forth general and specific water quality objectives for the boundary waters of the Great Lakes system. In addition, it requires that all reasonable and practicable measures must be taken to maintain the water quality in those areas of boundary waters where the quality is presently better than the objectives require.

The parties committed themselves to seek funds and legislation to implement the Agreement and agreed that by December 31, 1975, the programs mentioned would be either completed or in the process of implementation. These programs involve municipal and industrial pollution; eutrophication; pollution from nonpoint sources, shipping, dredging, and onshore and offshore facilities; hazardous substances; and the continuance of a joint contingency plan to deal with a discharge of oil or hazardous polluting substances or the imminent threat of one.

Courtesy of Minnesota Department of Natural Resources

The Great Lakes Water Quality Agreement seeks to improve and maintain the quality of the Great Lakes boundary waters, shown here along the Lake Superior shoreline of Minnesota.

The parties to the treaty requested the International Joint Commission to study and report on the pollution of the Great Lakes system resulting from agriculture, forestry, and other land use activities and on actions needed to preserve and enhance the water quality of Lake Huron and Lake Superior.

(3) Federal Water Pollution Control Act Amendments of 1972

The Federal Water Pollution Control Act Amendments of October 1972 (P.L. 92–500) completely replaced the text of the original act (Appendix F20, pp. 24-31). The revised act sets a national goal that calls for the elimination of all discharges of pollutants by 1985 and improvement of water quality wherever possible to a level that protects fish, shellfish, and wildlife and permits recreational uses by 1983.

The basic mechanism of the act for implementing these goals is the establishment of a permit system administered by the Environmental Protection Agency regulating discharges of pollutants from point sources. States may assume the permit program upon showing that their program will comply.

Publicly owned treatment works must secure permits in order to discharge treated wastes. The effluent limits required of each plant are the more stringent of two alternatives: (1) meeting the stream water quality standards, or (2) providing secondary treatment by 1977. The best practicable wastewater treatment technology must be utilized by mid-1983. Point sources that discharge into publicly owned treatment plants do not need a permit, but are required to meet pretreatment and toxic discharge requirements.

Permits for industrial and other non-municipal sources set effluent limitations for particular dischargers. These are based on what is needed to achieve State water quality standards for ambient water and on national effluent standards, established primarily according to the availability of pollution control technology. The act requires the "best practicable" control technology to be in use by July 1977 and the "best available technology economically achievable" by July 1983. Dischargers of dredged or fill material must obtain a separate permit issued by the Army Corps of Engineers subject to EPA guidelines.

Other important provisions of the act include continuation of support for the construction of waste treatment plants at an increased funding level, allowing a maximum Federal contribution of 75 percent. Regulations relating to the discharge of oil are extended to hazardous substances; requirements concerning notice of discharges, liability, vessel financial responsibility, and equipment are thus applicable to hazardous substances as well as to oil discharges.

The act also provides for limited citizen suits, limits on the strictness of thermal discharge requirements, regulations requiring the use of marine sanitation devices, and limits on ocean dumping. Finally, the act provides for Federal support of various research and demonstration projects as well as Federal support of State water pollution control programs.

(4) Marine Protection Research and Sanctuaries Act

The Marine Protection Research and Sanctuaries Act (16 U.S.C. 1432–1434; 33 U.S.C. 1401–1444), commonly known as the Ocean Dumping Act, became law only a few days after the Federal Water Pollution Control Act. The first of this law's three major sections establishes a permit system to strictly limit dumping of harmful wastes into ocean waters, and does not directly concern the Great Lakes.

The second section directs the Department of Commerce to work with the Environmental Protection Agency on research on the effects of dumping of material into ocean waters or the Great Lakes or their connecting waters. The act also directs the Department of Commerce to assist research into methods to minimize or end all dumping by 1978.

The third section of the act establishes a marine sanctuaries program. Under this provision, the Secretary of Commerce may designate areas of the ocean waters as far seaward as the outer edge of the Continental Shelf, other coastal waters, or the Great Lakes and their connecting waters, as marine sanctuaries for the preservation or restoration of their conservational, recreational, ecological or aesthetic values.

(5) Coastal Zone Management Act

The Coastal Zone Management Act (16 U.S.C. 1451–1464) was also passed in October 1972. It encourages States bordering the oceans or the Great Lakes to develop and administer plans regulating public and private uses of land and water in their coastal regions. The Secretary of Commerce may make grants of two-thirds of the costs of these programs, but the Secretary must approve the final plans before the States can obtain Federal funds for administrative costs. To gain approval, programs must be consistent with any rules and regulations the Secretary promulgates pursuant to the act. In addition, the States must demonstrate that they will maintain control over the implementation of the project and that they have provided adequate enforcement mechanisms.

The act requires Federal agencies conducting activities or undertaking to develop projects in the coastal regions to act consistently with State programs to the "maximum extent practicable." Applicants for Federal licenses or permits for activities affecting land or water uses in a coastal area must provide a State certification that the activity will comply with the State program. Finally, State and local governments submitting applications for Federal assistance under other Federal programs affecting the coastal zone are required to indicate the views of the appropriate State or local agency as to the consistency of the proposal with the State coastal zone program. If the two are inconsistent, Federal agencies may not approve the proposal unless it is necessary for national security.

Like the Marine Protection Reseach and Sanctuaries Act, the Coastal Zone Management Act authorizes funds for the establishment of estuarine sanctuaries. Although some overlap exists between the two acts, they serve different functions. The first act is aimed at preservation and restoration, whereas the purpose of the Coastal Zone Management Act is to provide field laboratories for the study of natural processes.

(6) Flood Disaster Protection Act

The 1973 Flood Disaster Protection Act (42 U.S.C. 4001–4128) made significant changes in the National Flood Insurance Program (Appendix F20, pp. 21–22). Most importantly, the act withholds certain benefits from those who fail to participate in measures for prevention and mitigation of flood damage. First, State and local communities in flood-prone areas are required to participate in the flood insurance program and adopt effective flood plain ordinances as a condition of eligibility for Federal aid for acquisition or construction purposes. Also, property owners must obtain flood insurance in order to receive loans or grants from Federal agencies or Federally regulated lending institutions to buy, construct, or substantially improve buildings on land subject to flooding.

Increased insurance coverage is also available. The act increases the dollar amount of coverage available and broadens the definition of the word "flood" to include new risks. Protection is now provided for damage from mudslides and erosion under specified circumstances.

Finally, the act requires the Secretary of Housing and Urban Development to identify flood-prone areas and to disseminate this information to the communities in those areas.

(7) Water Resources Development Act

The Water Resources Development Act of 1974 (88 Stat. 49) requires Federal agencies to consider nonstructural alternatives in surveys, planning, or designs involving flood protection projects. Previously, the Federal government had relied primarily on constructing dams and levees to control flooding. Agencies must now examine alternatives such as floodproofing structures, flood plain regulations, acquisition of flood plain lands for recreation, fish and wildlife, and other public purposes, and relocation.

(8) Safe Drinking Water Act

The Safe Drinking Water Act (42 U.S.C. 300f–300J), signed December 1974, is directed at regulating the quality of water delivered by public water systems and applies to most commercial water systems. The Administrator of the Environmental Protection Agency is to establish standards specifying a maximum level for contaminants considered harmful to human health. He is to establish interim standards initially and final ones after the completion of a study conducted by the National Academy of Sciences. States can substitute their own enforcement programs if they adopt requirements at least as strict as the Federal requirements and demonstrate that they have adequate enforcement procedures.

The act has several other significant provisions. It requires water systems subject to the act to notify both consumers and news media when violations occur. Safeguards are also provided to protect underground drinking water sources from contamination. Finally, the act authorizes research, technical assistance, and financial grants to further its purposes.

Methodology and Study Organization

One of the features of framework studies is that they rely heavily on the judgment of experienced planners. This is especially true of the Great Lakes Basin Framework Study because of the size and complexity of the Basin. Analyses were made of data already available. No attempts were made to collect new data.

Addressing such a massive topic was made manageable by dividing the Basin into 22 data and resource use subjects and then assigning a work group to study each subject. Work group chairmen were selected on the basis of their knowledge of the subject and the support their employer agencies could give to the Framework Study. Other members of the work group were appointed by the various commissioners to provide balance.

For planning purposes the Basin was divided into 15 river basin groups (based on hydrologic boundaries) over which were superimposed 15 planning subareas (based on county boundaries). To study these subareas the work group used economic and demographic data determined by disaggregations from the OBERS projections furnished by the Water Resources Council and available information on the resource under study.

Using these data, each work group analyzed the magnitude and present use of the resource and projected the growth of use to the years 1980, 2000, and 2020. These resource use requirements were then translated into requirements for water and related land, and each work group studied the possibility of meeting these requirements. The results were compiled into a single-purpose appendix for each subject that addressed that basic data available, the methodology used in projecting the needs to the target years, and ways in which the needs could be met most satisfactorily. Only single uses of the resources were taken into account by the work groups, and the solutions the groups proposed were devised for single purposes. The work groups did, however, indicate alternative solutions that could be considered which might be more compatible with solutions for other functions. The work groups also provided information on both capital investment and annual operation and maintenance costs.

For certain of the subjects, the work groups compiled data on the total amount of the resource available for enhancement or treatment, and the requirement for the resource, or the opportunities for enhancement at the target years of the study (1980, 2000, 2020). The difference between the amount available at the base year and the amount required at a future year was generally a measure of the need to be met. This information became basic data for developing the frameworks, which identify solutions or methods by which water and related land could be provided and thus meet the needs.

The Commission established two subordinate groups to advise and guide the study. One was the Framework Study Executive Committee. Composed of commissioners, it addressed particular questions relevant to the Framework Study and made recommendations to the Commission for action. Another group was the Plan and Program Formulation Committee, made up of commissioners or their technical respresentatives. The committee was responsible for the development of the frameworks and acted as the top level technical review group for the Framework Study, making discretionary decisions or referring policy matters to the Commission. Some of the policy matters were referred in the form of specific issues on which decisions were made by the Commission, and others were stated as general questions, with the answers agreed to by consensus following discussion by the Commission.

To consider the interrelationships of all of the resource uses and the implications for water and land requirements, plan formulation task forces were established by the Plan and Program Formulation Committee. Each task force consisted of a chairman from the Commission staff and personnel from the State and Federal agencies. One task force was formed for each of the 15 river basin groups. Whereas the work groups each considered a single subject over the entire Great Lakes Basin, the task forces each considered all resource uses within their assigned subareas.

Each task force reviewed the work done by the work groups and initially considered their proposed solutions for meeting the needs for water and land. The task forces then looked at the other possible ways meeting water and land needs, including structural measures, nonstructural measures, educational procedures, legislative changes, and reduction of needs through more careful use of the resource. Finally, each task force prepared appropriate documents outlining its findings and incorporated those findings into tables of needs and outputs from the various solutions proposed. The first such series of programs for solutions, referred to as the Normal Framework, was based on meeting the national economic development objective.

Studies of limited development and accelerated development also were undertaken to discover the way in which the Basin might develop under various rates of growth. Although neither the extreme high nor the extreme low rates of growth were expected in the Basin during the planning period, these rates did provide limits for choice. Using the national economic objective and the Normal Framework, as well as the extreme high and low rates of population growth and economic development, projections were made of the requirements for a number of the resource use categories of the 15 river basin groups at the three time periods studied, 1980, 2000, and 2020.

Public Participation

Prior to the mid-1960s, most of the public had relatively little awareness of natural resource problems. The Framework Study was begun in 1968, prior to legal changes requiring public participation, such as the mandates for environmental impact statements. As public consciousness was raised, the Basin Commission responded. The number of organizations and associations involved in planning and the variety of relationships among them and the agencies of the State and Federal governments necessitated a flexible approach to public involvement. The large study area and the diversity of interests across the Basin made public involvement complex.

When framework formulation began early in the study, planners attempted to involve the public and local government officials. Some members of the public attended plan formulation meetings and reviewed draft copies of appendixes as they were written.

As the Framework Study progressed, public announcements and regular communication through the Commission's newsletter, the *Communicator*, kept the public informed. Also, a series of formal and informal workshops was held. General public and representatives of citizen groups were invited to the formal meetings, which were held in Green Bay, Wisconsin, January 10, 1970; Elkhart, Indiana, January 20, 1970; Fort Wayne, Indiana, May 12, 1970; Toledo, Ohio, July 8, 1970; and Duluth, Minnesota, September 17, 1971. Prior to each meeting the general public received advance notice and the media were advised. Following each meeting and several workshops, the Basin Commission planning staff analyzed the views presented by independent individuals and by representatives of groups and interests. These analyses were considered by the appropriate Plan Formulation Task Force.

In August 1971 the Commission issued an interim report on the Great Lakes Basin Framework Study, called *Challenges for the Future*. The interim report contained a questionnaire that asked about respondents and their views concerning growth and resource development, land and water

Great Lakes Basin Commission

The views of Basin residents were solicited during framework preparation.

resources, and pollution controls. Responses were received from some residents of all the Lake basins, providing planners with further indicators of public views.

In late 1972 the Commission held 15 public meetings across the Basin under the sponsorship of the States and, in some cases, with local cosponsorship of regional groups. Meeting sites were in Toledo and Cleveland, Ohio; Erie, Pennsylvania; Duluth, Minnesota; Marquette, Muskegon, Bay City, Port Huron, and Detroit, Michigan; Fort Wayne, Indiana; Milwaukee and Green Bay, Wisconsin; Chicago, Illinois; and Syracuse and Buffalo, New York.

To educate the public to encourage its constructive involvement in the meetings, booklets on water and land resource problems and their alternative solutions were published for each of the five Great Lakes areas. To facilitate reaching a larger segment of the public, planners and public information staff solicited the names of individuals interested in the resource subjects. The booklets were sent to more than 9,000 individuals, planners, technicians, elected and appointed officials, environmental organizations, news media, libraries, businesses, and industries.

The public meetings were led by Basin Commission Chairman, Frederick O. Rouse. The meeting programs permitted the planning staff to review the alternatives for the future with citizens and enabled citizens to present statements and to question planners and technical experts from State and Federal agencies.

Organization, scheduling, publicity, and publications were planned to involve the maximum number and widest variety of concerned citizens. Those who attended were sent meeting summaries and were surveyed by mail to learn whether they wished to become further involved in Great Lakes planning.

At each meeting the persons present were asked whether they preferred economic growth, environmental quality, or what degree of each in combination. Statements given at the meetings or received in the mail indicated a definite preference for environmental quality, but with a strong influential minority in some areas favoring development. Following the meetings, planners began incorporating

Photo by Mary Gretchen Zale, Great Lakes Basin Commission

Many citizens attended the public meetings and expressed their opinions and concerns.

public responses into the Proposed Framework, as recorded in Appendix 1, *Alternative Frameworks.*

Both before and after the above series of public meetings, the views of the State and local governments of the various areas were considered and reported to the Plan and Program Formulation Committee, which adopted criteria for the selection of a Proposed Framework. The Committee made no changes in the needs to be met because, at the time, there were insufficient differences in projections of population or economic activity to warrant such changes. However, the Committee selected those methods for meeting needs and solving problems that reflected to the extent practicable the individual desires in the local areas.

Proposed recommendations were drawn up, using technical information and advice obtained from the Commissioners and members of the Plan and Program Formulation Committee, and from work groups and task forces. When the Framework Study recommendations were compiled, public interest was such that it was thought that public comment on the contents of the recommendations would be instructive and beneficial. These proposed recommendations were presented to the public directly by mail, and to the press and news media, announcing another set of public meetings to gain citizen views. The public was also encouraged to comment on the recommendations by mail.

This series of 12 public meetings was held in January and February 1976 in six cities, with an afternoon and evening meeting in each location to provide scheduling that would assure convenience for attendees. The meeting programs were similar to those of the 1972 meetings, but the content was quite different. This time citizens commented on specific resources recommendations, some affecting only certain portions of the Great Lakes Basin. Other recommendations were for future actions and proposed studies to be performed by the Great Lakes Basin Commission and by others. Response of citizens was critically constructive. The public was alert to the need for certain conservation measures, such as energy conservation and regulatory action regarding use of PCBs. The Commission reviewed responses in a regular quarterly meeting and later as a committee of the whole and made considerable changes in the recommendations.

Public involvement with the Framework Study and with development of the comprehensive coordinated joint plan is expected to continue after submission of the study to the Water Resources Council, the President, and Congress. The Great Lakes Basin Commission is already planning the next step of the comprehensive coordinated joint plan, and is reviewing means to provide ample opportunity for continuing public involvement.

Problems, Requirements, Needs, Opportunities

Although the Great Lakes Basin's wealth of natural resources supports a population that enjoys an average income above the national average, there are still resource problems. Even though the Basin provides recreation for its own people as well as many from surrounding areas and contributes more than its share to the national economy, other resource requirements need attention. There are still both needs and opportunities to preserve resources, enhance the quality of life, and enhance the quality of the environment. The purpose of the Framework Study is to determine what these needs, opportunities, and problems are and how to deal with them.

Explanation of the Terms

(1) Need

A need exists when there is not enough developed resource for all the people who wish to use it. A need can be quantified, whether it exists now or is projected to exist at some future date, because it is perceived by the individual in terms of tangibles—food and drink, gasoline for the car, electric power, or a place to swim. In the Framework Study these tangible needs are translated into what constitutes an adequate supply of suitable water or land to provide them. In addition, however, there may also be a need to control the water to have it available at the right time and place, or to reduce damage from flooding and other causes.

If the requirement for a resource in a given year is greater than the supply (for example, if more persons would like to swim than can be accommodated by the facilities), there is a "need" that year. Conversely, if the supply is greater than the requirement, there is a surplus. Both situations can be stated in terms of a quantity of water or land or the number of persons using a facility.

(2) Opportunity

Like a need, an opportunity can also be stated as a quantity. The concept of opportunity can be applied to land that could be drained to make it more useful, an area that could be irrigated to make it more productive, or forest land that could be properly managed to produce a greater return, enhance the environment, or improve habitat. The quantified evaluations of needs and opportunities for the base year and the projected years are given in tables in Section 4 of this report.

(3) Problem

The term problem is much broader in scope than either need or opportunity. It may refer to needs. The water quality problem is reflected in the quantified need for waste treatment. It may also refer to conditions that could be improved by taking advantage of opportunities, or it may refer to situations where no quantification is possible, as in flooding. In some of these latter cases, the consequences of solving a problem may be numerically measurable. For example, the solution of a flooding problem results in reduction of flood area and damages. However, there are no numerically measurable consequences when one deals with the problem of protecting historic sites. The solution merely involves preserving the site for future use and enjoyment.

Some problems such as streambank erosion may not be correctable. In these cases the statement of the problem simply indicates a condition that may have ramifications elsewhere. Streambank erosion has a cost in terms of loss of land at the point of erosion, but it also often has an even greater cost resulting from sediment deposits downstream. It may not be possible to relate the cost of removing the sediment to the many points where the basic "problem" exists.

Not all needs are identified as being problems. A municipality may need a water supply to meet future requirements, but if the water is available nearby at reasonable cost, it is not identified as a problem. On the other hand, a conflict of land use between recreational purposes and commercial timber harvest is likely to be identified as a problem, even though no resource use category is shown to cover such a situation and no quantification of a need or opportunity is given.

Some problems are institutional. The appropriate control of land use through zoning or other means in the situation just cited is an institutional problem as are the arrangements for the control of air and water pollution. Either limited or unlimited access to certain restricted wildlife habitat may be an institutional problem, under some conditions.

General problems and major problems in each Lake basin are identified in this section. Section 4, Proposed Framework and Projected Costs, discusses programs developed to solve the problems.

Framework Program Options

The most important aspect of the Framework Study is the selection of programs to solve problems identified in the study. The solutions are designed to meet the needs for water and related land, while taking advantage of opportunities for enhancing environmental quality of the Great Lakes Basin. The suggested programs are not detailed plans but are general solutions capable of achieving the intended results with the help of further study, refinement, and selection among alternatives.

Program Alternatives

Some of the solutions involve structural changes, while others involve institutional or non-structural changes. Some solutions serve only a single purpose. Some of them can be considered independently, while others are closely interrelated and affect one another. Whatever their nature, they fit together in a framework of programs for dealing with a single set of needs, problems, and opportunities. The selection of these solutions and an arrangement of them into a series of programs in the framework is the central purpose of the Framework Study.

There may be more than one way to meet a need or solve a problem. For example, a municipality aware of projected increase in population or per capita use requiring an additional water supply may be able to meet this need by pumping from ground water, by diverting from a stream, by building a reservoir to capture flood flows, or by diverting from one of the Great Lakes. These are all structural solutions. It may also meet a significant portion of the need by controlling wastes, metering water supplies, or using other nonstructural measures that could promote a more efficient use of the existing supply.

The selection of solutions and programs for meeting the needs projected in this study was accomplished by the plan formulation task forces, largely on the basis of judgment. While most of the solutions were well known, standard lists of a wide range of program alternatives were generated and consulted to ensure that possibilities were not overlooked. These lists, initially containing 150 items, were screened as to their applicability in particular circumstances. For example, about 20 items were considered for providing water supply. Some of these were structural solutions for tapping nearby water sources or bringing water from a distance. Others had to do with increasing the amount of water obtained from an existing supply. Still others dealt with reducing the requirement for water, thereby decreasing the need. Some of the alternatives, such as public education to reduce the use of water, had almost universal application. Others were related to a specific industry, site, or water source. In many programs two or more solutions were included to supplement one another. Often structural and nonstructural techniques were combined.

Resource Use Categories

The resource uses considered in the Framework Study fall logically into three categories: water withdrawals, nonwithdrawal water uses, and related land uses. The elements in each category have common characteristics that facilitate orderly selection of framework programs.

Each use in the water withdrawal category depends on water being withdrawn from a source and put to that use. Normally, some of the water is returned to a source and can be reused. In some cases only a small amount of the water is returned, and in other cases nearly all of it is.

The second category, nonwithdrawal water uses, includes water for swimming, boating, fishing, and for the production of hydroelectric power. Also included in this category by definition is the treatment of wastewater to improve its quality and usefulness since water quality is most directly related to nonwithdrawal uses, although not a use in itself.

In the third category are the related land uses, including both the use of land as a resource and the protection of the land against loss or damage.

Solutions to Resource Use Problems

Most needs relating to water withdrawal are expected to be met by taking water from the Great Lakes, inland lakes and streams, or ground water, although in some cases, reservoir storage, either in-stream or off-stream, is provided. The choice among these several alternatives is usually influenced by the cost of withdrawing the water, transporting it to the place of use, and providing treatment necessary to make it suitable for the specific use. These choices may change with time. That is, at an early date a need may be met from a limited local source, whereas later with changed conditions the need may have to be met with a larger, more distant supply of water.

In addition to these simple and direct solutions, indirect solutions often provide at least part of the needed supply. For example, teaching urban dwellers to use less water may lead to reduction in the water supply to households and obviate withdrawing additional water. The introduction of meters may save a significant amount of water where the municipal supply has not been metered. Increased irrigation efficiency may result in additional land irrigated from a given supply. In general, these are less frequent solutions and their costs cannot be estimated as easily as the costs of providing additional withdrawal. But where they can be employed, they are less expensive and more desirable from the standpoint of conserving the resource.

The solutions adopted to meet the needs and solve the problems of nonwithdrawal water uses are more varied than those associated with water withdrawals, simply because nonwithdrawal water uses are more diverse. However, there is a fairly standard group of solutions, supplemented in specific instances by innovative practices. The treatment of municipal and industrial wastewater discharges generally requires a treatment plant (a structural solution), although increasing the efficiency of existing plants, process changes, and education will also help. Increased hydroelectric power production in the future in the Great Lakes Basin will probably involve construction of reservoirs, because the developments are expected to be pumped storage projects.

Additional water-oriented outdoor recreation can be provided largely by changing present land and water use and by multipurpose reservoir construction. Sport fishing can be enhanced by programs on the Great Lakes and inland lakes and streams, by

Courtesy of Wisconsin Department of Natural Resources

Forest management results in timber stands such as this on previously cleared land.

some reservoir construction, and by the acquisition of land for access points and recreational facilities. Recreational boating could be enhanced by providing additional surface area through reservoir construction. The reservoirs might be constructed primarily for recreational boating but they could serve several purposes. Single-purpose construction is seldom economically justified.

Many programs are available to solve land use problems. Agricultural land treatment, cropland drainage, and forest land treatment can all alleviate problems. Shoreline and streambank erosion could be controlled by primary reliance on structural measures including stream modification. However, flood damages could be reduced in a number of ways, such as storage of flood flows, flood proofing, reduction of number of buildings in the flood plain, stream modification, and onsite structural measures such as dikes.

Rearrangement of responsibilities among government institutions and actions by legislatures often can be used to prevent increases in future damages. Where institutional measures can accomplish the objective, they are preferred because the structural measures are generally more expensive and have greater impact on the environment.

Effective wildlife management depends largely on land management and treatment measures, but legislative and institutional arrangements, public acquisition of habitat, public access to private lands through private consent, and increasingly efficient use can have a more dramatic effect. Maintaining aesthetic and cultural features depends primarily upon public acquisition and increased emphasis on maintenance. The land required for outdoor recreation can be supplied in some instances by land use changes, but in many cases the land or the rights for its use must be acquired by public bodies for this specific purpose.

Selection of Frameworks

In this Framework Study, as in any such study, the selection of solutions, the combination of programs, and the organization of the framework were largely matters of judgment. These judgments were guided by studies of costs of the alternative solutions, potential benefits from adopting the solutions, effect on the environment, and the desires of the local people. Detailed cost and benefit calculations were not made. Instead, the experience and results of detailed work in other areas were used by the Great Lakes Basin Commission planning staff.

The process began with the work groups, whose suggested solutions for individual resource uses were correlated into the programs of a framework

TABLE 5 Costs Used in Framework Estimates and Allocations of Costs of Programs Among Federal, Non-Federal, and Private Sectors, (percent)

Resource Use Category	Capital Costs (dollars)	Annual OM&R Costs (dollars)	Capital FED	Capital NON FED	Capital PVT	OM&R FED	OM&R NON FED	OM&R PVT
WATER WITHDRAWALS								
Municipally Supplied	299,000/mgd	29,800/mgd	30	70	0	0	100	0
Self-Supplied Industrial	83,000/mgd	14,800/mgd	0	0	100	0	0	100
Rural Domestic and Livestock	71,000/mgd	14,600/mgd	10	0	90	0	0	100
Irrigation	22,600/mgd	600/mgd	0	0	100	0	0	100
Mining	66,400/mgd	11,900/mgd	0	0	100	0	0	100
Thermal Power Cooling	35,000/mgd	1,800/mgd	0	5	95	0	5	95
NON-WITHDRAWAL WATER USES								
Municipal Wastewater Discharges[2]			75	25	0	0	100	0
NOR Framework	lump sum estimate for RBG	variable by RBG	---	---	---	---	---	---
PRO Framework	$300 per capita	$10 per capita per year	---	---	---	---	---	---
Industrial Wastewater Discharges	lump sum estimate for RBG	variable by RBG	0	0	100	0	0	100
Hydroelectric Power	80-120/kw	variable/kw of installed capacity	---[3]	---	---	---[3]	---	---
Water-Oriented Outdoor Recreation	see below	--------	---	---	---	---	---	---
Sport Fishing	lump sum estimate for RBG	lump sum estimate for RBG	---[4]	---	---	---	---	---
Recreational Boating	lump sum estimate for RBG	lump sum estimate for RBG	35	35	30	0	0	100
Commercial Fishing	not estimated	--------	---	---	---	---	---	---
Commercial Navigation	lump sum estimate for RBG	lump sum estimate for RBG	100	0	0	100	0	0
RELATED LAND USE AND PROBLEMS								
Agricultural								
Land Treatment	lump sum estimate for RBG	.5% of total periodic capital cost	28	0	72	0	0	100
Cropland Drainage	lump sum estimate for RBG	.5% of total periodic capital cost	30	0	70	0	0	100
Forest Land Treatment	lump sum estimate for RBG	variable by RBG	80	5	15	10	20	70
Shoreland Erosion	lump sum estimate for RBG	2% of total periodic capital cost	20	0	80	20	0	80
Streambank Erosion	33,000/mile	2% of total periodic capital cost	28	0	72	0	0	100
Flood Plains	lump sum estimate for RBG	--------[5]	75	0	25	5	95	0
Wildlife Management	lump sum estimate for RBG	not available	10	90	0	0	100	0
Aesthetic and Cultural	not estimated	--------	---	---	---	---	---	---
Outdoor Recreation	lump sum estimate for RBG	lump sum estimate for RBG	35	65	0	20	80	0

[1]Costs presented are for surface water development only. Costs for ground-water development vary more widely over the Basin than do the costs for surface water development. The outside range for Capital Cost of wells is from $21,000 to $71,000 per mgd, and the range for pumping costs is from $8,000 to $117,000 per mgd. The average cost in unconsolidated aquifers is $32,000 Capital Cost for the wells and $30,000 for pumping per mgd. In bedrock aquifers the averages are $45,000 Capital Cost and $27,000 for pumping.

[2]Costs of NOR are based on applying unit treatment costs per mgd on a judgment basis for each RBG. The include only interceptors and treatment. Replacement is included with Capital Cost. Costs for PRO are based on population and are applied by RBGs. They cover all costs, including sewers, to which Federal grants are available, except separate storm waste control. Replacement is included with O&M.

[3]Either 100% State or 100% private. No Federal money.

[4]40% of sum of Capital plus OM&R is Federal, 60% is State. No private.

[5]Annual OM = 0.1% total Capital Cost for the period if such is greater than $1,400,000. If Capital Cost is less than $1,400,000, annual OM = 0.4% total Capital Cost.

by the plan formulation task forces (described in Methodology and Study Organization in Section 2). This process was conducted for each river basin group. For a number of the resource uses, the Commission established guidelines when Basinwide use of the Lakes was involved. Commercial navigation is an example. Policy decisions on issues guided plan formulation personnel. Commissioners gave guidance both in a formal manner and through informal discussion and consensus.

The process used by each plan formulation task force to develop a framework began with correlation of information from a great many sources. The second and third steps were to interpret the wishes of the local people and governmental agencies, and to select program elements. For each river basin group the quantified needs were compiled, and the suggestions of the work groups and the task force were analyzed and sifted to eliminate those not applicable. The extent to which each of the solutions could contribute to meeting needs or solving problems was estimated.

Single-purpose solutions were considered first. After the resource uses were considered and the solutions screened, it was sometimes apparent that some multipurpose solutions could be chosen. For example, a reservoir built to provide water supply might also be adapted to prevent a certain amount of flood damage or to provide a fishery or recreational boating. Similarly, a proposal to zone a flood plain against building encroachment might permit the development of the area for recreational purposes. When the full range of possible multipurpose solutions had been explored, the effectiveness of the program elements to meet needs was determined and summarized. The quantified needs met at each time period were obtained by adding the outputs of the program elements for the time period.

Occasionally, in the process of selecting from among alternative solutions, cost data were prepared to provide guidance. However, least cost, cost effectiveness, or cost-benefit considerations generally were not major factors in making selections. The principal determinations of cost were made following the development of the framework, when cost information, both capital cost and operation maintenance and replacement costs (OM&R), was calculated for all programs.

Framework Costs

Capital costs refer to first time costs, including installation and such related nonstructural program costs as technical and financial assistance. They were developed to include all appropriate components. The capital costs associated with each of the program elements differ according to resource use. (Resource use categories are shown in Table 5). Uniformity among the river basin groups was achieved by providing uniformly based cost data for each.

Similarly, annual OM&R costs were provided for the task forces. It should be noted that allowance for interest and amortization have not been included. Thus, the OM&R costs are not total annual costs. A summary of the capital cost and OM&R cost for each resource use category is shown in Table 5, as is the distribution of the capital and OM&R costs among Federal, public non-Federal, and private sectors.

The costs estimated in a framework study are not intended to be precise. However, they are an essential common denominator when comparing the Great Lakes Basin requirements with other areas, and in analyzing the water resources management programs from a national budgetary perspective. It is, therefore, necessary to adopt one framework for cost purposes, while recognizing that even though other solutions may prove more desirable over time, the costs will be of the same magnitude.

Section 3

THE GREAT LAKES REGION RESOURCES, POPULATION, ECONOMY

The land area of the entire Great Lakes Basin is approximately 4 percent of the land in the 48 contiguous United States, but it supports 14 percent of the population and contributes a much larger percentage of the country's economic activity. Half the steel-producing capacity of the nation and a large proportion of petroleum refining capacity and manufacturing facilities for chemicals and food products are located in the Basin. The Basin produces more than 90 percent of the nation's red tart cherries and 50 percent of dry edible beans. Table 6 compares the numbers of square miles of water surface and land surface among the Lake basins. Table 7 shows the summary of land and water area and present land use.

Physiography and Topography

The physiography and topography of the Great Lakes Basin are largely the result of glaciers advancing and retreating over many thousands of years. They scoured and gouged the land, leaving thick deposits of material over much of the Basin.

The Superior Highlands of northern Minnesota, northern Wisconsin, and northwestern Michigan, are in the Laurentian Uplands Province, or Laurentian Plateau. This area is generally characterized by low-lying swamps, poorly drained areas, and occasional ranges of hills. Elevations range from 600 to approximately 2,300 feet. An outlying portion of the Laurentian Plateau includes the Adirondack Mountains of New York, east of Lake Ontario and south of the St. Lawrence River. Here the relief is sharply defined, with elevations up to 4,500 feet above sea level. The four lower Lakes and much of the Basin are in the better-drained Interior Lowlands Province. Its major ridges consist largely of glacial moraines and outcrops of resistant, dipping, older bedrock. The bedrock appears, for example, as the Door Peninsula of Wisconsin. Elevations in the Interior Lowlands range from 700 to 1,000 feet. Minor portions of the drainage basins of Lake Ontario and Lake Erie are in the Appalachian Plateau Province. The adjacent higher area, which forms the Basin boundary, is the Allegheny Mountains or Allegheny Plateau.

Climate

The Great Lakes Basin has a continental to semi-maritime climate, largely influenced by the atmospheric circulation from west to east and modifying influences of the Great Lakes. Climate over the Region is normally humid, with cold winters and cool summers in the north and warm summers in the south. The average frost-free season is four months at the northern extremity of the Basin and six months at the southern extremity.

Prevailing winds in the Great Lakes are generally from the west. Mean annual surface air temperatures range from 39°F on Lake Superior to 49°F on Lake Erie. Minimum and maximum monthly temperatures occur in February and July on all the Great Lakes. The difference in latitude from south to north accounts for the 10°F difference in temperatures.

The Great Lakes, which cover about one-third of the area of their hydrologic Basin, store great quantities of heat. As a result, the Lakes moderate the temperatures on adjacent, and particularly lee, land areas. Thus, the interiors of Michigan's Upper and Lower Peninsulas are colder than areas on the shores at the same latitude. In addition to moderating air temperatures, the Great Lakes increase annual average humidity approximately 15 percent. Short-term local variations in surface air temperatures are sometimes extreme, and cells of cold arctic air can lower temperatures as much as 50°F in one day.

Annual precipitation over most of the Great Lakes Basin ranges from approximately 28 to 37 inches, increasing generally from northwest to southeast. Annual snowfall ranges from 40 inches to 120 inches. In the Adirondack Mountains and Allegheny Plateau the total annual precipitation exceeds 47 inches, the greater precipitation caused by the higher elevations. The lake effect influences

TABLE 6 General Great Lakes Information, (area in square miles)

	Drainage Basin (land & water)			Water Surface			Land Surface[1]		
	U.S.	Canada	Total	U.S.	Canada	Total	U.S.	Canada	Total
Lake Superior	37,500	43,500	81,000	20,600	11,100	31,700	16,900	32,400	49,300
Lake Michigan	67,900	0	67,900	22,300	0	22,300	45,600	0	45,600
Lake Huron	25,300	49,500	74,800	9,100	13,900	23,000	16,200	35,600	51,800
Lake St. Clair	2,370	4,150	6,520	162	268	430	2,208	3,882	6,090
Lake Erie	23,600	9,880	33,500	4,980	4,930	9,910	18,620	4,950	23,600
Lake Ontario	16800	15,300	32,100	3,460	3,880	7,340	13,340	11,420	24,700
Total to Lake Ontario Outlet	173,470	122,330	295,800	60,602	34,078	94,680	112,868	88,252	201,100[3]
Lake Ontario Outlet to Moses-Saunders Dam	1,685[2]	1,325[2]	3,010	120[2]	115[2]	235	1,565[2]	1,210[2]	2,775
Total[3]	175,200	123,600	298,800	60,720	34,190	94,910	114,430	89,450	203,900
Grass-Raquette-St. Regis	3,200						3,200		
Total Basin Study Area	178,350			60,720			117,630		

[1]Difference between total basin area and water area.

[2]Estimated breakdown between U.S. and Canada.

[3]Rounded.

NOTE: The drainage basin area in both U.S. and Canada, above the mouth of the St. Regis River is approximately 302,000 square miles.

TABLE 7 Water Area and Land Use by State, (Base Year 1966–1967), (thousands of acres)

State[1]	Total Area[2]	Rivers, Lakes, and Embayments	Total Land Area	Urban Built-Up	Cropland	Pasture Range	Forest Land	Other	Total
Illinois	2,401.3	34.0	2,367.3	678.0	1,249.6	98.7	93.0	248.0	1,689.3
Indiana	3,687.0	51.7	3,635.3	381.4	2,392.5	203.1	302.6	355.7	3,253.9
Michigan	37,258.1	1,035.0	36,223.1	2,594.8	11,338.2	1,268.4	19,347.7	1,674.0	33,628.3
Minnesota	7,317.8	737.9	6,579.9	162.5	258.3	62.0	5,981.5	115.6	6,417.4
New York	14,309.8	487.3	13,822.5	1,103.6	4,164.6	1,072.4	6,773.4	708.5	12,718.9
Ohio	7,816.4	68.9	7,747.5	1,074.6	4,837.5	304.5	920.3	610.6	6,672.9
Pennsylvania	524.2	5.1	519.1	49.1	142.2	41.2	223.7	62.9	470.0
Wisconsin	13,192.3	507.3	12,685.0	943.7	4,226.1	455.5	5,982.5	1,077.2	11,741.3
Great Lakes Total	86,506.9	2,927.2	83,579.7	6,987.7	28,609.0	3,505.8	39,624.7	4,852.5	76,592.0

[1] See Table 42 for information by Plan Area.

[2] Information is by county boundaries.

precipitation patterns, with spring and summer precipitation greater over the land than over the Lakes and coastal areas and, conversely, winter precipitation greater over the Lakes and lee coastal areas than inland.

Natural Resources

No other area of the United States has the combination of agricultural and forest land, minerals, and water resources found in the Great Lakes Basin. To understand the kind of economy that has developed in the Basin, it is necessary to know the development and use of this diverse wealth of resources. This information is also basic to understanding the problems considered in this study.

Soils

The soils of the Great Lakes Basin are for the most part developed from glacial drift. Exceptions are shoreline areas, where the soils were formed in lakes, and some of the swamp and marsh areas, where soils were derived from organic materials.

In Minnesota, the Upper Peninsula and northern Lower Peninsula of Michigan, and northern Wisconsin, soils were formed under cool, moist forests.

Flat topography in parts of the Great Lakes Basin allows urban sprawl.

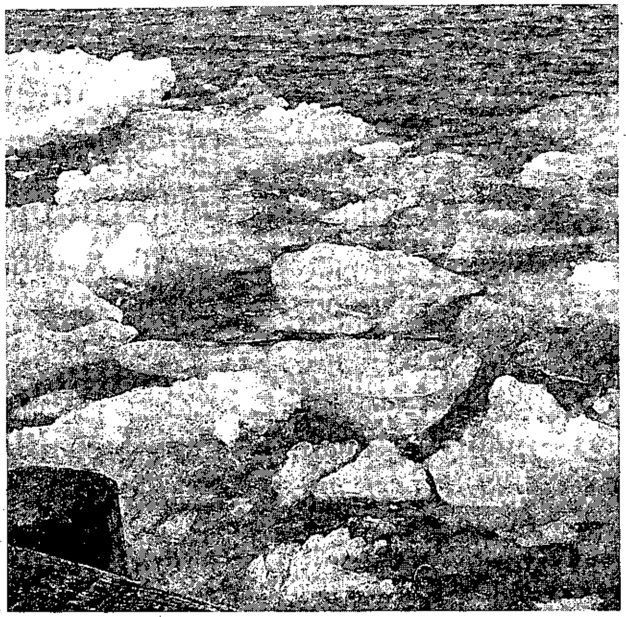
Photo by Rahim Oghalai, courtesy of Wisconsin Department of Natural Resources

Peninsula State Park, Wisconsin. Geologic forces have created dramatic scenery.

These are light-colored, acidic, rather infertile, and low in organic matter. They vary greatly because of differences in parent material and the small amount of good soil intermixed with the poor. Stones, sands, and gravels are common, and there are swamps and marshes in which organic soils have formed. In the northern portion of this area the topography is uneven because of glaciation. Primary cover is pine, spruce, fir, and hardwood.

Sandy soils with sandy or gravelly subsoils predominate in the southern part of this area. Although these soils can support some crops, productivity is limited, and the area is best suited to pine forest. Minnesota, Michigan, and Wisconsin all have some gently sloping flat plains on the shores of Lake Superior, which are relatively smooth and stone-free. Even though these plains are rich in lime in the subsoil and would make good-to-excellent cropland, much of the land remains in forest. The Porcupine Mountains near the west end of Michigan's Upper Peninsula form one of the few rocky highlands in the area.

Nearly all the soils in eastern Wisconsin and southern Michigan were formed under forest vegetation. These are light in color and low in organic matter, except in areas of poor natural drainage. All the soils in these two areas developed after heavy glaciation. Application of lime is essential to



Ice covers a large portion of the Great Lakes during the cold winter months.

Humid weather encourages lush plant growth during spring and summer.

neutralize the acidity of these soils, particularly for growing alfalfa. Fertilization with phosphorus and potassium is required for efficient crop production, and use of nitrogen fertilizer has increased greatly in recent years. Both internal and surface drainage are required for efficient economic operations.

In the eastern Wisconsin area, where the topography is level or gently rolling, the soils are good crop producers. Most of these are loams to clay loams, which are permeable and capable of holding large quantities of water. There are, however, limited areas of sandy soils and scattered areas of peat and muck in poorly drained areas. The least productive soils in this general group are near the Basin boundary in Wisconsin where primarily loamy sands and poorly drained organic soils are found.

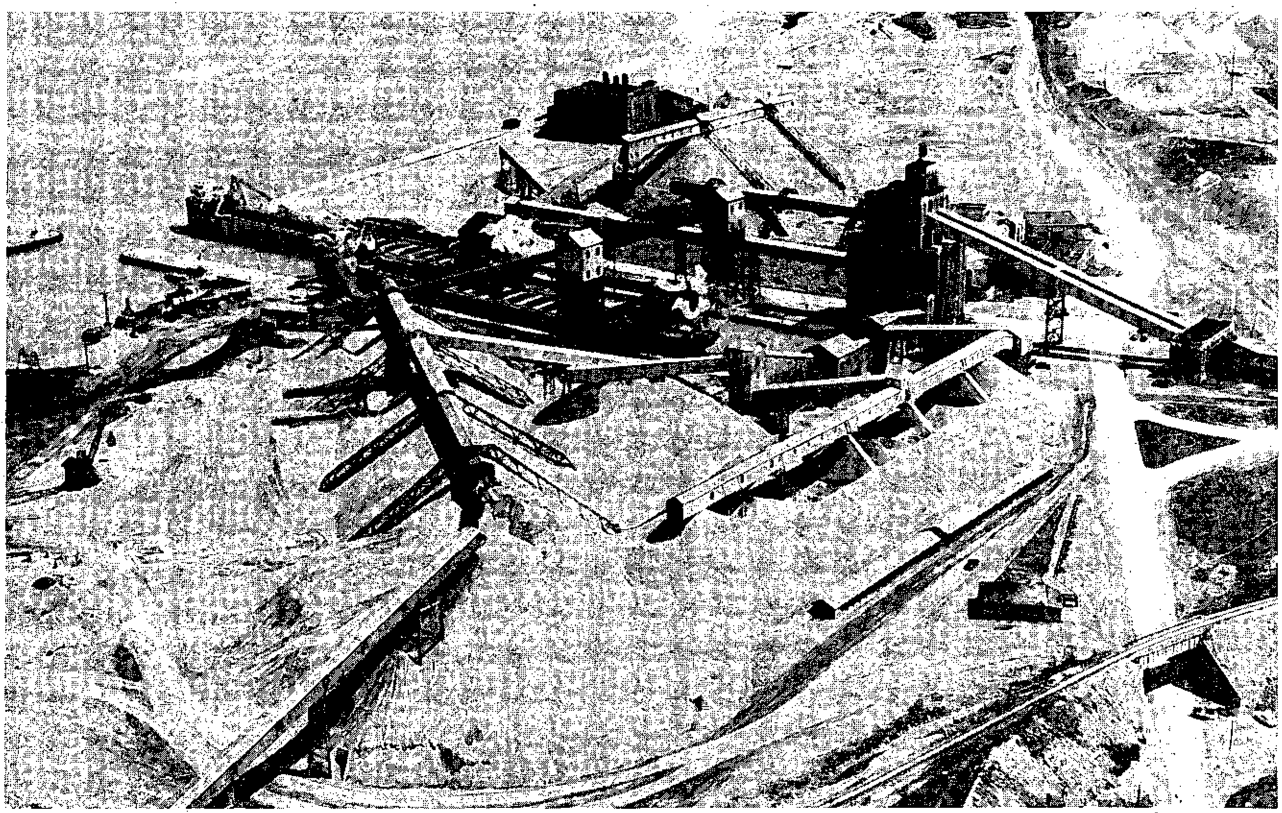
The glacial material in southern Michigan varies in texture from sand to clay, and similarly, the soils are quite variable in texture, permeability, and management requirements. The topography is mostly level to gently rolling with glacial knolls and hills common in some places.

Across all of Wisconsin and Michigan the peat and muck soils require special treatment. If drained and fertilized, they can support either specialized or general farm crops.

The area including northern Indiana, eastern Illinois, northwestern Ohio and extreme southern Michigan has been heavily glaciated. Soils that were formed mostly under forest vegetation are generally light in color and low in organic matter. Other extensive areas contain dark colored, poorly drained soils developed from various types of glacial materials. These vary considerably in texture.

Finely textured soils are extensive in the lacustrine lake plain area of northwestern Ohio. Sands and sandy loams occur in northwestern Indiana. Most of the soils in other areas, however, have a surface layer of friable loam. The land is mostly level to gently rolling except on moraines and near the main streams where the hills may vary from rolling to steep. Man has drained much of the land, although inadequately in some areas. Peat and muck soils are extensive in northwestern Indiana and are intensively used.

In the northeast area of the Basin, including portions of northeastern Ohio, the northern portion of Erie County, Pennsylvania, and northern New York, the soils were derived from parent material that varied from hard crystalline rock to lake plain sands and clays. During glaciation, the older soils were mixed with various kinds of rocks, such as sandstone, shale, limestone, and clay. Most of the soils are in the podzolic group and are quite deficient in lime and phosphorus. The surface horizons are fairly high in organic matter. South of Lake Ontario in New York, a considerable area contains more productive soils, which developed from calcareous glacial drift. Poor drainage is a serious problem in northeastern Ohio and Erie County, Pennsylvania, and where the soils have been developed from sandstone or shale.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Calcite plant and loading docks at Calcite, Michigan. Minerals are the foundation of many of the major heavy industries in the Basin.

Forests

Most of the land of the Basin was covered by forest before cutting and clearing began in the early 1800s and increased during the settlement period. Initially, the land was cleared for agricultural use, but the nation's lumber needs were increasingly supplied from these forests, particularly during the last half of the 19th century. This dramatic harvest of original stands attracted wood-using industries, which depleted the supply and moved to other areas by the early 1900s.

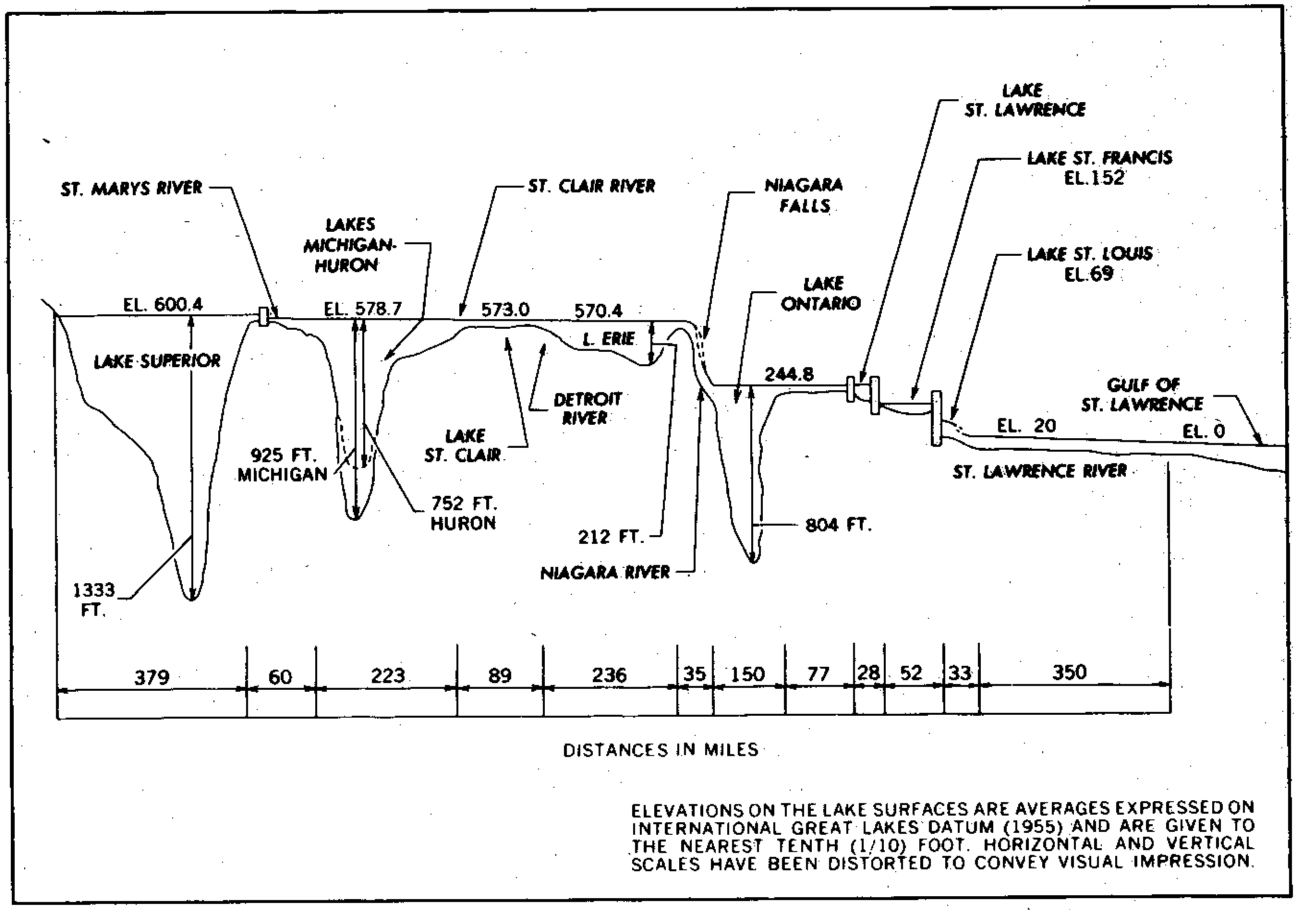
Nearly half the Basin is now classed as forest land. Most of the forest cover has been reestablished by natural regeneration and forest management. States in the Basin with the highest percentages of forest resources are Minnesota, Wisconsin, Michigan (northern half), and New York. Common species are conifers, such as the pine, spruce, and fir that dominate the upper Basin and the mountainous regions of New York, and hardwoods, which cover much of the southern and central Basin. Agricultural land in central lower Michigan, Ohio, Pennsylvania, and New York has largely replaced extensive forested lands.

Minerals

Minerals are the foundation of the heavy industry that has developed in the Basin. Virtually all of the metallic minerals, including iron, zinc, lead, silver, and copper, are found in the northwestern and extreme eastern parts of the Basin in Michigan, Minnesota, and New York. The mineral fuels of oil and gas, and the nonmetallics, including limestone, dolomite, sandstone, shale, salt, gypsum and natural brines, are largely found in lower Michigan, Ohio, Illinois, Indiana, and New York. Sand and gravel, clay, marl, and peat are found generally throughout the Basin. Only a small amount of coal is in the Basin, but in adjacent areas there are large mining operations and large reserves, the output of which affects the economy of the Basin.

Water Resources

The Great Lakes have a combined surface area of approximately 95,000 square miles, nearly one-third of the entire Great Lakes drainage area. The



From Appendix 11, *Levels and Flows*

FIGURE 3 Profile of the Great Lakes System

Basin streams are relatively short and immature, and the Basin is dotted with inland lakes. Ground water is present throughout the Basin in varying quantities.

Generally speaking, about one-third of the average annual precipitation, nearly 12 inches, becomes runoff and eventually reaches the Great Lakes. The low topographic relief and surficial glacial deposits allow water to infiltrate, while numerous lakes, marshes, and peat bogs reflect the poor development of regional drainage systems. The base flow of regional streams is derived largely from ground-water sources. The average annual yield from these ground-water systems is estimated at 26 billion gallons per day.

Nearly half the land portion of the study area is underlain by aquifers that provide usable quantities of ground water. Well yields reach as much as 5,000 gallons per minute. The occurrence of ground water and its availability and suitability for use depend in part on the underlying bedrock structure. While fresh water is present throughout the study area, saline water may also be encountered in one or more aquifers in most areas. Salinity precludes use of some Michigan and Pennsylvania waters.

The Great Lakes receive water from the streams draining the land area and from precipitation falling over the Lakes. Waters from Lake Superior drain into Lake Huron through the St. Marys River where the flows are artificially controlled. Lake Huron is also the sole natural outlet for Lake Michigan and Georgian Bay. Lake Huron discharges the water from these other basins and its own supply to Lake Erie through the St. Clair River, Lake St. Clair, and the Detroit River. Lake Erie, in turn, drains this water plus its contribution through the Niagara River to Lake Ontario. The Lake Ontario outlet forms the head of the St. Lawrence River.

A progressive drop in surface elevation occurs through the series of Lakes as shown in Figure 3. Twenty-two feet of elevation separate Lake Superior and Lake Huron. Lake Huron and Lake Michigan are one large reservoir at the same level, connected by the wide, deep Straits of Mackinac.

Only eight feet in elevation separate Lakes Huron and Erie. The Niagara River drops 325 feet from Lake Erie to Lake Ontario. More than half of this elevation change is at Niagara Falls.

The chemical and biological characteristics of the four lower Great Lakes are undergoing profound changes. Lake Huron is the least affected of the four. The Lakes changing the most are those surrounded by the greatest concentrations of people. Significant increases have occurred in recent years in total dissolved solids, largely calcium, sodium, sulphate, and chlorides, in Lakes Erie and Ontario. These conditions are generally considered to correlate with rapidly aging aquatic systems.

The most critical condition is found in Lake Erie. The phosphorus content of Lake Erie water is much greater than that of the other Great Lakes. Dissolved oxygen content in most of the Lakes is near saturation even at the greatest depths, and supersaturation is common. However, in a several-hundred-square-mile area in the bottom waters of central Lake Erie, dissolved oxygen concentrations of less than one part per million have been found during certain periods. The shallow western part of Lake Erie also stratifies occasionally, and oxygen rapidly becomes depleted in its bottom waters.

Plankton found in the Great Lakes are generally characteristic of large, deep lakes. Diatoms are the most abundant phytoplankton. However, blue-green and green algae are abundant at times, especially in Lake Erie and Lake Ontario, where nuisance blooms sometimes occur. The distribution and abundance of zooplankton in the Great Lakes vary from lake to lake, and in general the composition is quite diverse. Nevertheless, recent reductions in species diversity of both the phytoplankton and zooplankton indicate a shift toward a more eutrophic assemblage of organisms, even in the relatively unpolluted upper Great Lakes.

Fish and Wildlife

Fish habitats provided by streams and inland lakes, as well as by the Great Lakes, support a wide variety of coldwater and warmwater species for sport fishing and a limited commercial fishery. More than 170 species are in the Great Lakes system. Eleven of them have been introduced either intentionally or accidentally and have established themselves. An additional seven species were introduced but failed to establish permanent populations.

Of all the species supported by the Great Lakes only about 50 have been consistently sought commercially as food. Less than 15 command prices commensurate with the costs of capture and processing. However, some prime species provide good angling for both sport and food.

Habitat conditions range widely over the inland lakes and streams, with coldwater species dominating the northern half of the Basin and warmwater species dominating the southern portion. Trout fishing is good in many lakes and streams in Minnesota, Wisconsin, Michigan, Pennsylvania, and New York. Sport fishing for warmwater species, such as small mouth bass, northern pike, walleye, large mouth bass, and muskellunge, is a multimillion-dollar business. In addition, there are abundant pan fish throughout the Basin, such as bluegill and perch. The number of fishermen seeking these species may exceed those angling for game fish.

The introduction and immigration of exotic species have modified the natural fish fauna greatly. Carp were introduced in the latter part of the 19th century and substantial populations were well-established by 1900. Smelt were stocked in a lake tributary to Lake Michigan in the 1920s and spread quickly throughout the Upper Great Lakes and into Lake Erie. The sea lamprey and alewife, now abundant in most of the Lakes, migrated to Lake Erie through the Welland Canal when it opened. Carp and smelt have contributed to the commercial take, but the alewife is difficult to market. White perch is a recent immigrant. A large population is established in Lake Ontario in the Bay of Quinte and in eastern Lake Erie. Certain salmonoids are a recent and apparently very successful introduction. The sea lamprey, because of its parasitic nature, has caused drastic decreases in certain native fishes. Control measures have been undertaken by both the U.S. and Canada. The relationship of other exotics to native species is not yet fully known.

Nearly all of the Great Lakes Basin is wildlife habitat. The U.S. portion of the land area, 85 million acres, contains 75 million acres of habitat. The shoal waters in the U.S. portion of the Great Lakes total 610,000 acres. Of these, 491,000 acres are useful to wildlife. Migrating waterfowl use all the open waters from time to time. The value of this habitat varies greatly, but the important consideration is that all nonurbanized land, some urban land, and all waters have some value to wildlife.

As a rule, the supply of wildlife habitat other than cropland is good in the northern and far eastern areas of the Basin but only fair south of these areas. The country north of the Milwaukee-Buffalo line is forested and sparsely settled, while south of this line the area is heavily settled and is primarily industrial and agricultural. The single most important factor affecting Basin wildlife and habitat is human population growth and the resultant increase in intensity of land use, which causes both degradation and loss of habitat.

Photo by Rahim Oghalai, courtesy of Wisconsin Department of Natural Resources

The Great Lakes and tributaries have historically provided a variety of fish species for sport and commercial fishing. Maintenance of the fish population is a major concern.

The many species of wildlife found in the Basin include big and small game, waterfowl, shore birds, wading birds, song birds, and furbearers. More than 60 varieties of mammals are native to the Basin, including the whitetailed deer, black bear, rabbit, and squirrel. Muskrat and beaver contribute to the area's reputation as one of the most productive trapping areas in North America.

Some of the Basin's animals and birds, such as the timber wolf and the Kirtland's warbler, are rare or endangered.

Population

The population of the Great Lakes Region has accounted for 14 to 15 percent of the total U.S. population since 1940. Tables 8 and 9 show the distribution of 1970 population according to plan area and State within the Great Lakes Region. These relationships have been fairly stable since 1940. These tables also show percentage of urban population for each of the areas. The trend suggests urbanization increasing to almost 100 percent urban population in the Chicago-Milwaukee metropolitan area by the year 2020. Population projections to 2020 are shown in Tables 10 and 11.

Five of the standard metropolitan statistical areas (SMSAs) in the Basin encompassed more than a million people each in 1970: Chicago, 7.0 million; Detroit, 4.2 million; Cleveland, 2.1 million; Milwaukee, 1.4 million; and Buffalo, 1.4 million. These total 55 percent of the population of the Region.

Employment

Employment in the Great Lakes Region accounted for about 15 percent of the total U.S.

TABLE 8 Great Lakes Region Population and Urban Population by Plan Area, 1970

Plan Area	1970 Population	Percent of Great Lakes Region	Urban Population	Percent of Region Population
1.0--Lake Superior	533,539	1.8	315,789	1.1
2.0--Lake Michigan	13,516.965	46.1	11,186,962	38.1
3.0--Lake Huron	1,236,265	4.2	702,813	2.4
4.0--Lake Erie	11,513.853	39.3	9,727,303	33.2
5.0--Lake Ontario	2,531,673	8.6	1,593,388	5.4
TOTAL	29,332,295	100.0	23,526,255	80.2

TABLE 9 Great Lakes Region Population and Urban Population by State, 1970

State	1970 Population	Percent of Great Lakes Region	Urban Population	Percent of Region Population
Illinois	6,978,947	23.8	6,710,912	22.9
Indiana	1,575,143	5.4	1,206,116	4.1
Michigan	8,875,083	30.2	6,553,773	22.3
Minnesota	265,539	0.9	175,612	0.6
New York	4,109,855	14.0	2,851,286	9.7
Ohio	4,485,701	15.3	3,691,014	12.6
Pennsylvania	263,654	0.9	197,659	0.7
Wisconsin	2,778,373	9.5	2,139,883	7.3
TOTAL	29,332,295	100.0	23,526,255	80.2

TABLE 10 Projected Great Lakes Region Population by Plan Area, 1980, 2000, 2020

Plan Area	1980	% of Great Lakes Region	2000	% of Great Lakes Region	2020	% of Great Lakes Region
1.0	538,000	1.6	594,000	1.4	669,000	1.3
2.0	15,542,000	46.3	19,645,000	46.4	24,830,000	46.4
3.0	1,411,000	4.2	1,810,000	4.3	2,324,000	4.3
4.0	13,299,000	39.6	16,794,000	39.7	21,281,000	39.7
5.0	2,776,000	8.3	3,495,000	8.2	4,393,000	8.3
TOTAL	33,566,000	100	42,338,000	100	53,497,000	100

TABLE 11 Projected Great Lakes Region Population by State, 1980, 2000, 2020

State	1980	% of Great Lakes Region	2000	% of Great Lakes Region	2020	% of Great Lakes Region
Illinois	7,885,000	23.5	9,626,000	22.7	11,782,000	22.0
Indiana	1,845,000	5.5	2,418,000	5.7	3,165,000	5.9
Michigan	10,384,000	30.9	13,294,000	31.4	17,111,000	32.0
Minnesota	288,000	0.9	334,000	0.8	386,000	0.7
New York	4,541,000	13.5	5,639,000	13.3	7,011,000	13.1
Ohio	5,036,000	15.0	6,302,000	14.9	7,867,000	14.7
Pennsylvania	293,000	0.9	362,000	0.9	453,000	0.9
Wisconsin	3,290	9.8	4,363,000	10.3	5,721,000	10.7
TOTAL	33,566,000	100	42,338,000	100	53,496,000	100

TABLE 12 Employment by Selected Industries, 1950–1970 and Projected 1980–2020, (in thousands)

Industry & Plan Area	1950	1960	1970	1980	2000	2020
Agriculture Forestry & Fisheries						
1.0	18.3	7.6	3.8	4.5	2.9	1.8
2.0	220.0	142.2	95.1	97.0	69.5	49.7
3.0	40.6	21.3	11.4	12.4	7.3	4.5
4.0	131.8	87.2	58.7	60.0	43.0	30.5
5.0	69.0	47.3	31.7	31.6	22.6	16.1
Total	479.7	305.8	200.7	205.5	145.3	102.6
Mining						
1.0	19.3	21.9	17.0	17.2	16.8	16.6
2.0	7.2	7.3	8.4	6.1	6.2	6.1
3.0	2.3	2.0	1.7	1.8	1.6	1.5
4.0	5.8	5.7	8.7	5.3	5.5	5.7
5.0	3.8	3.6	3.2	2.4	2.1	1.9
Total	38.7	40.5	39.0	32.8	32.2	31.8
Manufacturing						
1.0	33.4	27.7	25.5	29.6	31.5	34.8
2.0	1,544.6	1,769.1	1,808.4	2,101.3	2,357.4	2,705.0
3.0	120.3	146.6	165.4	201.3	247.1	305.9
4.0	1,422.6	1,532.5	1,597.4	1,816.0	2,015.6	2,286.7
5.0	264.2	295.2	308.8	355.8	413.9	485.8
Total	3,385.1	3,771.0	3,905.5	4,504.0	5,065.5	4,818.2
Other (Including Federal Military)						
1.0	109.2	117.3	125.5	143.8	170.5	198.3
2.0	2,339.8	2,756.9	3,436.0	4,172.6	5,673.9	7,436.2
3.0	137.9	186.1	243.5	315.7	442.4	595.4
4.0	1,808.4	2,175.9	2,731.3	3,401.9	4,672.1	6,207.4
5.0	407.2	488.2	620.7	718.8	972.9	1,271.5
Total	4,802.5	5,724.6	7,157.1[1]	8,752.8	11,931.8	15,708.9
Total Employment						
1.0	180.2	174.5	171.8	194.8	221.8	251.5
2.0	4,111.6	4,675.4	5,347.9	6,378.0	8,107.8	10,198.0
3.0	301.5	356.0	422.1	530.2	698.0	907.0
4.0	3,368.6	3,801.4	4,396.2	5,283.2	6,736.1	8,530.1
5.0	744.1	834.6	964.4	1,108.8	1,411.8	1,776.2
Total	8,706.0	9,841.8	11,302.3	13,495.0	17,175.5	21,662.8

[1]See Figure 3 for breakdown of "other".

NOTE: Entries may not add to total because of rounding.

employment from 1940 to 1970. This is slightly greater than the Great Lakes Region share of the U.S. population, and this relationship is expected to continue. However, employment in the Region is projected to decrease by the year 2020 to about 13.6 percent of total U.S. employment, only slightly higher than the percentage of total U.S. population in the Region at that time. Table 12 shows employment by selected industries for the census decades 1950, 1960, and 1970, and forecasts for 1980, 2000, and 2020, according to plan area. Figure 4 shows the distribution of 1970 employment among the major categories.

Income

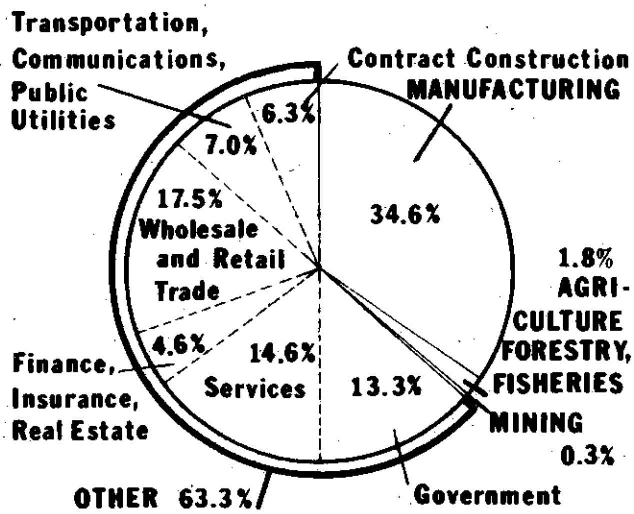
The heavy concentration of industrial activity in the Great Lakes Region provides relatively high total income and per capita personal income. The

TABLE 13 Per Capita Personal Income, Great Lakes Region by Plan Area, 1940–2020, (1958 dollars)

Great Lakes	Per Capita Personal Income 1940	1950	1959	1980	2000	2020
Region Total	1,640	2,157	2,420	4,455	7,516	12,754
Lake Superior	1,000	1,504	1,736	3,658	6,800	11,819
Lake Michigan	1,685	2,239	2,551	4,553	7,633	12,865
Lake Huron	1,138	1,746	2,024	4,030	7,160	12,473
Lake Erie	720	2,213	2,392	4,463	7,490	12,714
Lake Ontario	1,503	1,848	2,102	4,211	7,321	12,613
	Ratio to Basin					
Lake Superior	61.0	69.7	71.7	82.1	90.5	92.7
Lake Michigan	102.7	103.8	105.4	102.2	101.6	100.9
Lake Huron	69.4	80.9	83.6	90.5	95.3	97.8
Lake Erie	104.9	102.6	98.8	100.2	99.7	99.7
Lake Ontario	91.6	85.7	86.9	94.5	97.4	98.9

Region has maintained a greater share of the nation's personal income throughout the period 1940 to 1960 than the proportion of population would imply. Census data regarding income for 1970 were not yet available when the economic information for the Framework Study was compiled in final form. Table 13 shows the comparison of per capita personal income in 1958 dollars for 1940, 1950, and 1959, and the projections for 1980, 2000, and 2020. Although it is anticipated that the Region will remain ahead of the nation, the difference is likely to decrease.

Areas having the highest per capita income in the Region are those with strong industrial development. The only area that has less than 90 percent of the Region average is the northern part of the Lower Peninsula of Michigan and the southern part of the Upper Peninsula.



Appendix 1, *Alternative Frameworks*

FIGURE 4 Great Lakes Region Employment, 1970

Manufacturing, Agriculture, Forest, Mining, Services, and Other Employment

In 1970 nearly four million persons were employed in manufacturing in the Great Lakes Region. This was 35 percent of the total employment in the Region.

Table 14 shows rank and value added by manufacture in 1967 for major industry groups in the Great Lakes Region. The left column shows the Standard Industrial Classification code number, drawn from the *Standard Industrial Classification Manual* published in 1972 by the Office of Management and Budget. An analysis of production was made to develop data on the most significant industries contributing to the economic development of the Region. Of these, those ranking high in water use or as creators of water quality problems were identified. The industries investigated were iron and steel, petroleum refining, selected bulk chemicals, paper, and selected food products. The steel producing districts in counties immediately adjacent to the Great Lakes produced 50 million

TABLE 14 Rank and Value Added by Manufacture in 1967 for Major Industry Groups within the Great Lakes Basin

SIC Code No.	Industry Group Description	Value Added by Manufacture within the Great Lakes Basin Counties[1]									Total Great Lakes Basin Counties as a Percent of Eight States & U.S.	
		Total	Ill.	Ind.	Mich.	Minn.	N. Y.	Ohio	Pa.	Wis.	(8) States	U.S.
35	Machinery, except elec.	8,311.6	1,635.3	293.2	2,750.4	7.3	999.6	1,365.6	78.1	1,182.1	48.4	29.9
37	Transportation equipment	7,588.6	631.1	168.7	5,805.8	-----	-------	971.6	-----	11.4	53.1	26.9
34	Fabricated metal prod.	5,746.7	1,494.2	158.9	1,987.7	-----	402.4	1,168.8	87.7	447.0	55.6	31.8
33	Primary metal industries	4,885.4	1,034.2	166.6	1,481.7	-----	590.2	908.6	73.0	331.1	38.3	24.4
20	Food and kindred prod.	4,304.3	1,617.2	161.3	926.0	27.6	533.1	453.9	38.2	547.0	40.0	16.2
36	Electrical machinery	4,042.1	1,916.1	32.0	539.5	-----	462.6	469.8	91.2	530.9	33.2	16.5
28	Chemicals & allied prod.	3,028.5	1,084.2	85.1	1,039.6	-----	421.2	346.0	-----	52.4	36.6	12.9
27	Printing & publishing	2,538.2	1,386.7	56.7	464.0	13.3	134.9	266.9	10.7	205.0	31.5	17.7
38	Instruments & rel. prod.	2,416.9	511.2	7.7	141.4	-----	1,714.2	-------	-----	42.4	61.8	37.6
30	Rubber & plastic prod.	1,503.8	343.8	64.2	290.7	-----	10.0	721.7	34.0	39.4	45.1	22.1
26	Paper & allied products	1,463.4	419.2	28.4	367.0	-----	200.8	25.7	-----	422.3	36.6	15.0
32	Stone, clay & glass prod.	1,162.3	269.8	36.7	410.3	-----	157.5	252.7	-----	35.3	30.9	13.9
25	Furniture and fixtures	676.9	227.7	46.2	275.0	-----	48.1	48.0	16.9	15.0	38.9	16.2
23	Apparel & related prod.	625.9	217.3	9.2	254.9	-----	101.9	20.6	-----	22.0	12.8	6.2
39&19	Misc. mfg. - Ordinance	595.1	323.4	40.8	137.0	-----	23.3	38.5	6.5	25.6	24.1	5.8
29	Petroleum and coal prods.	401.5	96.5	188.9	-------	-----	-------	126.1	-----	-------	31.8	7.4
24	Lumber and wood prod.	270.5	60.6	5.7	131.6	6.5	15.6	-------	-----	50.5	29.3	5.4
31	Leather & leather prod.	130.1	6.0	-------	47.9	-----	3.8	-------	-----	72.4	13.2	5.0
22	Textile mill products	98.7	35.5	-------	37.8	-----	6.3	-------	-----	19.1	6.9	1.2
21	Tobacco products	--------	--------	-------	-------	-----	-------	-------	-----	-------	----	----
TOTAL ALL INDUSTRY GROUPS		58,126.6	13,755.3	3,786.9	17,241.6	157.1	8,225.3	9,129.1	575.1	5,256.2	47.0	22.2

[1] In Millions of Dollars

SOURCE: U.S. Bureau of the Census, Census of Manufactures, 1967 Area Series: by State, MC67(3), U.S. Government Printing Office, Washington, D.C. 1970.

TABLE 15 Great Lakes Region Share of United States Total for Selected Agricultural Commodities, 1964

Commodity	Percent of U.S. Total
Alfalfa	12.7
All Hay	10.3
Dry Field Beans	49.6
Corn Silage	15.7
Oats	14.7
Potatoes	8.7
Corn, Grain	8.5
Sugar Beets	7.2
Soybeans	6.8
Wheat	6.8
Rye	5.8
Barley	0.1
Sour Cherries	90
Sweet Cherries	35
Apples	23
Pears	7
Grapes	5
Peaches	4
Cucumbers & Pickles	33
Snap Beans	30
Cabbage	21
Dry Onions	18
Sweet Corn	17
Green Peas	16

tons of steel in 1970 or 39 percent of the national total, and those districts partially served by Great Lakes ports produced an additional one-third of the total. The Great Lakes Region also contains significant concentrations of petroleum refining and chemicals, paper, and food products manufacturing. These manufacturing industries account for about 80 percent of the industrial water requirements and industrial water quality problems in the Basin.

TABLE 16 Great Lakes Basin Share of United States Total for Selected Characteristics

Characteristic	Percent of Total U.S.
Number of farms	7.7
Number of dairy farms	19.0
Number of commercial vegetable farms	15.0
Number of fruit farms	13.0
Land in farms	3.3
Value of farm products sold	6.7
Rural farm population	8.0
Agricultural employment	7.0
Farmers working off-farm	8.5

Source: U.S. Department of Commerce, Agricultural Census 1964

While employment in agriculture in the Great Lakes Region is relatively small, the agricultural industry itself helps support the urban and industrial centers of the nation by supplying labor to these centers and providing a market for their products. The importance of the agricultural sector is likely to be minimized simply because it is overwhelmed by the urban-industrial complex. The Region, containing only four percent of the land area of the nation, has a population density four times the national average. However, the Region produces a significant portion of many U.S. agricultural commodities (Table 15). Table 16 shows the Great Lakes Region share of the U.S. total in selected agricultural characteristics as determined in the 1964 agricultural census.

In 1960 the Basin farm labor force of 296,000 supported a rural farm population of 1,144,000 and produced farm products that sold for $2.7 billion. A distinguishing characteristic of the agricultural economy is that many opportunities exist for off-farm employment. A much greater proportion of the farmers in the Basin work part or full time at nonfarm jobs than do farmers in the nation as a whole.

The trend established during the decade prior to 1964 indicates a decrease in the number of farms and an increase in farm acreage, both on a national basis and in the Great Lakes Region. While average farms in the Great Lakes Region are of smaller size than the national average, they represent about 80 percent greater per-acre investment in land and buildings than the national average. The range is from much less than the national average

TABLE 17 Production, Employment, and Income of Forest-Based Industries, United States and Great Lakes Basin

	United States (1962)	Great Lakes Basin (1962)	Percent of U.S.
	Million Cubic Feet		
Production of saw and veneer logs and misc. products			
1962	6,515.0	140.1	2.1
1980	8,110.0	194.3	2.4
2000	9,790.0	233.8	2.4
2020	10,730.0	255.0	2.4
	Million Cords		
Production of pulpwood			
1962	41.7	2.4	5.7
1980	78.4	3.8	4.8
2000	128.6	5.6	4.4
2020	142.2	6.4	4.5
	Thousand People		
Employment (SIC 24 & 26 & forest management)			
1962	1,224.0	147.0	12.0
1980	1,326.0	150.1	11.3
2000	1,328.0	133.6	10.1
2020	1,093.5	100.2	9.2
	Million Dollars		
Income (Payrolls) (SIC 24 & 26 & forest management)			
1962	6,190.3	799.8	12.9
1980	10,505.0	1,251.6	11.9
2000	16,432.5	1,800.3	10.9
2020	21,002.6	2,130.4	10.1

Source: "Preliminary Projections of Economic Activity in the Agricultural, Forestry, and Related Economic Sectors of the United States and Its Water Resource Regions 1980, 2000, and 2020," Economic Research Service and Forest Service, USDA 1967.

in the northern areas to several times the average in the southern farming areas near urban centers.

The Region is agriculturally diverse. Types of products are determined by the proximity of farm land to large urban markets, as well as by the comparative advantages of specific types of production. Major dairy areas are in Wisconsin and New York. Feed, grain, and livestock production are economically important in southern Michigan, Ohio, Illinois, and Indiana. Fruit and commercial vegetables are important in areas of Wisconsin, Michigan, Ohio, Pennsylvania, and New York. Small grain and timber production contribute significantly to the economy of the northern portions of the Region.

The types of agriculture found in parts of the Basin vary for a number of reasons. Some variations are due to climatic and topographic conditions, others to historical and settlement patterns. More than half the total value of farm products sold is from the Lake Michigan basin and the southwestern part of the Lake Erie basin.

The rate of loss of agricultural land to other uses has been greater within the Region than in the country as a whole. This reflects the population pressures of the area and the trend toward urbanization.

Employment in forest-based industries is expected to decrease substantially by 2020 (Table 17). While 147,000 persons were employed in forest-based industries in 1962, only 100,200 are expected to be employed by 2020.

The distinguishing characteristic of the forests in the Great Lakes Basin is their disproportionate amount of hardwood. The Basin has a much larger proportion of acreage, growing stock, and saw timber in hardwood than is found in the nation as a whole. Saw logs, veneer logs, and miscellaneous products produced in the Great Lakes Basin account for about 2.1 percent of total U.S. production, and the production of pulpwood in the Basin is about 5.7 percent of the U.S. total. The production of saw logs, veneer logs, and miscellaneous products in the Basin is expected to increase slightly, and pulpwood production is expected to decrease, while total production in the Basin is expected to remain fairly constant as a percentage of the U.S. total. The figures for manufacturing include the production of finished wood products and paper and paper products from pulp.

While employment in mining is not a significant part of total employment, certain mineral products of the Great Lakes Region are very significant in terms of United States totals (Table 18). The Great Lakes Basin produces about 70 percent of the U.S. iron ore, half of the magnesium compounds, and more than 40 percent of the lime and peat. Values of mineral production are given in Table 19.

Service industry employment was not differentiated in the Framework Study, but it was included in the classification "other employment," which accounts for more than 60 percent of the total employment in the Region (Figure 4).

The service industries are particularly significant because they include the growing recreation industry and tourism. These two big industries are not specifically identified in the economic data but are reflected in several of the classifications. "Wholesale and retail trade" provides approximately 18 percent of the Region's employment, and "services" provides an additional 15 percent, together accounting for half of the "other" category. "Transportation, communications, and public utilities," "finance, insurance, and real estate," and "contract construction" each account for approximately 5 to 7 percent of the Region's employment, and they total 28 percent of "other." "Government," approximately 13 percent of the Region's employment, accounts for about 21 percent of "other employment."

Resource Interrelationships

The Framework Study examines both land and

TABLE 18 United States and Great Lakes Region Mineral Production, 1968[1]

Commodity		National Quantity	Great Lakes Region Quantity	Percent of National
Cement:				
Portland	376-pound barrels	388,525,000	45,729,463	11.8
Masonry	280-pound barrels	23,167,000	2,483,654	10.7
Clays and shale	short tons	57,233,000	4,139,014	7.2
Coal, bituminous	short tons	545,245,000	593,543	0.1
Copper[2]	short tons	1,204,621	74,805	6.2
Iron ore (usable)	long tons, gross weight	81,934,000	56,635,595	69.1
Lead[2]	short tons	359,156	1,396	0.4
Lime	short tons	18,637,000	7,744,542	41.6
Magnesium compounds	short tons, MgO equivalent	525,210	266,406	50.7
Peat	short tons	619,161	260,509	42.1
Petroleum	42-gallon barrels	3,329,042,000	12,974,404	0.4
Sand and gravel	short tons	917,739,000	128,947,000	14.1
Silver[2]	troy ounces	32,729,000	500,428	1.5
Stone (crushed and broken)	short tons	815,946,000	110,557,798	13.5
Stone (dimension)	short tons	3,457,000	142,007	4.1
Zinc	short tons	529,446	66,194	12.5

From Appendix 5, *Mineral Resources*

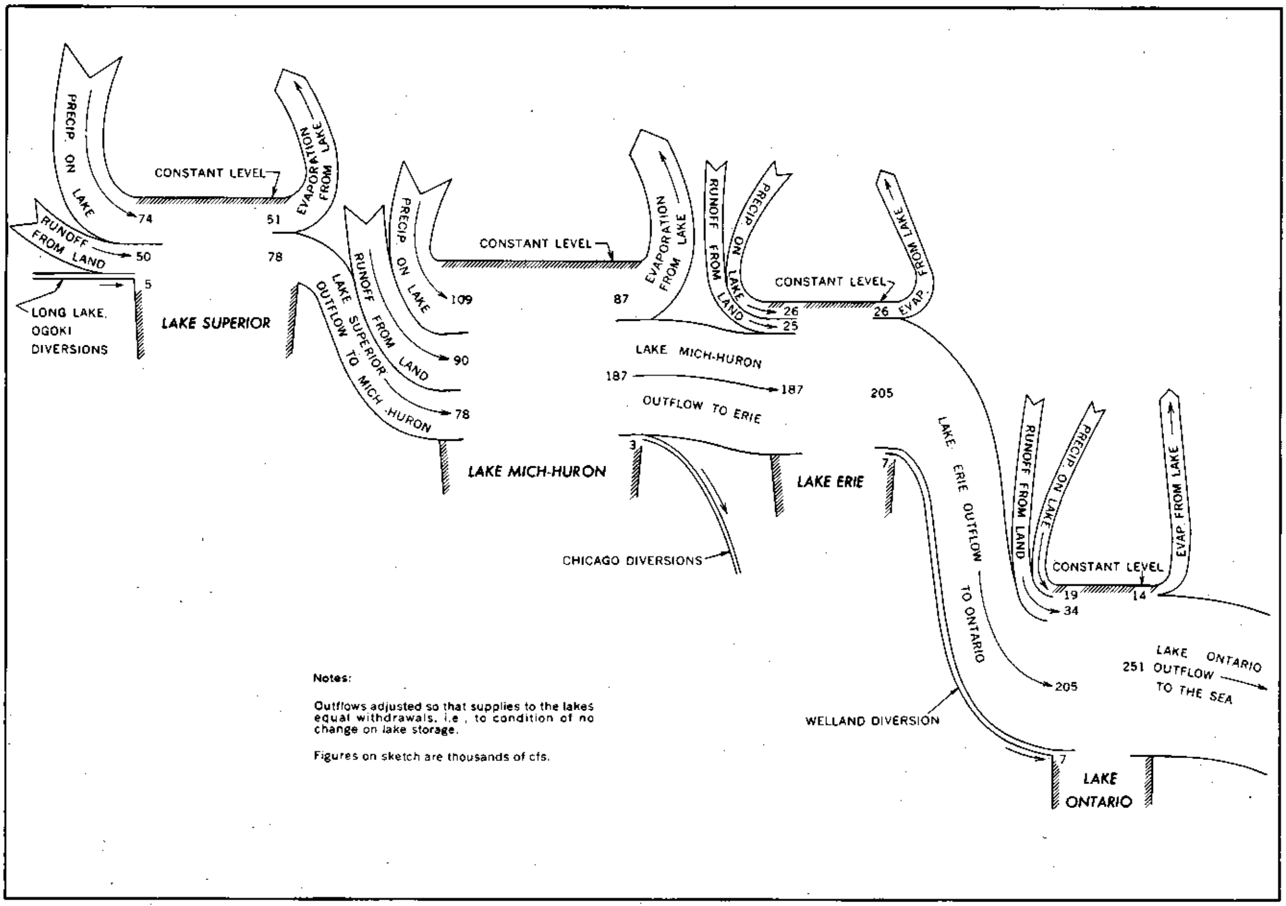
[1]Excludes petroleum data for New York and Ohio, and natural gas and natural-gas liquids data, which are not available.
[2]Recoverable content of ores, etc.

TABLE 19 United States and Great Lakes Region Mineral Production Value, 1968[1]**, (thousands of dollars)**

Commodity		National Value	Great Lakes Region Value	Percent of National
Cement:				
Portland	376-pound barrels	1,227,942	145,975	11.9
Masonry	280-pound barrels	66,259	6,986	10.5
Clays and shale	short tons	246,898	5,328	2.2
Copper[2]	short tons	1,008,195	62,607	6.2
Iron ore (usable)	long tons, gross weight	836,433	597,233	71.4
Lead[2]	short tons	94,903	369	0.4
Lime	short tons	249,639	98,553	39.5
Magnesium compounds	short tons, MgO equivalent	43,449	25,087	57.7
Peat	short tons	7,230	3,322	45.9
Petroleum	42-gallon barrels	9,794,826	38,287	0.4
Sand and gravel	short tons	1,020,336	124,311	12.2
Silver[2]	troy ounces	70,191	1,073	1.5
Stone (crushed and broken)	short tons	1,218,105	154,171	12.7
Stone (dimension)	short tons	99,648	4,323	4.3
Zinc[2]	short tons	142,950	17,872	12.5
Value of items that cannot be disclosed for the Great Lakes Region: Bituminous coal, bromine, calcium compounds, grindstones, gypsum, iodine, potash, salt and talc		3,038,604	193,876	6.4
Total		19,165,608	1,479,373	7.7

From Appendix 5, *Mineral Resources*

[1]Excludes petroleum data for New York and Ohio, and natural gas and natural-gas liquids data which are not available.
[2]Recoverable content of ores, etc.



From Appendix 11, *Levels and Flows*

FIGURE 5 Factors of Water Supply to the Lakes, Average Values for October 1950–September 1960

water resources in the Great Lakes Basin because the two are inevitably related. They are bound together because land use determines how the water is used or how much is needed in a given area.

Although they must be considered together, these two resources have distinct characteristics. While the quantity of land is considered constant, the supply of water constantly changes. Water that enters the Great Lakes system through precipitation can leave through evaporation, consumptive use, diversion, or as flow in the St. Lawrence River. Alternatively it can be stored in the Lakes. The system is too large to respond immediately to variations in annual precipitation, but the amount of stored water in the system does vary in response to long-term trends in precipitation.

Water Availability

The water available for withdrawal and use in the Great Lakes Basin comes primarily from precipitation that falls over the U.S. and Canadian parts of the Basin. Diversions of water into the Basin are about 5,500 cubic feet per second, and diversions from the Basin are 3,200 cubic feet per second. Interflows of ground water from adjacent basins contribute insignificantly to the system.

The precipitation that falls into the Lakes or remains above ground in streams and rivers is immediately accessible for use. The precipitation that percolates deep into the soil may enter aquifers that underlie much of the Basin. Water that percolates to relatively shallow depths in the soil maintains the base flow in the streams of the Basin. Figure 5 shows the factors that affect the water supply of the Great Lakes.

When planning water withdrawals from streams or inland lakes, it is necessary to study precipitation runoff from U.S. land in the Basin. However, when planning Great Lakes water withdrawals, precipitation over both U.S. and Canadian land and water must be considered.

Planning for the use of the water in the Basin involves two considerations: nonconsumptive withdrawal and return of available water from and to a particular location, and consumptive use, which will reduce flow in downstream rivers and lakes, including average flow in the St. Lawrence River. The flows necessary for navigation and power must be considered when planning large consumptive uses.

The actual amount of water available to either the United States or Canada under early 1970s conditions for upstream use is only a small portion of the total outflow from the Basin. The limit of consumptive use has not been determined, although some estimates have been made of the amount of water consumed as a result of maximum projected development.

Under the Boundary Waters Treaty of 1909 between the U.S. and Canada, water may be withdrawn from the Lakes and consumed in quantities necessary for municipal and industrial purposes, including agriculture. Nonconsumptive uses, those that withdraw water and return it, are also permitted.

No estimate of total water supply available for use was made in the Framework Study. There is no indication that the water uses considered in the study would result in excess withdrawal, return, or consumptive use.

The average annual runoff from the U.S. land portion of the Basin is estimated to be 63 billion gallons per day. The outflow from the Great Lakes through the St. Lawrence River is 162 billion gallons per day. This outflow includes runoff from the U.S. and Canadian portions of the Basin, water that goes underground and reappears as surface water, and precipitation falling on the Great Lakes minus the water that evaporates from the surface of the Lakes and the water that is diverted to areas outside the Basin. Because of interconnections between the surface-water system and the ground-water system, diversion from aquifers through pumping may reduce the total amount that could be captured in streams. Conversely, surface diversion and consumption may reduce the amount of water going into aquifers.

In general, lack of water supply has not precluded development in the Great Lakes Basin. But the economics of providing a supply have sometimes dictated the location of development. There are areas where the currently developed water supply is becoming inadequate and the cost of the new supply may require a change in location for some manufacturing operations. There are cases, too, where the quality of the water is a controlling factor in its use.

No place in the Great Lakes Basin is so far removed from one of the Great Lakes that withdrawal from a lake would be physically impractical. However, inland surface sources of supply and ground-water sources will continue to be more economical to use than Great Lakes sources for many locations.

Because precipitation is relatively uniform over the Great Lakes Basin, there is not great disparity in runoff per square mile among the Lake basins. The greatest precipitation occurs in the mountainous southeast portion of the Basin, where orographic factors affect precipitation. Much of the moisture falls as snow in this area. This is also the area in which the greatest opportunities for reservoir storage occur because of topographic relief. Where snow is a principal component of the total precipitation, spring runoff must be stored to provide maximum usable year-round supply. This increases the cost of the surface water and makes development of ground water or Great Lakes sources more competitive. This requirement for storage reduces the effective quantity of surface water available.

Ground Water

The Great Lakes Basin has, in general, a bountiful supply of ground water. This supply has been overlooked in some instances and overused in others. Its relationship to surface water has not been fully understood. The complete hydrologic system of an area needs to be understood before extensive use of either surface water or ground water is undertaken. Consequently, adequate data are needed to avoid inadvertently changing the quantity and quality of either source. It is estimated that approximately 26 billion gallons per day of ground-water runoff is potentially available in the Great Lakes. Tables 20 and 21 show the estimated ground water available in each Lake basin and State.

The Lake Superior basin has poor to fair ground-water supplies, but good aquifers exist in local areas. The best aquifers are in sand and gravel deposits, especially in the east end of the Upper Peninsula of Michigan, in the headwaters of the St. Louis River system of Minnesota, and in headwaters areas in Wisconsin. Sedimentary rocks in the eastern part also have good aquifers. The major ground-water problem is the generally low yield of wells. Highly mineralized water occurs in a few areas, particularly in the Superior Slope and the Apostle Islands complexes, the Keewenaw Peninsula area, and the headwaters of the Tahquamenon complex. There is little human-caused pollution of ground water.

The Lake Michigan basin has the greatest ground-water potential of any of the Great Lakes basins. The glacial drift contains many very productive aquifers, particularly in most of the Lower

TABLE 20 Ground-Water Potential by Lake Basin, Based on 70% Flow Duration

Basin	Yield (mgd)
Lake Superior	4,240
Lake Michigan	11,710
Lake Huron	3,215
Lake Erie	1,930
Lake Ontario	4,910
TOTAL	26,005

TABLE 21 Ground-Water Potential by State, Based on 70% Flow Duration

State	Yield (mgd)
Illinois	90
Indiana	780
Michigan	13,615
Minnesota	1,010
New York	5,240
Ohio	765
Pennsylvania	65
Wisconsin	4,440
TOTAL	26,005

Peninsula of Michigan. In addition, the western shore of Lake Michigan is underlain by productive bedrock aquifers. The sandstone aquifer in the Chicago-Milwaukee area is being overpumped in northeast Illinois. There are also problems of excessive lowering of water levels around Lansing, Michigan, and Green Bay, Wisconsin, although early 1970 evidence indicates levels may be recovering since the water supply source has been shifted to Lake Michigan and ground-water pumping has ceased. Areas of poor ground-water yield are relatively small. Highly saline water is present at shallow depths in the bedrock formations of Michigan's Lower Peninsula and in extremely deep wells in northern Indiana. However, overlying aquifers in the glacial drift provide good freshwater sources.

The Lake Huron basin contains several moderate-size areas in which large ground-water supplies are available for development. Most of these areas are in the central upland part of the Lower Peninsula of Michigan. The Au Sable River basin has the greatest potential and considerable storage. However, demand for water has been small because this basin is relatively undeveloped.

In some small areas in the lower part of the Lower Peninsula of Michigan large supplies are available. Careful management of the ground-water resource is required there to avoid contamination of the high quality water by saline water. There is also a potential for local pollution from solid waste disposal, industrial waste, oil field brines, and highway salting.

Because of the tendency to develop ground-water sources where they are to be used, some of the less desirable aquifers have been tapped and many of those that have greater potential remain unused. Development of regional systems may be the answer to this problem.

The Lake Erie basin has the least ground-water potential of any of the five basins. In contrast to excellent aquifers in glacial drift in selected areas of Michigan, Ohio, and New York, other areas have limited ground-water potential. In some areas surface water and ground water must be combined to provide an adequate supply of water. The chemical quality of the ground water has been a limiting factor in its development, and the potential contamination of relatively good water in the surficial sand and gravels through mixing with the inferior water in the bedrock is a problem that must be dealt with constantly.

The Adirondack area of the eastern part of the Lake Ontario basin has the greatest estimated ground-water yield of that basin and one of the greatest in the entire Great Lakes Basin. In the remainder of the Lake Ontario basin, ground-water resources are moderate to poor. Most of the basin is underlain by fine-grained sedimentary or igneous rocks. The better aquifer yields occur locally in carbonate rocks in central New York, and the sandstone and carbonate rocks along the St. Lawrence valley, and in the sand and gravel in the glacial drift in the valley bottoms.

Water-critical areas occur along the entire Lake Ontario lowlands from Niagara Falls to the Black River where the bedrock aquifers yield small supplies and saline water is present.

The high runoff areas of the Adirondacks and the Tug Hill Plateau permit conjunctive use of surface- and ground-water supplies. Adequate quantities serve the water needs of the area.

Surface Water

Surface water is available in streams throughout the Basin. The stream pattern in the Great Lakes Basin differs from that of other river basins in that the streams are often short with relatively small

TABLE 22 Flow Characteristics at Selected Stations

Station No. 4-	Stream and Station	Period of Record	Drainage Area (sq mi)	Average Discharge (cfs)	Monthly Mean Discharge Maximum (cfs)	Monthly Mean Discharge Minimum (cfs)	Annual Mean Discharge Maximum (cfs)	Annual Mean Discharge Minimum (cfs)
Lake Superior West, PSA 1.1								
105	Pigeon River Middle Falls, Minn.	1921-71	600	502	4,020	34	849	158
300	Montreal River Saxon, Wis.	1938-70	262	325	1,790	21	487	166
Lake Superior East, PSA 1.2								
430	Sturgeon River near Arnheim, Mich.	1942-73	705	826	4,323	234	1,072	520
455	Tahquamenon River near Paradise, Mich.	1953-73	790	921	4,510	201	1,281	616
Lake Michigan Northwest, PSA 2.1								
590	Escanaba River at Cornell, Mich.	1903-12 1913-15 1950-73	870	905	4,330	14.1	1,385.0	493.7
595	Ford River near Hyde, Mich.	1954-73	450	553	2,480	34.8	640.0	183.3
660	Menominee River near Pembine, Wis.	1949-72	3,240	2,965	12,100	1,200	4,318	1,877
735	Fox River at Berlin, Wis.	1898-72	1,430	1,075	4,200	311	1,623	599.1
790	Wolf River at New London, Wis.	1896-72	2,240	1,710	9,170	429.0	2,810	865.5
870	Milwaukee River at Milwaukee, Wis.	1914-72	686	382	3,550	19.4	791.6	111.6
Lake Michigan Southwest, PSA 2.2								
940	Little Calumet River at Porter, Ind.	1945-73	66.2	71.1	414	20	110	35
Lake Michigan Southeast, PSA 2.3								
1015	St. Joseph River at Niles, Mich.	1930-73	3,666	3,112	13,600	828	5,718	1,454
1190	Grand River at Grand Rapids, Mich.	1930-73	4,900	3,454	21,600	617	6,314	1,618
Lake Michigan Northeast, PSA 2.4								
565	Manistique River near Manistique, Mich.	1938-73	1,100	1,400	6,960	350	2,229	638
1220	Muskegon River at Newaygo, Mich.	1930-73	2,350	1,928	5,840	595	2,604	1,119
Lake Huron North, PSA 3.1								
1300	Cheboygan River near Cheboygan, Mich.	1942-73	865	805	1,520	260	1,042	602
1365	Au Sable River at Mio, Mich.	1952-73	1,100	973	2,241	578	1,167	746
Lake Huron Central, PSA 3.2								
1450	Shiawassee River near Fergus, Mich.	1939-73	637	400	2,560	41	688	118
1485	Flint River near Flint, Mich.	1932-73	954	1,041	4,210	31	972	153
1560	Tittabawassee River at Midland, Mich.	1936-73	2,400	1,603	8,100	225	2,289	699
Lake Erie Northwest, PSA 4.1								
1655	Clinton River at Mount Clemens, Mich.	1934-73	734	495	3,090	52	822	230
1665	River Rouge at Detroit, Mich.	1930-73	187	108	965	6	204	26
1745	Huron River at Ann Arbor, Mich.	1948-73	729	442	2,230	52.7	812	186
1765	River Raisin near Monroe, Mich.	1937-73	1,042	681	4,680	4	1,374	178
Lake Erie Southwest, PSA 4.2								
1805	St. Joseph River near Ft. Wayne, Ind.	1941-55	1,060	967	5,820	65	1,790	396
1820	St. Marys River near Ft. Wayne, Ind.	1930-73	762	561	4,900	12	1,093	174
1835	Maumee River at Antwerp, Ohio	1921-72	2,129	1,642	11,600	79	3,459	389
1980	Sandusky River near Fremont, Ohio	1924-72	1,251	920	7,660	9.9	1,551	275

TABLE 22 (continued) Flow Characteristics at Selected Stations

Station No. 4-	Stream and Station	Period of Record	Drainage Area (sq mi)	Average Discharge (cfs)	Monthly Mean Discharge Maximum (cfs)	Monthly Mean Discharge Minimum (cfs)	Annual Mean Discharge Maximum (cfs)	Annual Mean Discharge Minimum (cfs)
Lake Erie Central, PSA 4.3								
2080	Cuyahoga River at Independence, Ohio	1922-72	707	752[1]	3,585	61	1,173	278
2125	Ashtabula River near Ashtabula, Ohio	1925-72	121	149	746	0.0	210	85
Lake Erie East, PSA 4.4								
2135	Cattaraugus Cr. at Gowanda, N.Y.	1941-73	432	714	3,820	78	1,027	536
2170	Tonawanda Cr. at Batavia, N.Y.	1945-73	171	197	1,210	5.6	299	124
Lake Ontario West, PSA 5.1								
2320	Genesee River at Driving Park, N.Y.	1921-72	2,457	2,712	14,300	152	4,746	1,666
Lake Ontario Central, PSA 5.2								
2435	Oneida Cr. at Oneida, N.Y.	1950-73	113	154	626	18	294	100
Lake Ontario East, PSA 5.3								
2650	Grass R. at Pyrites, N.Y.	1925-73	335	594	2,550	70	1,107	353
2690	St. Regis R. at Brasher Center, N.Y.	1911-73	616	1,032	4,530	129	1,880	581

[1] Does not include discharge of Ohio Canal (approximately 64 cfs)

NOTE: $\text{Runoff (inches per year)} = 13.6 \times \frac{\text{Mean annual discharge (cfs)}}{\text{Drainage area (sq mi)}}$

drainage areas, and many streams flow directly into one of the Lakes. Although gaging stations have been operated on a number of the streams, the coverage is far from complete. Table 22 provides information on selected streams.

A number of these streams have diversion or storage development, and the records indicate present discharges, not those under natural conditions. Opportunities exist for additional development. In some cases of additional development, storage would be required to retain the flood flows for use during the periods of low discharge. Storage reservoir sites are available in all Lake basins, but studies of their effectiveness have not been made. For this reason no generalized statement of the availability of surface water can be made, except that there are surface supplies available for use throughout the Basin. Economic considerations often dictate whether the surface supply, ground-water supply, or a Great Lake source will be used.

The Great Lakes

The Lakes constitute a series of large reservoirs that naturally moderate the rates of the runoff from their sources to the head of the St. Lawrence River. A stream system of this size would produce wide fluctuations in discharges if it were not for the efficient natural storage afforded by the Lakes. Thus, the discharges into the St. Lawrence are relatively uniform.

The levels of the Lakes that respond to natural change in precipitation, evaporation, and similar natural phenomena are also affected by man-made dams and diversions. The outflow from Lake Superior has been completely regulated since 1921. Lake Ontario has been regulated since 1958. There are two diversions into Lake Superior from the Albany River Basin in Canada and a diversion out of Lake Michigan at Chicago to the Mississippi River.

The levels of the Lakes fluctuate seasonally, reflecting the normal hydrologic cycle. Long-term variations are the result of persistent high or low precipitation. Near-record low levels on the Lakes occurred in the mid-1960s. In 1972–76 extreme high levels prevailed on the Lakes. While there is more water available to withdraw during high-level periods than at low-level periods, withdrawals must as a matter of course be restricted to quantities that will not result in permanent lowering of Lake levels.

In addition to serving as a water supply, the Great Lakes are used for commercial navigation, recreational boating, and commercial and sport fishing. For these purposes, the real availability is measured not in terms of the quantity of water in

TABLE 23 Municipal and Industrial Water Supply Data for the Great Lakes Basin by Lake Basin, 1970, (mgd)

	Municipal									
	1970 Average Demand				Source			Gross	Self-Supplied Industrial	
Lake Basin	Domestic & Commercial	Industrial	Total	Source Capacity	Great Lakes	Inland Lakes & Streams	Ground-water	Industrial Water Req.	Withdrawal	Consumptive Use
1.0	38.1	10.3	48.4	98.2	56.9	3.5	37.8	352.0	126.0	11.0
2.0	1,528.2	514.5	2,042.7	3,588.2	2,631.7	84.7	871.8	14,145.0	5,654.0	986.0
3.0	79.8	52.8	132.6	198.9	140.8	2.1	56.0	895.0	540.0	34.0
4.0	1,213.0	566.0	1,779.0	3,028.0	2,508.0	312.0	208.0	8,955.0	3,867.0	338.0
5.0	233.0	130.0	363.0	496.0	187.0	245.0	64.0	1,062.0	388.0	31.0
TOTAL	3,092.1	1,273.6	4,365.7	7,409.3	5,524.4	647.3	1,237.6	25,409.0	10,575.0	900.0

TABLE 24 Municipal and Industrial Water Supply Data for the Great Lakes Basin by State, 1970, (mgd)

	Municipal									
	1970 Average Demand				Source			Gross	Self-Supplied Industrial	
State	Domestic & Commercial	Industrial	Total	Source Capacity	Great Lakes	Inland Lakes & Streams	Ground-Water	Industrial Water Req.	Withdrawal	Consumptive Use
Illinois	1,084.5	252.4	1,336.9	1,843.9	1,566.0	0	277.9	NA	1,348	100
Indiana	117.1	53.9	171.0	397.7	146.8	49.1	201.8	NA	3,251	285
Michigan	738.1	414.8	1,152.9	1,915.9	1,529.4	41.4	345.1	3,833	2,374	224
Minnesota	18.1	7.6	25.7	49.6	38.3	0.2	11.1	153	68	5
New York	435	200	635	909	539	268	102	1,062	1,187	99
Ohio	487	187	674	1,173	886	208	79	2,786	1,605	119
Pennsylvania	36	19	55	78	70	3	5	NA	145	12
Wisconsin	182.3	122.9	305.2	1,042.2	748.9	77.6	215.7	95	595	54
TOTAL	3,098.1	1,257.6	4,355.7	7,409.3	5,524.4	647.3	1,237.6	---	10,575	898

NA--Not Available

the Lakes, but primarily in terms of the water surface area (Table 6) and, for some purposes, water depth.

Water Withdrawals

Water is withdrawn from the Great Lakes, their tributaries, and the ground-water system for many different purposes. Table 23 shows the withdrawals for municipal water supply and self-supplied industrial water according to Lake Basin, while Table 24 shows the same information according to State.

Municipal water systems range from very small systems serving approximately 1,000 customers to the metropolitan Chicago system, which handles about 30 percent of the total municipal water withdrawn in the Great Lakes Basin. Most of Chicago's water, supplied by Lake Michigan, is used by persons who actually live outside the Basin but within the Region. Another large system serves Detroit and environs. Although the City of Detroit is in the Lake Erie Basin, the withdrawal is largely from Lake Huron, due to a change in operation that occurred after the base year for which data and the table were developed. Under this system most of the water is used in the Lake Erie Basin and is discharged to Lake Erie.

Smaller systems generally use a local source, either from inland lakes and streams or from ground water. Availability of supplies and economics of development are generally the controlling factors for the larger systems, which may use more than one source of supply.

Industrial water supplies provided from private supply systems are generally taken from the Great Lakes and connecting channels. Ground water and surface supplies are used, however, if they are more economical and available. Water for rural domestic and livestock use comes principally from ground-water sources (Tables 25 and 26). Crops are irrigated principally from ground water, but some irrigators use surface supplies. The demand is seasonal and varies with the crop and location (Tables 27 and 28).

Although most water requirements for mineral processing are seasonal, the largest single user processes taconite and has a year-round requirement. This processor, which uses a Great Lakes source, accounts for three-fourths of the water used in mineral processing in the Basin. Most of the other supplies come from surface sources, and a smaller portion comes from ground water. Tables 29 and 30 provide information on water requirements for mineral processing in each Lake basin and State.

TABLE 25 Water Supplies for Rural Domestic and Livestock Use by Lake Basin, (mgd)

Lake Basin	Developed Source Capacity	Consumptive Use
1.0	12.5	3.3
2.0	234.2	75.0
3.0	39.3	11.4
4.0	133.0	39.0
5.0	52.2	22.4
TOTAL	471.2	151.1

TABLE 26 Water Supplies for Rural Domestic and Livestock Use by State, (mgd)

State	Developed Source Capacity	Consumptive Use
IL	39.8	10.2
IN	40.2	11.4
MI	186.9	53.7
MN	5.2	1.5
NY	66	27
OH	61.0	19.0
PA	3	1
WI	68.9	26.9
TOTAL	471	151

TABLE 27 Estimated Irrigation Water Withdrawals, Great Lakes Basin by Lake Basin, (Base Year)

	Agriculture			Golf Courses			Total Annual
Lake Basin	Acres 1,000	Seasonal mgd	Annual mgd	Acres 1,000	Seasonal mgd	Annual mgd	Withdrawal mgd
1.0	1.7	2.6	0.7	1.8	6.8	1.9	2.6
2.0	133.7	242.8	66.5	21.6	101.5	27.8	94.3
3.0	11.0	18.9	5.2	1.1	4.1	1.1	6.3
4.0	38.6	62.8	17.2	35.8	173.7	47.6	64.8
5.0	11.8	21.0	5.8	5.8	28.0	7.7	13.5
TOTAL	196.8	348.1	95.4	66.1	314.1	86.1	181.5

TABLE 28 Estimated Irrigation Water Withdrawals in the Great Lakes Basin by State, (Base Year)

	Agriculture			Golf Courses			Total Annual
State	Acres 1,000	Seasonal mgd	Annual mgd	Acres 1,000	Seasonal mgd	Annual mgd	Withdrawal mgd
Illinois	3.1	5.6	1.6	6.6	31.0	8.5	10.1
Indiana	4.0	7.3	2.0	8.5	40.4	11.0	13.0
Michigan	125.7	222.3	60.9	5.6	26.6	7.3	68.2
Minnesota	0.0	0.0	0.0	1.6	6.6	1.8	1.8
New York	16.1	27.5	7.5	7.9	39.6	11.0	18.5
Ohio	9.9	16.2	4.4	28.9	136.5	37.4	41.8
Pennsylvania	1.0	1.7	0.5	0.3	1.6	.4	0.9
Wisconsin	37.0	67.5	18.5	6.7	31.8	8.7	27.2
TOTAL	196.8	348.1	95.4	66.1	314.1	86.1	181.5

TABLE 29 Minerals Water Supply for the Great Lakes Basin by Lake Basin, (estimated 1968), (mgd)

Lake Basin	Total Water Requirements	New Water[1] Seasonal	New Water[1] Annual Average	Annual Consumptive Use
1.0	938.1	576.5	572.2	54.2
2.0	67.2	45.9	33.5	2.4
3.0	22.0	24.8	16.6	1.7
4.0	131.6	115.1	88.6	11.8
5.0	29.2	17.7	16.1	5.4
TOTAL	1,118	780	727	75

[1]New water is that portion of the total supply which is withdrawan from the source during the period considered. The balance of the total requirement is provided by recirculation.

TABLE 30 Minerals Water Supply for the Great Lakes Basin by State, (estimated 1968), (mgd)

State	Total Water Requirements	New Water[1] Seasonal	New Water[1] Annual Average	Annual Consumptive Use
Illinois	3.8	2.2	1.6	0.1
Indiana	23.0	14.3	11.1	0.6
Michigan	241.9	137.8	102.3	15.7
Minnesota	871	542	542	42
New York	40.5	25.0	21.0	5.6
Ohio	55.8	42.0	36.9	10.4
Pennsylvania	2.2	1.8	1.2	0.0
Wisconsin	31.0	14.4	10.7	1.0
TOTAL	1,269	780	727	75

[1]New water is that portion of the total supply which is withdrawn from the source during the period considered. The balance of the total requirement is provided by recirculation.

TABLE 31 Power Development, Great Lakes Basin by Lake Basin, 1970

Lake Basin	Installed Capacity (MW) Hydro-electric[1]	Thermal Non-Condensing[2]	Fossil Steam	Nuclear Steam	Total	Steam-Electric Water Withdrawal (mgd)
1.0	130	55	604	0	789	516
2.0	273	614	9,846	599	11,332	5,429
3.0	120	341	1,366	0	1,827	750
4.0	0	690	12,081	70	12,841	8,760
5.0	3,544	44	1,276	1,159	6,023	1,783
TOTAL	4,067	1,744	25,173	1,828	32,812	17,238

[1]Conventional hydroelectric except 240 MW pumped storage in New York.
[2]Internal combustion and gas turbine.

TABLE 32 Power Development, Great Lakes Basin by State, 1970

State	Installed Capacity (MW) Hydro-electric[1]	Thermal Non-Condensing[2]	Fossil Steam	Nuclear Steam	Total	Steam-Electric Water Withdrawal (mgd)
Illinois	0	113	1,068	0	1,181	580
Indiana	11	106	2,831	0	2,948	1,562
Michigan	285	1,148	9,932	145	11,510	6,149
Minnesota	83	8	307	0	398	250
New York	3,544	45	2,732	1,159	7,480	3,109
Ohio	0	188	4,388	0	4,576	3,400
Pennsylvania	0	4	119	0	123	144
Wisconsin	144	132	3,796	524	4,596	2,044
TOTAL	4,067	1,744	25,173	1,828	32,812	17,238

Power development in the Basin in 1970 is shown in Tables 31 and 32. Many plants are relatively small, with less than 10-megawatt capacities. Except in local areas and for some peaking operations, the larger plants supply almost all the power and energy.

Condenser cooling is the principal use of water for thermal power plants. Practically all of the cooling systems in use in 1970 returned the water directly to the source, usually the Great Lakes or a large inland lake or stream, with comparatively little consumptive loss. However, because of thermal effects on aquatic life at the return point, there is an increasing tendency toward water recycling cooling systems that require less withdrawal of water but result in greater consumptive use. This is further discussed in connection with the assumptions made for the programs adopted in the study (Section 2).

Use of water for hydroelectric power generation in the Great Lakes Basin is largely nonconsumptive, and the return is usually near the point of withdrawal. The installed capacity is shown with other power data in Tables 31 and 32. The 1,872-megawatt pumped storage plant at Ludington, Michigan, is not included in these tables because it did not begin operations until 1973.

Nonwithdrawal Water Uses

For ease of classification in this study, waste treatment, boating, fishing, and commercial navigation are considered nonwithdrawal uses because these activities make use of the water while it remains in the lake or the stream.

The municipal and industrial waste treatment that occurred in 1970 is shown in Tables 33 and 34. Little waste treatment is shown for Illinois because all the municipal and most industrial waste discharges from the entire Chicago metropolitan area and north to the Wisconsin border are diverted from the Lake Michigan Basin to the Chicago Sanitary and Ship Canal and the Des Plaines River. These wastes are thus finally diverted to the Upper Mississippi River. Five communities now discharging to the Lake have plans to stop this discharge and are now beginning to transfer diversion to the Upper Mississippi River. Some industrial wastes in addition to heated power plant cooling water are discharged to the Lake.

Data on recreational boating and sport fishing uses are shown in Tables 35, 36, 37, and 38. Although the Great Lakes provide many opportunities for boating and fishing, the tables indicate that the greatest total activity occurs on the inland lakes.

Because the Basin States now consider the commercial fishery merely a means to enhance the sport fishery, rather than an independent industry, detailed data on commercial fishing were not compiled for the Framework Study. Changing economic conditions of the industry, caused in part by predators that entered the Lakes through the Welland Canal and species changes, induced this change in the relationship between the sport and commercial fisheries (Figure 6).

Table 39 gives data on cargo movement in various parts of the commercial navigation system. A number of harbors have been deepened at Fed-

TABLE 33 Municipal and Industrial Waste Treatment by Lake Basin

Lake Basin	Municipal Waste Flow mgd	Industrial Waste Flow mgd
1.0	44.7	55.2
2.0	686.0	3,921.1
3.0	85.0	465.3
4.0	1,923	3,671
5.0	368.0	471.0
TOTAL	3,067	8,584

TABLE 34 Municipal and Industrial Waste Treatment by State

State	Municipal Waste Flow mgd	Industrial Waste Flow mgd
Illinois	7[1]	20
Indiana	223	2,983
Michigan	1,196	1,546
Minnesota	23	32
New York	590	1,551
Ohio	674	1,674
Pennsylvania	46	147
Wisconsin	308	631
TOTAL	3,067	8,584

[1]Work is underway to cease discharging to Lake Michigan and divert out of the Basin.

TABLE 35 Recreational Boating Use in the Great Lakes Basin by Lake Basin

Lake Basin	Great Lakes Harbors	Access Sites[1]	Total Number of Boats (000s) Resident	Non-Resident	Inland	Great Lakes	Boat Days in Use (000s) Inland	Great Lakes
Superior	37	426	62.5	25.5	78.4	9.6	2,157.0	112.0
Michigan	96	NA	301.8	197.4	362.9	136.3	9,759.1	3,019.9
Huron	23	198	49.4	80.2	93.1	36.5	2,720.9	1,071.7
Erie	59	129	190.9	17.9	134.3	74.5	3,956.9	2,148.1
Ontario	29	42	104.0	33.1	91.5	45.6	2,698.1	1,327.9
Great Lakes Basin	244		708.6	354.1	760.2	302.5	21,294.0	7,679.6

NA--Not Available
[1]Includes only access sites to inland lakes.

TABLE 36 Recreational Boating Use in the Great Lakes Basin by State

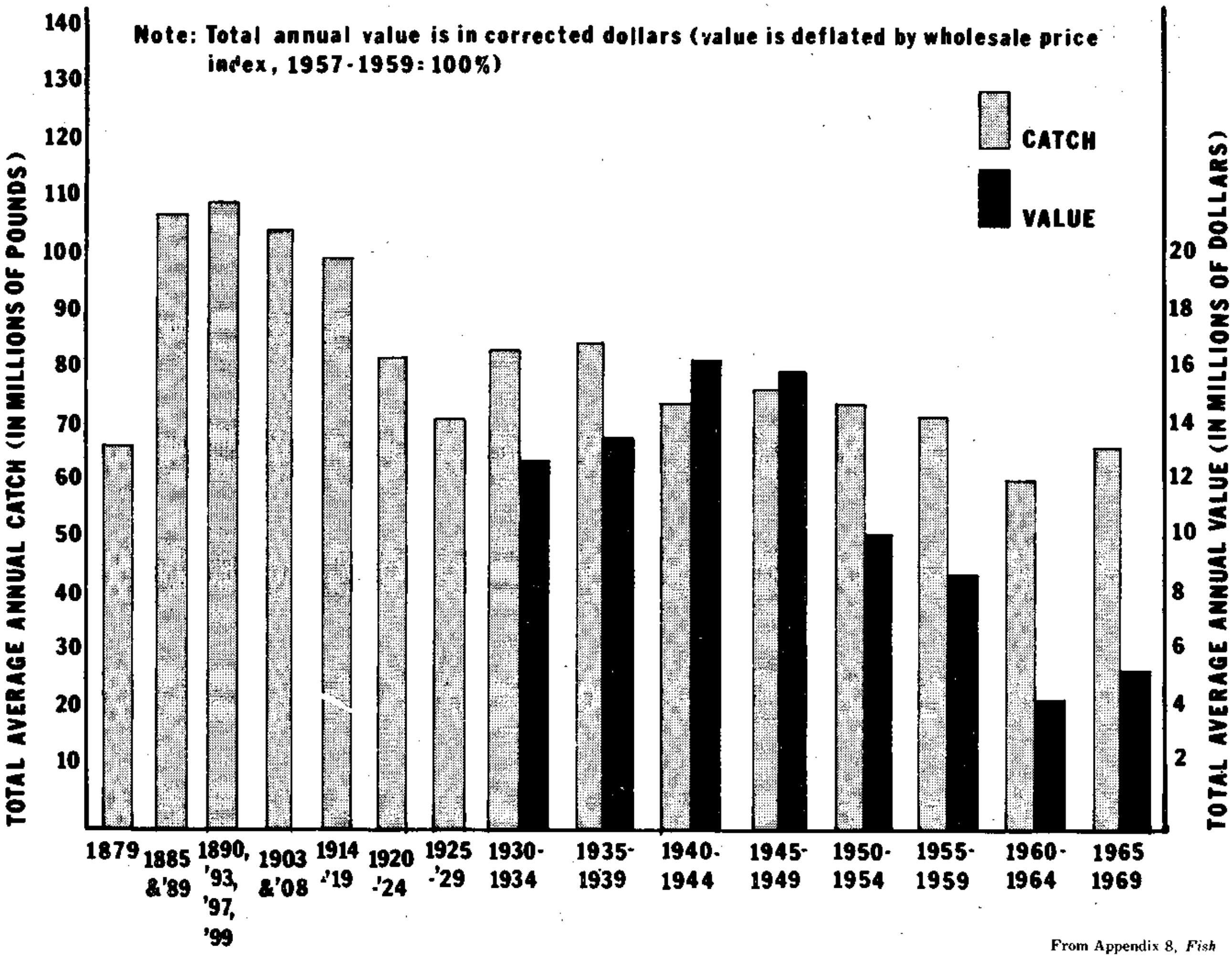
State	Great Lakes Harbors	Access Sites[2]	Total Number of Boats (000s) Resident	Non-Resident	Inland	Great Lakes	Boat Days in Use (000s) Inland	Great Lakes
Illinois	17	NA	41.8	13.8	18.2	27.4	239.6	359.4
Indiana	7	40	36.9	6.7	28.1	15.4	781.4	388.3
Michigan	94	839	299.2	199.1	362.2	136.1	10,590.4	3,840.9
Minnesota	7	130	36.4	13.5	47.4	2.5	1,275.6	26.0
New York	42	52	123.5	34.4	100.0	57.9	2,949.4	1,089.6
Ohio	27	10	52.8	4.8	33.4	24.2	975.9	699.6
Pennsylvania	5	0	1.3	0.2	0.6	0.9	18.1	25.9
Wisconsin	47	866	116.7	91.6	170.3	38.1	4,463.6	649.3
TOTAL	246[1]		708.6	354.1	760.2	302.5	21,294.0	7,679.0

NA--Not Available

[1]Total includes two harbors each lying in two States, actual number of harbors is 244.
[2]Includes only access sites to inland lakes.

TABLE 37 Sport Fishery Uses in the Great Lakes Basin by Lake Basin, 1970

Lake Basin	Ponded Waters (acres)	Fishing Licenses Resident	Non-resident	Angler Days (thousands) Inland	Great Lakes
1.0	777,757	145,359	74,179	6,729	363
2.0	804,874	1,140,440	212,191	25,517	2,737
3.0	168,352	166,346	17,909	5,200	943
4.0	110,243	682,830	27,066	16,850	11,000
5.0	263,614	271,933	7,838	10,747	1,100
TOTAL	2,124,840	2,406,908	339,183	65,043	16,143

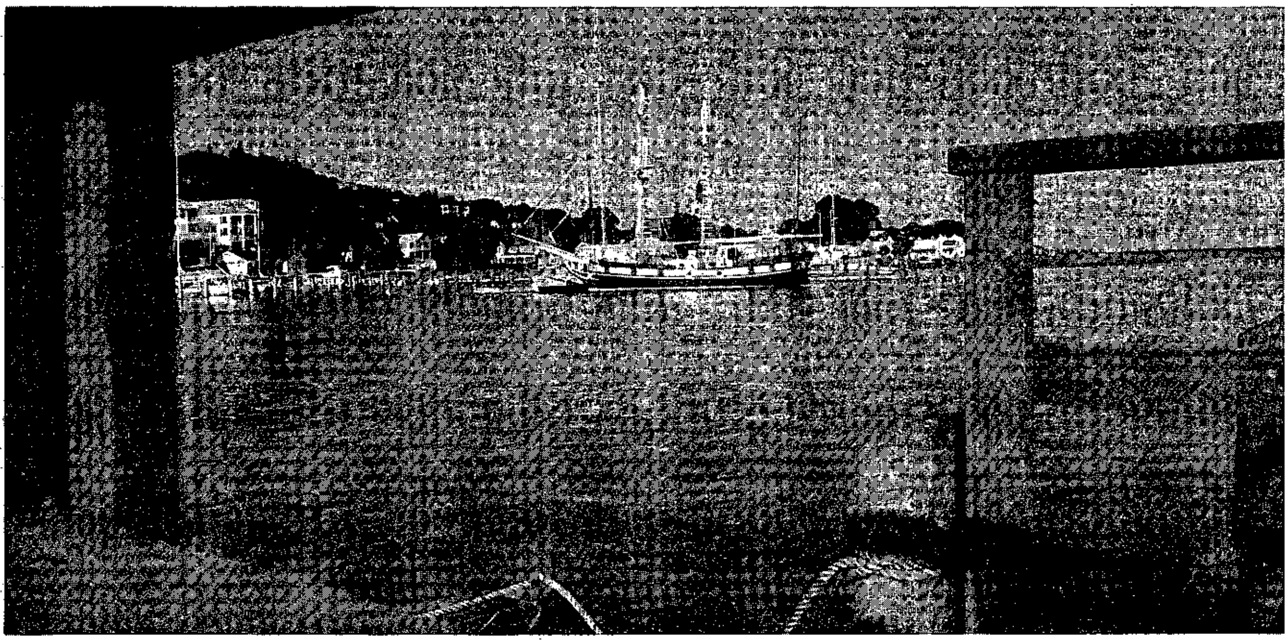


From Appendix 8, *Fish*

FIGURE 6 Total Average Annual Catch and Total Average Annual Value of the U.S. Great Lakes Commercial Fisheries

TABLE 38 Sport Fishery Uses in the Great Lakes Basin by State, 1970

State	Ponded Waters (acres)	Fishing Licenses		Angler Days (thousands)	
		Resident	Non-Resident	Inland	Great Lakes
Illinois	30,364	273,520	1,267	817	800
Indiana	33,393	162,377	12,628	1,101	170
Michigan	789,129	782,954	165,380	21,616	4,582
Minnesota	562,526	94,163	38,851	3,097	10
New York	264,336	367,182	14,649	13,606	1,800
Ohio	58,609	335,530	9,724	11,316	7,880
Pennsylvania	722	17,360	1,050	558	500
Wisconsin	385,761	373,822	95,624	12,932	481
TOTAL	2,124,840	2,406,908	339,183	65,043	16,143



Recreational boating opportunities are in continuing demand in the Great Lakes Basin.

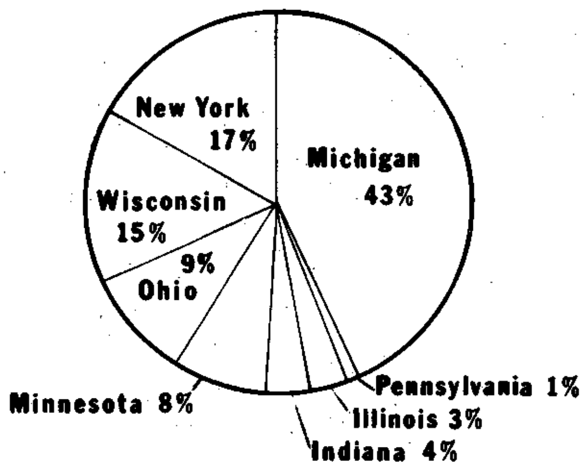
eral expense, while others have been developed by State, Regional, or local groups, or by private industry. All are constructed and maintained to aid economic interests in the Basin in transporting goods at low cost by water.

Land Availability

The land resources discussed in the Framework Study are those in the Great Lakes Region, defined by the political boundaries that most closely approximate the hydrologic boundaries of the Great Lakes Basin. Tables 40 and 41 compare the areas of the Basin and the Region. They indicate areas of rivers, lakes, and embayments that have been deducted from the total area to give net land area used in this study. Figure 7 shows the total area of the Region in each State and the percentage in each State.

Much Basin land can accommodate only restricted uses. Availability for any particular use is determined by the characteristics of the land itself and the land cover, and by the current uses of the specific area and the adjacent land.

From the standpoint of national and international needs, the most appropriate use of a piece of good agricultural land may be the growing of crops, but proximity to a city and the ease with which the land could be developed may result in its being used for urban purposes. Urbanization of good agricultural land has been a constant process that must be reversed if valuable agricultural land is to be retained in the resource base.



State	Total Area in Region (1,000,000 acres)
Michigan	37.3
New York	14.3
Wisconsin	13.2
Ohio	7.8
Minnesota	7.3
Indiana	3.7
Illinois	2.4
Pennsylvania	0.5
Total Area in Region	86.5

Appendix 1, *Alternative Frameworks*

FIGURE 7 Percentage of Total Region Area in Each State, 1970

TABLE 39 Cargo Carried on the Great Lakes and Connecting Channels by Area, 1959–1973, (million tons)

Area	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Lake Superior	60.3	81.8	68.9	70.0	72.7	77.9	78.7	85.3	75.4	76.5	85.3	78.7	71.6	75.6	92.0
St. Marys River	65.9	86.6	74.2	74.5	77.4	83.7	81.3	87.3	77.9	78.7	88.1	81.1	75.9	79.7	97.6
Lake Michigan including the Port of Chicago[1]	81.5	92.0	85.4	85.1	107.4	117.7	117.5	125.9	124.6	120.7	125.5	131.1	121.3	122.9	124.5
Lake Huron	106.4	126.0	113.8	114.9	122.7	136.7	138.9	148.0	136.0	138.5	144.5	141.3	130.8	135.5	155.4
St. Clair River, including Channels in Lake St. Clair	78.9	97.2	84.6	87.2	93.0	103.5	107.0	113.9	101.0	107.1	109.3	109.2	102.9	106.5	118.9
Detroit River	92.6	111.2	96.2	100.0	107.2	120.3	124.5	129.2	118.5	122.6	122.8	125.6	115.7	119.0	131.7
Lake Erie, including Upper Niagara River	100.7	114.9	101.0	107.4	120.2	134.5	140.6	147.5	136.6	143.2	142.7	142.7	129.9	132.6	147.4
Welland Canal	21.0	21.7	21.5	27.5	31.1	38.9	40.6	43.8	41.7	46.6	43.4	45.7	43.3	44.0	49.5
Lake Ontario, including Lower Niagara River	21.4	22.1	21.7	28.0	33.1	38.8	41.0	43.1	41.0	47.1	45.0	45.1	42.9	43.5	49.8
St. Lawrence River[2]	12.5	12.0	12.8	16.3	19.4	25.6	27.7	29.5	27.9	33.1	27.7	30.9	30.4	30.6	37.4
Net United States traffic on the Great Lakes				184.3	209.5	213.3	217.5	231.7	217.3	221.8	225.9	228.2	208.8	214.0	231.9

[1]This area includes Chicago Harbor, North Branch, South Branch, Sanitary Ship Canal, Calumet-Sag Canal, Calumet Harbor and River, and Lake Calumet.

[2]Includes the portion of the River between the International Boundary Line and Lake Ontario.

TABLE 40 Land and Water Areas, Great Lakes Basin and Great Lakes Region by Plan Area

	Political Boundaries 1000s Acres			Hydrologic Boundaries		
				Total Area		
Plan Area	Total Area	Rivers, Lakes, and Embayments	Land Area	1000s of Acres	Square Miles	% of Great Lakes Basin
1.0--Lake Superior	16,998.4	1,083.1	15,915.3	10,870.4	16,985	14.4
2.0--Lake Michigan	33,283.1	1,010.7	32,272.4	29,011.0	45,330	38.5
3.0--Lake Huron	8,628.4	186.5	8,441.9	10,357.8	16,184	13.8
4.0--Lake Erie	15,876.0	197.6	15,678.4	13,734.4	21,460	18.2
5.0--Lake Ontario	11,721.0	449.3	11,271.7	11,308.8	17,670	15.0
GLB TOTAL	86,506.9	2,927.2	83,579.7	75,282.4	117,629	----

TABLE 41 Land and Water Areas, Great Lakes Basin and Great Lakes Region by State

	Region--Political Boundaries 1000s Acres			Basin--Hydrologic Boundaries		
				Total Area		
State	Total Area	Rivers, Lakes, and Embayments	Land Area	1000s of Acres	Square Miles	% of Great Lakes Basin
Illinois	2,401.3	34.0	2,367.3	38.4	60	0.05
Indiana	3,687.0	51.7	3,635.3	2,331.5	3,643	3.10
Michigan	37,258.1	1,035.0	36,223.1	37,138.5	58,029	49.33
Minnesota	7,317.8	737.9	6,579.9	3,930.9	6,142	5.22
New York	14,309.8	487.3	13,822.5	12,714.9	19,867	16.89
Ohio	7,816.4	68.9	7,747.5	7,479.7	11,687	9.94
Pennsylvania	524.2	5.1	519.1	386.5	604	0.51
Wisconsin	13,192.3	507.3	12,685.0	11,262.0	17,597	14.96
TOTAL	86,506.9	2,927.2	83,579.7	75,282.4	117,629	100.00

Existing Development

Indians inhabited the Great Lakes Basin for centuries before Samuel de Champlain made the first European discovery of the Lakes in 1615. Soon the Lakes were being used by American and European voyagers and traders traveling throughout the area. The English, French, and later the new Americans, exercised sovereignty over portions of the Lakes, using water and land routes established by the Indians. The villages connected by these routes are the cities of today.

Trapping was an early industry, but as trappers and hunters diminished the numbers of fur-bearing animals, farmers began replacing explorers. Forests were first cleared for farms that sprang up through much of the southern portion of the Basin. Then a lumber industry grew to furnish material for the towns and cities that were built to support the agricultural industry. Eventually lumbering, which became an industry providing material for export from the Region, declined as forests were depleted. Low-cost water transportation developed naturally to bring together metallic minerals in the northern part of the Basin and fuels in the south. Thus the huge industrial complex along the southern shores of the Great Lakes began to develop.

Many factors spark development. The needs of the people in the Region and throughout the nation as well as the opportunities afforded by the natural resources in the area have all contributed to the economic situation that exists in the Basin today. The basic shifts from trapping to lumbering to farming to manufacturing brought drastic changes in resource use. Throughout all these stages the Great Lakes have remained a transportation route of significant importance.

Use of Related Land

The land resources of the Basin can be used in many ways, and the uses change over time. Table 42 summarizes land and water area and present land use by plan area. (See Table 7 for summarization by State.) The classification of land use shown in the

TABLE 42 Water Area and Land Use, by Plan Area, (Base Year 1966–1967), (thousands of acres)

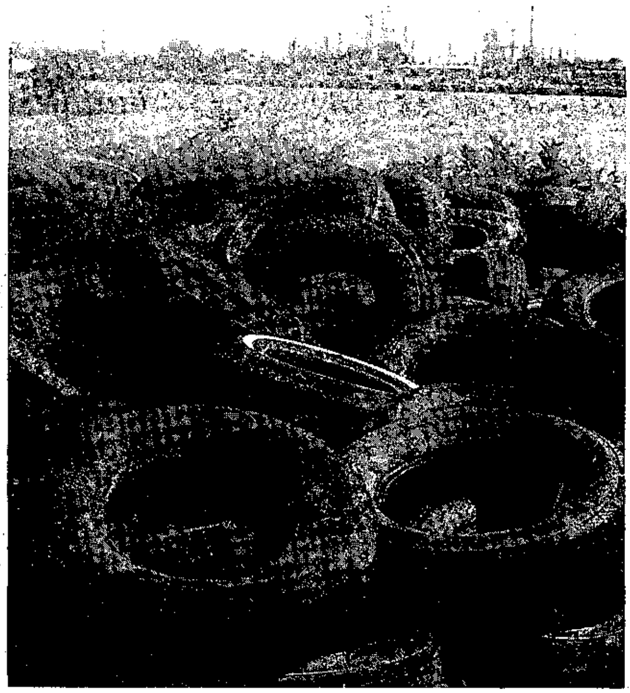
Plan Area	Total Area[1]	Rivers, Lakes, and Embayments	Total Land Area	Urban Built-Up	Land Resource Base: Cropland	Pasture Range	Forest Land	Other	Total
1.0	16,998.4	1,083.1	15,915.3	422.3	692.9	165.3	14,264.5	370.3	15,493.0
2.0	33,283.1	1,010.7	32,272.4	2,907.8	13,016.1	1,405.3	12,596.2	2,347.0	29,364.6
3.0	8,628.4	186.5	8,441.9	568.6	2,901.2	358.8	4,109.0	504.3	7,873.3
4.0	15,876.0	197.6	15,678.4	2,421.3	8,550.7	715.4	3,022.4	968.6	13,257.1
5.0	11,721.0	449.3	11,271.7	667.7	3,448.1	861.0	5,632.6	662.3	10,604.0
TOTAL	86,506.9	2,917.2	83,579.7	6,987.7	28,609.0	3,505.8	39,624.7	4,852.5	76,592.0

[1]Area measurement by county boundaries.

TABLE 43 Total Land Disturbed by Mining Activities as of January 1, 1965, by Commodity and Plan Area, (acres)

Commodity	Plan Area 1.0	2.0	3.0	4.0	5.0	Great Lakes Region Total
Copper	2,000	---	---	---	---	2,000
Clay and shale	80	506	260	2,433	570	3,849
Coal	---	5,488	---	728	---	6,216
Gypsum	---	---	1,105	377	40	1,522
Iron ore	47,615	449	---	---	630	48,694
Peat	620	200	675	418	32	1,945
Sand and gravel	7,949	37,655	14,005	19,214	11,977	90,800
Stone	1,614	7,364	3,876	9,291	3,875	26,020
Other	40	15	---	1,487	180	1,722
TOTAL	59,918	51,677	19,921	33,948	17,304	182,768

From Appendix 5, *Mineral Resources*



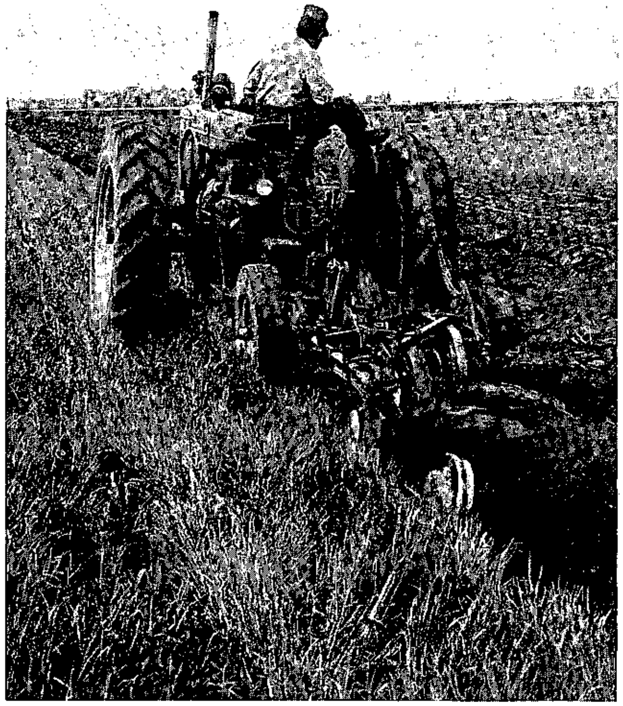


Photo by G. Bernath, courtesy of USDA, Soil Conservation Service

Land uses range from crop production to waste disposal.

tables is based on the Conservation Needs Inventory of the Department of Agriculture. Understandably, it is oriented largely toward agricultural uses. Mineral uses, recreational uses, and fish and wildlife uses are not specifically identified. Strip mines, quarries, and borrow pits are included in "other." In general, fish and wildlife and recreational lands are included in some other use classification.

Table 43 lists the number of acres disturbed by mining activities according to commodity and plan area as of January 1, 1965. Table 44 shows the mineral-bearing land requirements at about 1970 according to plan area and commodity.

While many areas used for fish and wildlife or recreational purposes may be devoted exclusively to these uses, no inventory of such lands is available. Much land under Federal ownership, such as national forests and national parks, is available for these purposes, as is land under State and other governmental ownership. This study does not attempt to identify the amount of such land. An inventory of the land available for fish and wildlife habitat was made in 1960 (Table 45).

A particularly valuable land resource in the area is the Great Lakes shoreland, stretching for almost 3,500 miles. The shore ranges widely in character and in use. Tables 46 and 47 show condition, ownership, and use in 1970. The high lake levels of 1973 created some problems of erosion and flooding above those indicated in the tables.

Great Lakes Basin Problems and Needs

The developed supply of water and related land at the 1970 base year and the needs projected for each of the years 1980, 2000, and 2020 for the Great Lakes Basin are shown in Table 48. The figures given are the totals of those for the 15 river basin groups and planning subareas. The total figures give an overview of the situation in the Great Lakes Basin and an idea of the magnitude of the solutions that must be devised.

Problems relating to specific resource categories that were identified in the various parts of the Basin are displayed in Table 49, the Resource Problems Matrix. This matrix gives information both for the Great Lakes Basin and for each of the five Lake basins.

The analysis and the development of solutions and frameworks were done for each river basin group, which allowed solutions to be quantified and displayed according to State and Lake basin. Tables 63, 66, 69, 72, 75, 78, 81, and 84 at the end of Section 4 present the needs of each State.

TABLE 44 Projected Mineral-Bearing Land Requirements[1] by Commodity and Plan Area, (acres)

	1968[2]	1980	1968 to 1980[3]	2000	1968 to 2000[3]	2020	1968 to 2020[3]
COMMODITY							
Clays and shale	64	81	893	129	2,956	207	6,368
Coal	121	53	1,130	0	1,300	0	1,300
Copper	4,500	4,500	4,500	7,000	7,000	10,000	10,000
Iron ore	55,600	90,700	90,700	174,600	174,600	286,600	286,600
Peat	2,477	2,660	3,194	3,216	4,507	4,106	6,388
Gypsum	24	30	329	40	1,026	54	1,970
Sand and gravel	1,929	2,568	26,662	4,422	95,827	7,638	217,148
Stone, crushed	473	615	6,440	841	19,894	1,315	40,883
Stone, dimension	3	6	64	9	225	17	487
Zinc-lead	250	500	500	500	500	700	700
TOTAL	65,441	101,713	134,412	190,757	307,835	310,637	571,844
PLAN AREA							
1.0--Superior	58,740	93,265	94,892	177,905	183,665	291,090	303,199
2.0--Michigan	2,576	3,266	17,341	5,943	55,705	9,483	124,271
3.0--Huron	1,133	1,272	5,013	1,743	15,577	2,532	33,050
4.0--Erie	1,579	2,056	12,055	2,880	38,331	4,358	80,828
5.0--Ontario	1,413	1,854	4,111	2,286	14,557	3,174	30,496
TOTAL	65,441	101,713	134,412	190,757	307,835	310,637	571,844

From Appendix 5, *Mineral Resources*

[1] Includes nonmineral-bearing surface lands required for copper, iron ore, and zinc-lead production.
[2] Estimated.
[3] Cumulative.

Most areas of the Basin have adequate supplies of good quality water for municipal use, for rural domestic and livestock use, and for industry. Where the quantity and quality of ground water are not satisfactory, surface-water supplies, including the Great Lakes, are used. As Table 48 indicates, the needs for municipal and industrial water supplies increase above base year supplies as population and economic activity increase.

Irrigation of golf courses is expected to increase. It is estimated that the total Basin irrigation water withdrawal in 2020 may be approximately five times the present withdrawal. Sufficient water has been available to fill the small demand for irrigation of agricultural land in the Basin. The availability of additional supplies, however, might induce more irrigation in some areas, and such supplies could be provided if economically justified.

Water withdrawals for processing minerals are expected to increase so that withdrawals in 2020 will be more than twice as great as in the base year. The problems identified with water used by mine operators are primarily related to the return of process wastewater to the Lake rather than to the withdrawals themselves. The use of shoreline land for industrial purposes to the exclusion of other uses is also a problem.

Photo by Andrew Stoddard

Clean water is essential to support life.

TABLE 45 Acres of Farm and Forest Game Habitat in the Great Lakes Region by State, 1960

State	Total Land Area (in acres)	Farm Habitat Acres	Farm Habitat % of Total Land	Forest Habitat Acres	Forest Habitat % of Total Land	Total Habitat Acres	Total Habitat % of Total Land
Illinois	2,367,300	1,466,500	62	148,100	6	1,614,600	68
Indiana	3,635,300	2,811,800	77	364,800	10	3,176,600	87
Michigan	36,223,100	13,447,700	37	18,993,600	52	32,441,300	89
Minnesota	6,579,900	587,400	9	6,037,500	92	6,624,900	101[1]
New York	13,822,500	6,788,000	49	5,527,900	40	12,315,900	89
Ohio	7,747,500	6,354,500	82	1,089,800	14	7,444,300	96
Pennsylvania	519,100	281,900	54	124,000	24	405,900	78
Wisconsin	12,685,000	5,506,500	44	6,003,200	47	11,509,700	91
TOTAL REGION	83,579,700	37,244,300	45	38,288,900	46	75,533,200	91

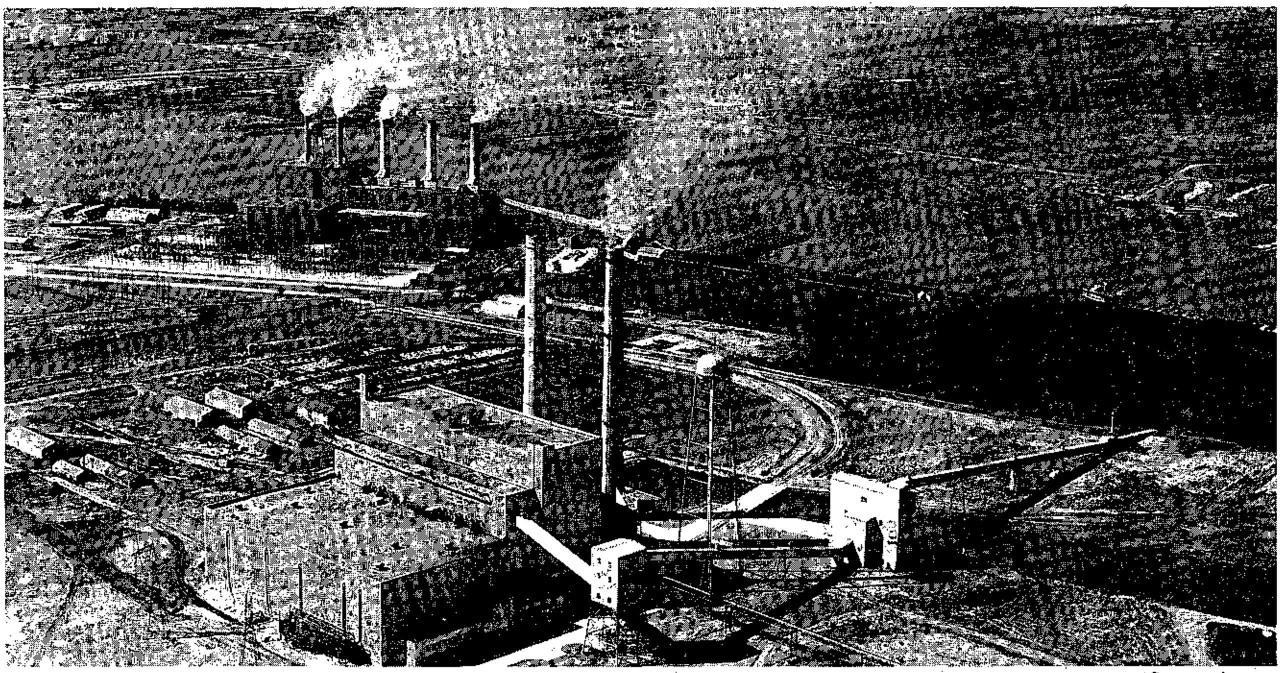
[1]Total habitat probably includes some water areas excluded from "land" area.

NOTE: The area of the land resource base, made up of the farmland and forest land, and reported elsewhere, is based on 1966-67 measurements and estimates. Habitat is based on 1960 information and estimates. In some instances changes in land use result in habitat being recorded as greater than the corresponding land base in the PSA or State.

TABLE 46 Great Lakes Shoreline Use, Ownership, and Condition by Lake Basin, 1970

Great Lakes Shoreline	Total	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
USE						
Residential, Commercial and Industrial, Public Lands and Buildings	1,362.4	201.4	552.4	256.6	202.5	149.5
Agriculture and Undeveloped	583.6	40.2	280.6	84.7	68.2	109.9
Forest	1,134.4	599.0	350.0	181.0	4.4	0.0
Recreation (Public)	334.8	70.2	160.8	25.6	48.0	30.2
Fish and Wildlife Wetlands	55.4	1.2	13.2	17.1	18.9	0.0
OWNERSHIP						
Federal	133.1	91.4	25.4	9.5	6.8	0.0
Non-Federal Public	466.2	87.0	219.9	56.4	71.0	31.9
Private	2,871.3	733.6	1,116.7	399.1	264.2	257.7
PROBLEM IDENTIFICATION						
No Problem	1,666.0	738.2	471.8	327.7	68.5	59.8
Critical Erosion	203.9	28.7	130.1	8.0	20.3	16.8
Noncritical Erosion	993.2	127.9	457.4	154.4	84.5	169.0
Subject to Flooding	289.8	11.8	140.7	74.9	44.0	18.4
Protected	317.7	5.4	162.0	0	124.7	25.6
Total Shoreline Mileage-- Great Lakes	3,470.5	912.0	1,362.0	565.0	342.0	289.6

NOTE: Mileages estimated for Lake basin and States from tables and small scale maps in *Great Lakes Region Inventory Report, National Shoreline Study*, August 1971, and Appendix 12, *Shore Use and Erosion, Great Lakes Basin Framework Study.*



Source unknown

Water withdrawals for use in power plants are expected to increase several fold by the year 2020.

Water withdrawals for condenser cooling in thermal power plants are expected to increase so markedly that needs in the year 2020 are projected at roughly 5½ times the present withdrawals. These projections are based on a mix of flow-through and supplemental cooling systems. If flow-through systems are used exclusively, the withdrawals will be even larger. If supplemental cooling systems are used, withdrawals will be smaller, but the consumptive use will be greater. Although no major problems have been identified with thermal power cooling at this time, the question of introducing heated effluents into the Lakes is under study to determine the effects both in the immediate vicinity of the discharge and on the Lake as a whole. The question of power plant siting is both a water and a land use problem closely related to the withdrawals. Studies of this problem and its ramifications are recommended as a part of the implementation of the Framework Study.

Both municipal and industrial wastewater discharges create problems in nearly all parts of the Basin. They demand the most immediate attention in the Lake Erie Basin. In the other Lake basins remedial measures taken now will prevent future trouble. One of the costs of manufacturing in the Basin is the cost of treating wastewater. This cost has not yet been reflected by manufacturers in the price structure of products. Table 48 shows that requirements for municipal wastewater treatment will more than double between 1970 and 2020. Industrial wastewater discharges, however, will decrease through the year 2000 and then increase to slightly above the 1970 figure. The decrease will result in part from industry reliance on municipal plants for wastewater treatment. More extensive in-plant treatment and reuse of water is also a factor. The cleaner effluent now required to be discharged into a lake or stream has increased the cost of manufacturing to the point where in-house treatment for reuse may effect considerable savings both in dollars and in water withdrawn. However, it may also increase consumptive use of water.

The Basin as a whole does not have much opportunity for conventional hydroelectric development beyond present installations, the largest of which are at Niagara Falls, along the St. Lawrence River, and elsewhere in New York State. There are a few additional smaller installations and possibilities for installations elsewhere in the Basin.

A number of pumped storage plants are being constructed and others are under study. The needs for water for this purpose are shown in Table 48. The large pumped storage plant at Ludington, Michigan, began production after the base year, and the needs for water for this plant are shown for 1980. Those for other plants under consideration are shown for 2000 and 2020.

Problems related to water-oriented outdoor recreation exist in many parts of the Basin. In general, these occur because locations suitable for recrea-

TABLE 47 Great Lakes Shoreline Use, Ownership, and Condition by State, 1970

Great Lakes Shoreline	Total	IL	IN	MI	MN	NY	OH	PA	WI
USE									
Residential, commercial & industrial, public lands & buildings	1,362.4	33.5	27.9	687.5	68.8	188.1	128.1	24.8	203.7
Agricultural & undeveloped	583.6	0.6	0.1	282.3	11.0	134.3	16.4	11.9	127.0
Forest	1,134.4	0	0	900.0	69.7	0	3.5	0	160.3
Recreation (public)	334.8	30.9	17.0	125.3	24.2	38.1	33.6	11.6	54.1
Fish & wildlife wetlands	55.4	0	0	27.3	1.2	0	8.7	0	18.2
OWNERSHIP									
Federal	133.1	3.1	9.3	38.2	20.1	0	5.8	0	56.6
Non-Federal public	466.2	35.8	8.7	217.5	19.0	44.7	24.5	11.6	94.3
Private	2,871.3	26.1	27.0	1,767.6	135.7	315.8	150.0	36.7	412.4
PROBLEM IDENTIFICATION									
No problem	1,666.0	0	0	1,203.4	163.5	106.6	21.7	0	170.8
Critical erosion	203.9	10.5	13.0	103.8	0.5	16.8	14.3	6.0	39.0
Noncritical erosion	993.2	0	9.6	479.2	10.9	179.6	37.9	36.0	240.0
Subject to flooding	289.8	0	0	185.7	0	19.1	10.8	0	74.2
Protected	317.7	54.5	22.4	51.2	0	38.4	105.6	6.3	39.3
TOTAL SHORELAND MILEAGE									
Great Lakes	3,470.6	65.0	45.0	2,023.3	174.9	360.5	140.3	48.3	563.3
Other[2]	521.7	0	0	206.2	31.3	154.0	74.5	0	55.7

[1]Mileages estimated for lake basins and States from tables and small scale maps in *Great Lakes Region Inventory Report, National Shoreline Study,* August 1971, and Appendix 12, *Shore Use and Erosion, Great Lakes Basin Framework Study.*

[2]"Other" includes: MI-St. Marys River 91.2 mi; St. Clair River 37.0 mi; Lake St. Clair 47.0 mi; Detroit River 31.0 mi; MN-Duluth Harbor 31.3 mi; NY-Niagara River 39.0 mi; St. Lawrence R. 115.0 mi; OH-Sandusky Bay 74.5 mi; WI-Superior Harbor 55.7 mi

tion are too remote from the concentrations of people. Specific conflicts in land use occur along the Lake shores and in areas where restrictions of access preclude the use of high quality recreation land and water. The amounts of water currently used and needed for recreational purposes have not been evaluated, but in general there is a shortage of facilities, including water for outdoor recreation in the southern part of the Basin. Generally there is surplus or adequate supply in the northern part of the Basin. This shortage-surplus relationship exists for the present population, in spite of the fact that many persons from the southern part of the Basin go north for recreation, shifting some of the demand from the densely populated to the sparsely populated area.

Except for problems related to the management of the resources and the development of facilities, there are few problems requiring urgent attention in the sport and commercial fishing, recreational boating, and commercial navigation categories. Although there is adequate water for recreatonal boating on the Great Lakes, the lack of adequate harbor facilities and suitable safe water surface limits use. Only areas within safe boating range of harbors of refuge can be used, and these harbors are spaced too far apart to permit complete use of the band of water along the shore. In addition, communication facilities for storm warning are not adequate.

The sport fishery on the streams in the Great Lakes accommodates all the present fishermen, but it is believed more people would take advantage of this sport if the competition for available fishing spots were not so great. Consequently, there is a general shortage of supply throughout the Basin.

TABLE 48 Future Water and Related Land Needs and Opportunities, Great Lakes Basin Total, Normal Framework

RESOURCE USE CATEGORIES	UNITS[1]	1970 Supply[2]	Needs and Opportunities[3] Base Year, 1970, to 1980	2000	2020
Water Withdrawals					
Municipally Supplied	mgd	4,300	870	2,810	5,400
Self-Supplied Industrial	mgd	10,600	1,110	4,670	10,300
Rural Dom. & Livestock	mgd	471	64	179	267
Irrigation	mgd*	681	824	1,570	2,460
Mining	mgd	780	148	450	965
Thermal Power Cooling	mgd	17,200	8,210	38,700	96,500
Nonwithdrawal Water Uses					
Mun. Wastewater Dischgs.	mgd[4]	3,060	3,680	4,940	6,720
Ind. Wastewater Dischgs.	mgd[4]	8,580	7,330	6,000	9,210
Hydroelectric Power	mgd	NA	47,300	51,300	105,000
W.O. Outdoor Recreation	1,000 rec. days	100,000	105,000	201,000	329,000
	1,000 acres W.S.[5]	NA	---	---	---
Sport Fishing	1,000 angl. days	80,700	24,800	52,300	79,200
	1,000 acres W.S.				
Recreational Boating	1,000 boat days	29,000	6,820	12,500	19,500
	1,000 acres W.S.*	7,260	7,260	7,260	7,260
Commercial Fishing	million tons/yr.				
Commercial Navigation	million tons/yr.	343	432	583	754
Related Land Use & Problems					
Agr. Land--Treatment	1,000 acres*	20,450	20,450	20,450	20,450
--Cropland Drainage	1,000 acres*	6,210	6,210	6,210	6,210
Forest Land--Treatment	1,000 acres*	27,900	27,900	27,900	27,900
Shoreland Erosion	miles	1,200	1,200	1,200	1,200
Streambank Erosion	miles	10,900	10,900	10,900	10,900
	$1,000 AAD[6]	1,710	1,710	1,710	1,710
Flood Plains--Urban	1,000 acres	222	230	240	251
--Urban	$1,000 AAD	46,300	67,100	118,000	190,000
--Rural	1,000 acres	2,570	2,560	2,560	2,550
--Rural	$1,000 AAD	14,200	18,000	24,200	32,400
Wildlife Management	1,000 acres		2,920	7,990	14,100
	1,000 user days	49,600	15,000	23,900	33,300
Aesthetic & Cultural	1,000 acres				
Outdoor Rec.--Intensive	1,000 acres		30	62	109
--Extensive	1,000 acres		170	348	600

[1]Asterisk denotes opportunity
[2]Includes problems and opportunities
[3]Additional resource requirements beyong 1970 requirements
[4]Total treatment requirement at each time period; footnote[3] does not apply
[5]Water Surface
[6]Average Annual Damages

Courtesy of Wisconsin Department of Natural Resources

Municipal and industrial wastewater discharges pollute waters in nearly every portion of the Basin.

Commercial fishing needs were not evaluated because all the States consider commercial fishing to be primarily a means of managing the fishery resource through removal of undesirable species and harvesting of excesses for the benefit of sport fishing rather than as a commercial enterprise.

For commercial navigation, the controlling elements are the harbors, locks, and connecting channels. Channels could be deepened and widened, harbors enlarged, and locks rebuilt if the benefits were shown to be greater than the costs and environmental impacts were acceptable. Projected needs are based on the amount of anticipated traffic. The base year figures and projections shown in Table 48 include receipts plus shipments at ports and are larger than actual traffic on the Lakes. They do not indicate the anticipated conditions and the need for port facilities.

In many parts of the Basin land use problems stem largely from a lack of adequate planning to insure that land is used wisely according to need and suitability. Degradation frequently occurs because of overuse—whether for housing, recreation, mining, or other purposes. The most crucial land use problem areas are lake and stream shorelines where erosion and damage result from development on erodible areas and in the flood plains.

In addition to these problems, opportunities exist for managing and treating the agricultural land resource base. This base (Table 50) represents the acreage remaining in each projection year after subtracting the acres used for urban and industrial expansion. Estimates of future agricultural land requirements are derived from an analysis of the productivity of the land and projected requirements for food and livestock production. The Basin's requirements for all major crop and livestock products except eggs are expected to increase more rapidly than those of the nation. Assuming that existing technology and management techniques will be more widely adopted to increase crop yields and livestock feeding efficiencies, it becomes clear that the resource base in each planning subarea is more than adequate to meet future requirements. Changes in world food production and requirements could greatly alter this situation, however. Although the resource base has the capacity to carry future needs, more efficient use of these resources is possible through agricultural land treatment, cropland drainage, and forest land treatment.

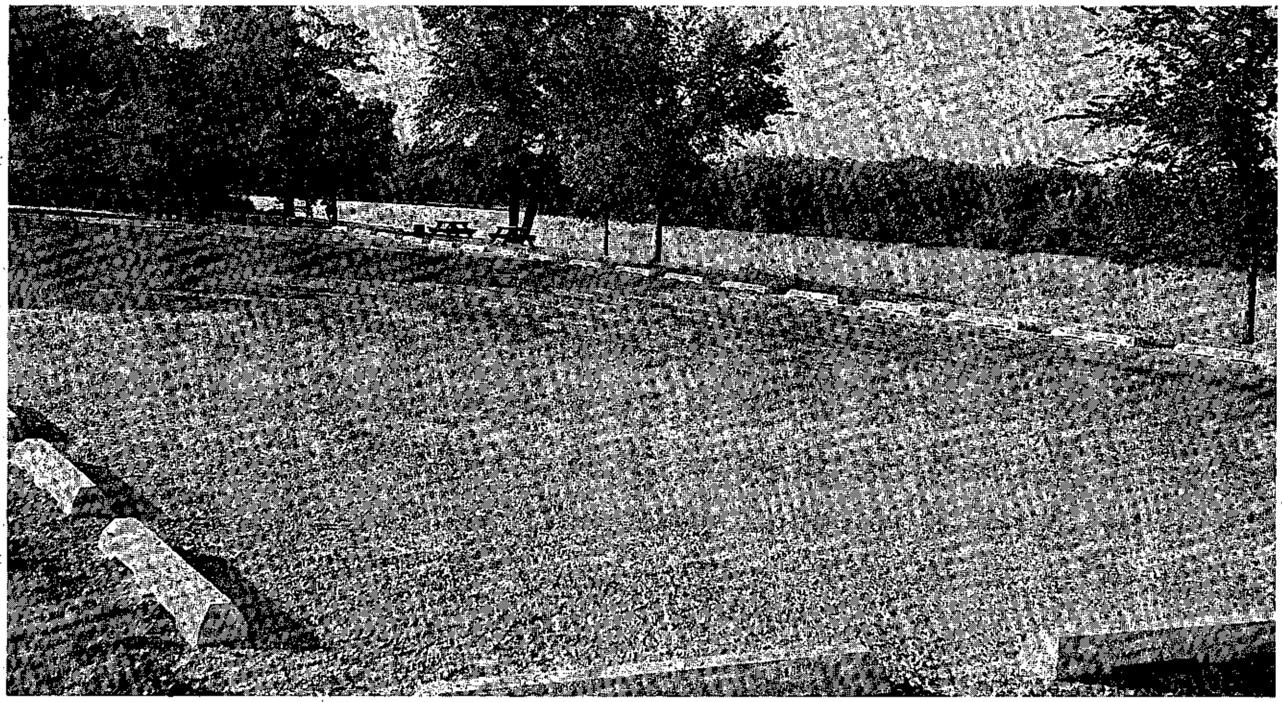
Damages from erosion and sedimentation in the Great Lakes Basin are extensive because of the intensively used land and water resources. The demand for a high level of water quality makes the problem critical. Erosion causes a wide variety of sedimentation damages, particularly on intensely cultivated soils in the southern parts of the Basin, on streambanks, roadsides, and other exposed areas, and in developing urban areas. These damages range from sedimentation of harbor facilities to debasement of water quality and fish and wildlife habitat. Table 51 summarizes the mean annual gross erosion rate for each Lake basin.

Table 48 quantifies the miles of Great Lakes shoreline subject to significant erosion and the need for measures that will alleviate it. This estimate is based on lake levels of 1970 and would be more if the high lake levels of 1973 and 1974 were used as the base. The number of miles of eroding streambank is also shown in the table together with the average annual damage.

A projection of the damages that will be caused by flooding was developed separately for urban and rural classifications. The damages were classed as problems (needs) that require some sort of action and are shown in Table 48 in terms of both the acres affected and the average annual damages (AAD).

Critical to wildlife management is the preservation of high quality habitat such as marshes and wetlands along the shores of the Lakes. Expenditure of public funds, public education regarding appropriate resource use, and legislation are required to solve wildlife management problems.

The Basin has many aesthetic and cultural areas



Courtesy of Wisconsin Department of Natural Resources

A common water-oriented outdoor recreation problem is that many opportunities for recreation are located too far away from population concentrations to be of great value.

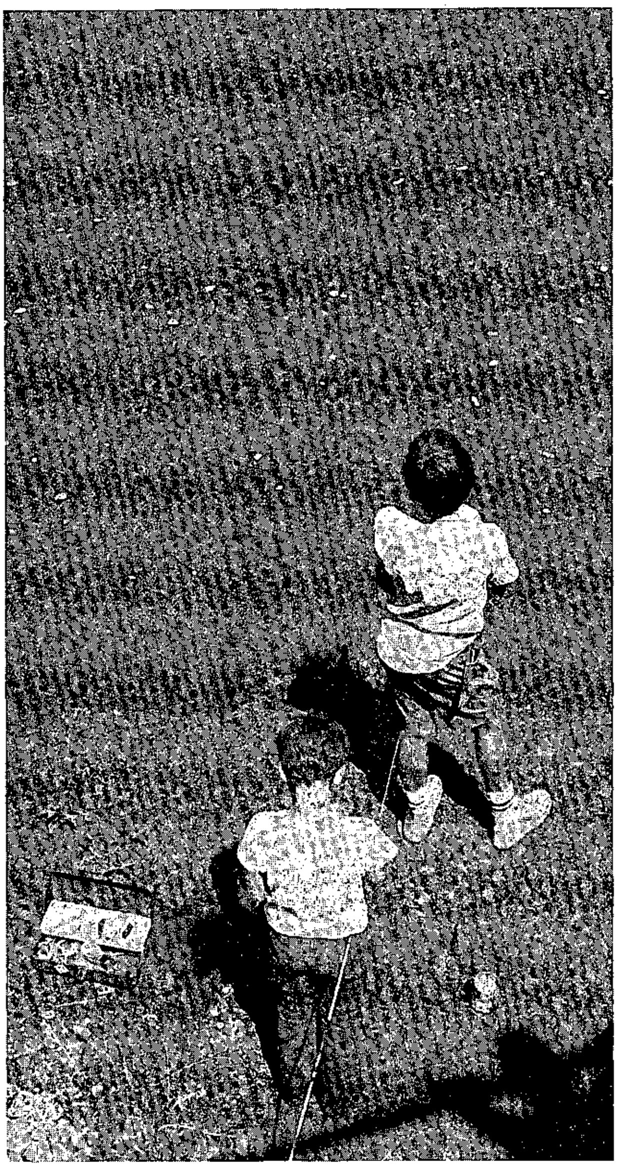
TABLE 49 Great Lakes Basin Resource Problems Matrix

	Great Lakes Basin					Lake Superior					Lake Michigan					Lake Huron					Lake Erie					Lake Ontario				
Resource Use Category	Overall	Open Waters	Urban	Rural	Interface	Overall	Open Waters	Urban	Rural	Interface	Overall	Open Waters	Urban	Rural	Interface	Overall	Open Waters	Urban	Rural	Interface	Overall	Open Waters	Urban	Rural	Interface	Overall	Open Waters	Urban	Rural	Interface
WATER WITHDRAWALS																														
MUNICIPALLY SUPPLIED	1	-	1	-	-	-	-	-	-	-	1	-	2	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
SELF-SUPPLIED INDUSTRIAL	1	-	1	-	-	1	-	-	1	-	1	-	1	-	-	1	-	1	-	-	1	-	1	-	-	-	-	-	-	-
RURAL DOMESTIC & LIVESTOCK	1	-	-	1	-	1	-	-	1	-	1	-	-	1	-	1	-	-	1	-	1	-	-	1	-	1	-	-	1	-
IRRIGATION	1	-	-	1	-	1	-	-	1	-	1	-	-	1	-	-	-	-	-	-	1	-	1	1	-	2	-	-	2	-
MINING	2	-	-	1	2	2	-	2	1	2	1	-	-	-	-	1	-	-	1	-	1	-	-	1	1	2	-	-	1	2
THERMAL POWER COOLING	1	-	-	1	1	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	1	-	-	-	1	2	-	-	2	2
NON-WITHDRAWAL WATER USES																														
MUNICIPAL WASTEWATER DISCHARGES	2	-	2	2	1	1	-	1	-	-	2	-	2	-	-	1	1	2	-	1	3	-	3	2	3	2	-	2	1	1
INDUSTRIAL WASTEWATER DISCHARGES	2	-	2	1	1	1	-	-	-	-	2	-	2	-	-	2	1	2	1	1	3	-	2	2	-	2	-	1	1	1
HYDROELECTRIC POWER	1	-	-	1	-	1	-	-	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WATER ORIENTED OUTDOOR REC.	2	-	2	2	2	1	1	1	-	1	2	-	3	1	2	1	-	1	1	1	2	-	2	2	2	3	-	2	2	3
SPORT FISHING	1	-	2	1	1	1	1	-	1	-	1	-	2	1	-	1	1	1	1	1	2	-	2	2	2	1	-	-	-	1
RECREATIONAL BOATING	1	2	2	1	2	1	2	-	-	-	1	1	2	1	2	1	-	-	1	1	1	1	2	-	2	1	2	1	-	1
COMMERCIAL FISHING	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-	-	-	-	-	-
COMMERCIAL NAVIGATION	1	-	2	-	1	1	1	2	-	1	1	-	1	-	1	1	-	1	-	-	1	-	-	-	1	2	-	2	-	-
RELATED LAND USES & PROBLEMS																														
LAND USE	2	-	3	2	3	2	-	2	1	3	2	-	2	2	2	3	-	-	3	3	1	-	3	2	2	2	-	3	2	1
AGRICULTURAL LAND TREATMENT	1	-	-	1	-	1	-	-	1	-	1	-	-	1	-	1	-	-	1	-	2	-	-	2	-	1	-	-	2	-
CROPLAND DRAINAGE	1	-	-	2	1	1	-	-	1	1	1	-	-	2	-	1	-	-	1	-	2	-	2	2	1	1	-	-	2	-
FOREST LAND TREATMENT	1	-	-	1	-	1	-	-	1	-	2	-	-	1	-	1	-	-	1	-	-	-	-	-	-	1	-	-	1	-
SHORELAND EROSION	1	-	-	-	2	1	-	-	-	1	2	-	-	-	2	1	-	-	-	2	1	-	-	-	1	1	-	-	-	1
STREAMBANK EROSION	1	-	-	1	-	1	1	-	1	-	1	-	-	2	-	1	-	-	1	-	1	-	-	2	-	2	-	3	1	-
FLOOD PLAINS	2	-	2	2	1	1	-	1	1	-	1	-	2	2	1	1	-	1	1	-	2	-	3	3	3	2	-	3	3	-
WILDLIFE MANAGEMENT	2	-	2	2	3	1	-	1	1	1	1	-	1	1	1	1	-	-	1	3	3	-	3	3	2	2	-	3	2	3
AESTHETIC & CULTURAL	1	-	2	1	1	1	-	1	1	1	1	1	2	1	1	1	-	-	1	1	2	-	2	1	2	1	-	-	1	1
OUTDOOR RECREATION	2	-	2	1	-	2	-	-	-	-	1	-	2	1	1	1	-	-	1	-	2	-	2	1	2	3	-	3	2	3

Legend: 3 Severe--Demands immediate attention
2 Moderate--Of major concern; potentially serious
1 Minor--Not considered a serious problem
\- Problem is insignificant or not known

TABLE 50 Projected Agricultural Land Resource Base, Great Lakes Region and Plan Areas, (thousands of acres)

Plan Area and Use	Base Year 1966-67	Projections 1980	2000	2020
Plan Area 1.0				
Cropland	692.9	692.9	692.5	691.7
Pasture	165.3	165.3	165.2	165.0
Forest Land	14,264.5	14,263.8	14,255.8	14,239.2
Other Land	370.3	370.3	370.0	369.5
TOTAL	15,493.0	15,492.3	15,483.5	15,465.4
Plan Area 2.0				
Cropland	13,016.1	12,569.4	11,966.1	11,452.5
Pasture	1,405.3	1,367.2	1,315.5	1,271.0
Forest Land	12,596.3	12,507.3	12,373.1	12,236.7
Other Land	2,347.0	2,261.9	2,147.9	2,054.2
TOTAL	29,364.7	28,705.8	27,802.6	27,014.4
Plan Area 3.0				
Cropland	2,901.2	2,869.5	2,823.4	2,791.0
Pasture	358.8	356.0	352.0	349.0
Forest Land	4,109.0	4,087.3	4,056.5	4,030.8
Other Land	504.3	500.1	494.1	489.6
TOTAL	7,873.3	7,812.9	7,726.0	7,660.4
Plan Area 4.0				
Cropland	8,550.7	8,217.6	7,702.7	7,301.0
Pasture	715.4	686.5	638.3	599.0
Forest Land	3,022.4	2,884.3	2,658.6	2,478.7
Other Land	968.6	918.5	835.6	769.5
TOTAL	13,257.1	12,706.9	11,835.2	11,148.2
Plan Area 5.0				
Cropland	3,448.1	3,408.8	3,356.8	3,297.1
Pasture	861.0	852.5	841.1	828.3
Forest Land	5,632.6	5,584.6	5,518.8	5,444.6
Other Land	662.3	654.9	645.3	634.6
TOTAL	10,604.0	10,500.8	10,362.0	10,204.6
Region				
Cropland	28,609.0	27,758.2	26,541.5	25,533.3
Pasture	3,505.8	3,427.5	3,312.1	3,212.3
Forest Land	39,624.7	39,327.3	38,862.8	38,430.0
Other Land	4,852.5	4,705.7	4,492.9	4,317.4
TOTAL	76,592.0	75,218.7	73,209.3	71,493.0



The demand for fishing spots is increasing faster than their availability.

Courtesy of Wisconsin Department of Natural Resources

Tons of soil are lost annually from eroding streambanks and are carried downstream where sedimentation problems result.

TABLE 51 Summary of Mean Annual Gross Erosion Rates and Total Tons of Erosion

Plan Area	Computed Gross Erosion Rate[1]	Acres in Plan Area (Thousands)	Total Tons (Thousands)
1.0	0.29	15,915	4,672
2.0	2.65	32,272	85,542
3.0	1.17	8,442	9,916
4.0	3.21	15,678	50,409
5.0	1.45	11,272	16,327
Region	2.00[2]	83,579	166,866

[1]Tons/acre/year
[2]Weighted average

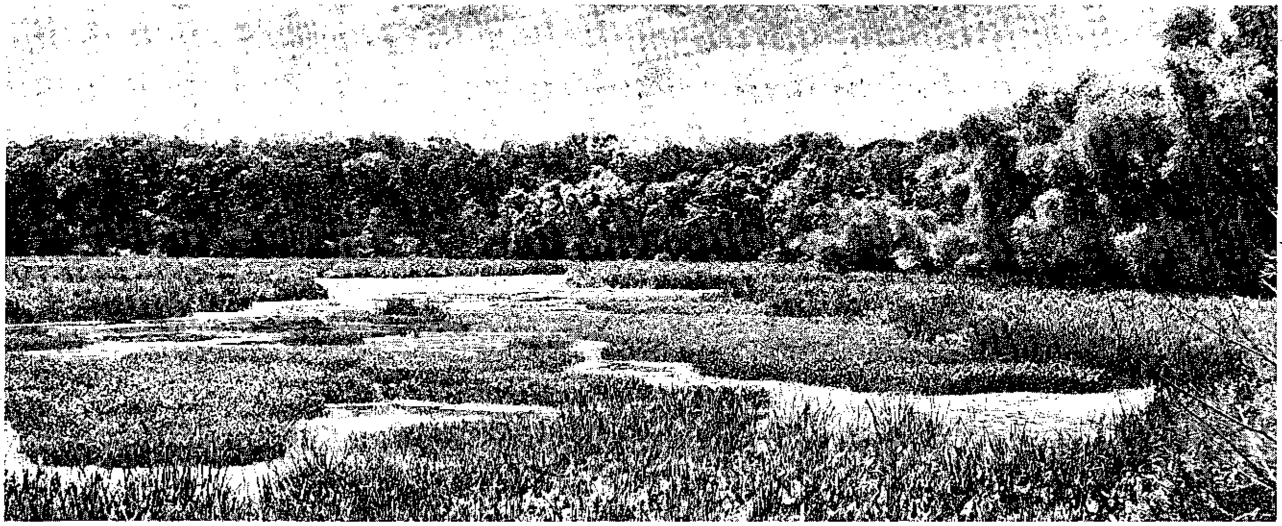
that are not being used effectively due to problems of conflicting uses, management, access, and availability for public use. These areas will require protection.

Lake Superior Basin Problems and Needs

Socioeconomic problems in the Lake Superior basin are serious. Over the past decade the region has experienced high unemployment rates, low incomes, and significant movement of workers out of the area. Per capita personal income is less than 80 percent of the average for the Great Lakes Region. These problems result from a decline in markets for forest and mineral products, a marginal agricultural economy, and a decline in commercial fishing.

Many municipal water supply systems throughout the area need to be repaired and replaced. There has been little expansion and modernization for many decades because of the lack of population and economic growth. Water quality is generally good throughout the Lake Superior basin, but some areas suffer from both municipal and industrial waste problems. A widely publicized problem, the subject of litigation, has been the discharge of wastes into the waters of Lake Superior from taconite (low grade iron ore) processing.

The heavy forest cover and lack of agriculture keep erosion from becoming a serious basinwide



Courtesy of Wisconsin Department of Natural Resources

Marshes and wetlands provide high quality habitat for wildlife. Ensuring their preservation is a major concern in the Great Lakes Basin.

problem, but in some areas the lack of conservation treatment practices has permitted runoff, erosion, and sedimentation to occur. This is particularly true in the western portion of the basin in Wisconsin where geologically young red clay soils are subject to heavy erosion and consequent sedimentation. Streambank erosion is widespread throughout the basin, reaching significant proportions in a few local areas. Flooding is serious only in a few urban areas and in the rural area of the Sturgeon River basin in Michigan.

Many lakes and streams in the Lake Superior basin need managing to be capable of supporting enough fish to satisfy the number of persons who would like to engage in fishing. In addition, changes in forest cover have threatened the wildlife habitat. As a result, this area needs forest management measures to support large numbers of wild animals and birds as it once did.

Problems in land use are particularly evident near the major cities and resort areas where there is competition for shoreline areas. Some land use problems are acute, partly because of the increasing influx of seasonal residents, speculative land development, and mining activities.

Table 52 displays the categories of existing uses for the various resources and the projected needs for the years 1980, 2000, and 2020.

Lake Michigan Basin Problems and Needs

The Lake Michigan basin constitutes 40 percent of the Framework Study area. It is the only Lake basin that lies entirely in the United States. Land use, land use problems, and population distribution vary greatly in this basin. A distinct pattern of these factors may be observed north of a line running approximately through Green Bay, Wisconsin, and Muskegon, Michigan. A separate pattern occurs south of this line. (River Basin Groups 2.1 and 2.4 are generally north and RBGs 2.2 and 2.3 are generally south of this line.)

More than 50 percent of the northern portion of this area is forested. Agricultural areas there are relatively small, although specialized and significant, and urban centers are also relatively small. This northern area is used throughout the year as a recreation retreat. In contrast, the southern portion of the Lake Michigan basin is largely cropland and highly urbanized, with only small areas of forest and pasture land. This area is heavily industrialized and heavily populated, and in places it is heavily polluted.

The problems of major concern in the Lake Michigan basin are municipal and industrial wastewater discharges, land use, and shoreland erosion. Waste discharge and land use problems occur largely in the heavily populated metropolitan area from Milwaukee to Chicago-Gary-Hammond.

Because of population density, there is not enough area to provide outdoor recreation, wildlife habitat, fishing opportunities, and other amenities in the southern part of the basin. The public water supply from Lake Michigan is generally adequate, and facilities are kept current. While some of the municipal water supply for parts of the Chicago area and nearby communities outside the Great

TABLE 52 Future Water and Related Land Needs and Opportunities, Lake Superior Plan Area

RESOURCE USE CATEGORIES	UNITS[1]	1970 Supply[2]	Needs and Opportunities[3] Base Year, 1970, to 1980	2000	2020
Water Withdrawals					
Municipally Supplied	mgd	48.5	3.3	13.2	25.3
Self-Supplied Industrial	mgd	125.5	2.1	14.9	72.8
Rural Dom. & Livestock	mgd	12.5	0.3	3.0	4.6
Irrigation	mgd*	10.7	8.0	17.2	27.4
Mining	mgd	576.5	38.9	97.3	190.0
Thermal Power Cooling	mgd	516	0	1,100	2,900
Nonwithdrawal Water Uses					
Mun. Wastewater Dischgs.	mgd[4]	44.7	48.1	55.9	67.3
Ind. Wastewater Dischgs.	mgd[4]	55.2	44.4	39.7	61.0
Hydroelectric Power	mgd	0	0	0	0
W.O. Outdoor Recreation	1,000 rec. days	8,820	+[5]	+[5]	+[5]
	1,000 acres W.S.[6]	NA	NA	NA	NA
Sport Fishing	1,000 angl. days	7,090	987	2,170	3,800
	1,000 acres W.S.	NA	NA	NA	NA
Recreational Boating	1,000 boat days	2,270	284	403	580
	1,000 acres W.S.*	1,800	1,800	1,800	1,800
Commercial Fishing	million tons/yr.	NA	NA	NA	NA
Commercial Navigation	million tons/yr.		99.5	136.0	179.0
Related Land Use & Problems					
Agr. Land--Treatment	1,000 acres*	473	473	473	473
--Cropland Drainage	1,000 acres*	117	117	117	117
Forest Land--Treatment	1,000 acres	10,000	10,000	10,000	10,000
Shoreland Erosion	miles	156	156	156	156
Streambank Erosion	miles	1,430	1,430	1,430	1,430
	$1,000 AAD[7]	254	254	254	254
Flood Plains--Urban	1,000 acres	5.8	5.8	5.8	5.8
--Urban	$1,000 AAD	706	871	1,360	2,200
--Rural	1,000 acres	187	187	187	187
--Rural	$1,000 AAD	272	346	511	638
Wildlife Management	1,000 acres		0	60.0	200.0
	1,000 user days	3,020.0	82.0	68.4	120.0
Aesthetic & Cultural	1,000 acres	NA	NA	NA	NA
Outdoor Rec.--Intensive	1,000 acres		0.1	0.5	1.0
--Extensive	1,000 acres	NA	0.0	0.0	1.1

[1]Asterisk denotes opportunity
[2]Includes problems and opportunities
[3]Additional resource requirements beyond 1970 requirements
[4]Total treatment requirement at each time period; footnote[3] does not apply
[5]Indicates surplus
[6]Water Surface
[7]Average Annual Damages

Lakes Basin is presently from Lake Michigan, there is extensive use of ground water. The aquifers are being overpumped and it will be necessary soon for some communities to seek other sources, probably Lake Michigan. This may require a reexamination of the decree limiting diversion by Illinois from Lake Michigan. Some of the municipal water supply for the Chicago area outside the Great Lakes Basin is supplied from Lake Michigan. A large amount of waste must be treated and disposed of, and currently most of the treated wastewater from the Chicago area is diverted through the Chicago Sanitary and Ship Canal to the Upper Mississippi River Basin west of the Great Lakes Basin.

In other parts of the Lake Michigan basin many

TABLE 53 Future Water and Related Land Needs and Opportunities, Lake Michigan Plan Area

RESOURCE USE CATEGORIES	UNITS[1]	1970 Supply[2]	Needs and Opportunities[3] Base Year, 1970, to 1980	2000	2020
Water Withdrawals					
Municipally Supplied	mgd	2,040	479	1,400	2,600
Self-Supplied Industrial	mgd	5,680	585	2,190	4,770
Rural Dom. & Livestock	mgd	234.2	30.9	88.5	128.0
Irrigation	mgd*	363	466	885	1,340
Mining	mgd	45.9	39.4	111.0	246.0
Thermal Power Cooling	mgd	5,430	3,160	17,100	42,400
Nonwithdrawal Water Uses					
Mun. Wastewater Dischgs.	mgd[4]	686	965	1,450	2,170
Ind. Wastewater Dischgs.	mgd[4]	3,920	3,310	3,130	5,090
Hydroelectric Power	mgd	NA	47,300	47,300	47,300
W.O. Outdoor Recreation	1,000 rec. days	42,300	49,100	94,200	154,000
	1,000 acres W.S.	NA	NA	NA	NA
Sport Fishing	1,000 angl. days	27,700	10,500	20,500	30,700
	1,000 acres W.S.	NA	NA	NA	NA
Recreational Boating	1,000 boat days	12,800	3,340	6,100	9,480
	1,000 acres W.S.*	2,630	2,630	2,630	2,630
Commercial Fishing	million tons/yr.	NA	NA	NA	NA
Commercial Navigation	million tons/yr.		111	151	197
Related Land Use & Problems					
Agr. Land--Treatment	1,000 acres*	8,950	8,950	8,950	8,950
--Cropland Drainage	1,000 acres*	1,520	1,520	1,520	1,520
Forest Land--Treatment	1,000 acres*	9,050	9,050	9,050	9,050
Shoreland Erosion	miles	587	587	587	587
Streambank Erosion	miles	3,800	3,800	3,800	3,800
	$1,000 AAD	410	410	410	410
Flood Plains--Urban	1,000 acres	70.8	74.9	78.5	83.1
--Urban	$1,000 AAD	14,100	20,300	40,700	83,500
--Rural	1,000 acres	1,100	1,100	1,100	1,100
--Rural	$1,000 AAD	3,600	4,590	5,660	6,560
Wildlife Management	1,000 acres		1,710	4,530	7,970
	1,000 user days	23,700	7,090	10,900	14,600
Aesthetic & Cultural	1,000 acres	NA	NA	NA	NA
Outdoor Rec.--Intensive	1,000 acres		14.9	31.6	56.1
--Extensive	1,000 acres	NA	87.8	183.0	316.0

[1] Asterisk denotes opportunity
[2] Includes problems and opportunities
[3] Additional resource requirements beyond 1970 requirements
[4] Total treatment requirement at each time period; footnote[3] does not apply
[5] Water Surface
[6] Average Annual Damages

stream reaches and some isolated points have substandard water quality. Although these occur more frequently in the southern part of the basin than the northern part, they are not restricted to any one area. There are not only point sources of pollution, such as factories and processing plants, but a good many indirect sources. The latter result from the pesticides, insectcides, fertilizer, and erosion associated with highly developed agriculture in the southern part of the basin.

The shore of Lake Michigan, particularly the eastern and southwestern portions, is subject to severe erosion from waves. This study reveals that the area should be given high priority in any consideration of Great Lakes shoreland management. The dunes in Indiana and southwestern Michigan

TABLE 54 Future Water and Related Land Needs and Opportunities, Lake Huron Plan Area

RESOURCE USE CATEGORIES	UNITS[1]	1970 Supply[2]	Needs and Opportunities[3] Base Year, 1970, to 1980	2000	2020
Water Withdrawals					
Municipally Supplied	mgd	132.6	33.8	121.0	245.0
Self-Supplied Industrial	mgd	540	107	354	861
Rural Dom. & Livestock	mgd	39.3	8.3	20.9	32.5
Irrigation	mgd*	23.3	84.9	132.0	210.0
Mining	mgd	24.8	8.6	25.6	55.5
Thermal Power Cooling	mgd	750	1,130	7,320	18,800
Nonwithdrawal Water Uses					
Mun. Wastewater Dischgs.	mgd[4]	85.0	111.0	175.0	263.0
Ind. Wastewater Dischgs.	mgd[4]	465	418	262	364
Hydroelectric Power	mgd	750	0	0	0
W.O. Outdoor Recreation	1,000 rec. days	5,310	6,650	12,500	19,900
	1,000 acres W.S.[5]	NA	NA	NA	NA
Sport Fishing	1,000 angl. days	6,140	3,060	5,790	8,800
	1,000 acres W.S.	NA	NA	NA	NA
Recreational Boating	1,000 boat days	3,800	1,040	1,810	2,700
	1,000 acres W.S.*	854	854	854	854
Commercial Fishing	million tons/yr.	NA	NA	NA	NA
Commercial Navigation	million tons/yr.		27.5	40.5	58.2
Related Land Use & Problems					
Agr. Land--Treatment	1,000 acres*	2,050	2,050	2,050	2,050
--Cropland Drainage	1,000 acres*	572	572	572	572
Forest Land--Treatment	1,000 acres*	2,810	2,810	2,810	2,810
Shoreland Erosion	miles	162	162	162	162
Streambank Erosion	miles	1,710	1,710	1,710	1,710
	$1,000 AAD[6]	142	142	142	142
Flood Plains--Urban	1,000 acres	8.1	8.9	9.9	10.9
--Urban	$1,000 AAD	622	856	1,380	2,530
--Rural	1,000 acres	294	293	292	291
--Rural	$1,000 AAD	1,110	1,300	1,510	1,770
Wildlife Management	1,000 acres		239	771	1,400
	1,000 user days	6,800	825	1,710	2,670
Aesthetic & Cultural	1,000 acres	NA	NA	NA	NA
Outdoor Rec.--Intensive	1,000 acres		1.7	3.2	5.8
--Extensive	1,000 acres	NA	9.6	18.3	33.1

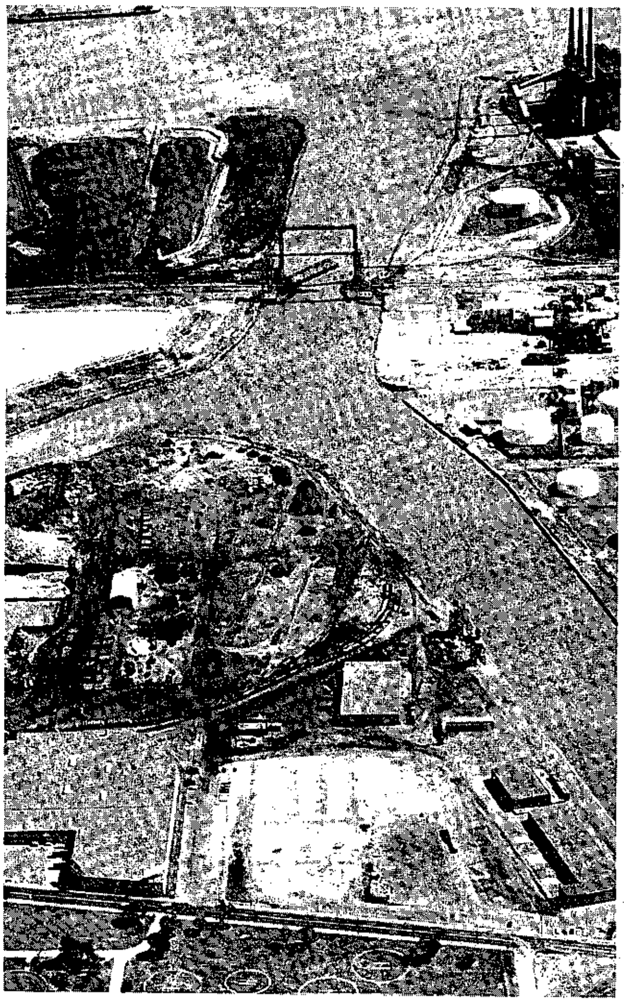
[1]Asterisk denotes opportunity
[2]Includes problems and opportunities
[3]Additional resource requirements beyond 1970 requirements
[4]Total treatment requirement at each time period; footnote[3] does not apply
[5]Water Surface
[6]Average Annual Damages

along the southeast shore of Lake Michigan are an unusual scenic feature, now being destroyed or damaged by both natural and man-made forces.

The Lake Michigan basin needs for each resource use category during the study years are shown in Table 53.

Lake Huron Basin Problems and Needs

The existing problems in the Lake Huron basin, some of which may become severe, are indequate land use planning, pollution from municipal and industrial wastes, and sedimentation resulting



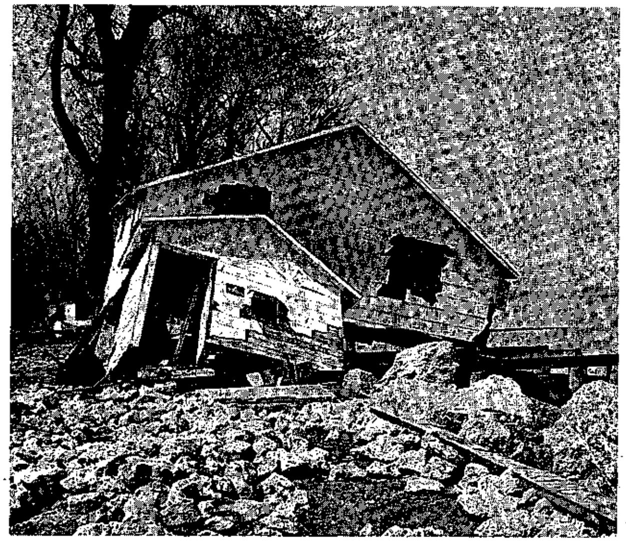
Courtesy of U.S. Army Corps of Engineers

Poor water quality in Lake Erie has resulted from industrial and municipal wastes and sediment received from its tributaries, such as the Rouge River (above), and from the upstream Great Lakes.

from various forms of erosion. Other problems relate to flooding, economic development, and inadequate recreational opportunities.

Agriculture is still a dominant factor in the economy of the southern portion of the basin. Recreation is fast becoming an important source of employment and income in the northern portion. The influx of seasonal residents, together with the speculative land development that accompanies this activity, is causing problems in the shoreline areas. Land use planning and controls have been slow to be promulgated or implemented.

Local water quality problems in the Lake Huron basin result from discharges of untreated and inadequately treated waste into lakes and streams. In the southern part of the basin the Saginaw River



Courtesy of Instructional Arts, Inc.

Flood damage along the Lake Erie shoreline. Measures must be taken to reduce shoreline and inland flooding damages throughout the Basin.

is of substandard quality throughout its entire length because of inadequate treatment of municipal and industrial wastewater.

Corrective measures are needed for the moderately severe streambank erosion and the resulting sedimentation in the basin. Even though many of the rivers and drainage areas are small, flood problems often result from ice jams, severe rain storms, or rapid runoff from snow melt and rain. Both urban and rural areas are affected. Flooding, relatively minor and generally local in nature in the northern part of the basin, is more severe in the southern part. Adequate land use controls would be a major step in preventing increased flood damages resulting from additional development.

Wildlife habitat is diverse in the Lake Huron basin, and some of the most valuable waterfowl marsh in the State of Michigan is located there. Construction of marine facilities for recreational boating has an adverse effect on this marsh area and causes a conflict in demand.

The quantified needs and opportunities for the Lake Huron Basin are shown in Table 54 for the present and for 1980, 2000, and 2020.

Lake Erie Basin Problems and Needs

The most persistent problem in the Lake Erie basin has been poor water quality and the eutrophication of the Lake itself. The phosphorus content has been high and the dissolved oxygen content less than one part per million in bottom waters

TABLE 55 Future Water and Related Land Needs and Opportunities, Lake Erie Plan Area

RESOURCE USE CATEGORIES	UNITS[1]	1970 Supply[2]	Needs and Opportunities[3] Base Year, 1970, to 1980	2000	2020
Water Withdrawals					
Municipally Supplied	mgd	1,770	307	1,060	2,110
Self-Supplied Industrial	mgd	3,870	256	1,930	4,030
Rural Dom. & Livestock	mgd	133.1	15.1	48.8	75.9
Irrigation	mgd*	237	215	414	667
Mining	mgd	115.1	48.3	180.0	398.0
Thermal Power Cooling	mgd	8,760	0	9,020	26,200
Nonwithdrawal Water Uses					
Mun. Wastewater Dischgs.	mgd[4]	1,880	2,130	2,670	3,550
Ind. Wastewater Dischgs.	mgd[4]	3,490	2,980	2,080	2,690
Hydroelectric Power	mgd	NA	0	0	0
W.O. Outdoor Recreation	1,000 rec. days	30,700	38,900	73,100	119,000
	1,000 acres W.S.[5]	NA	NA	NA	NA
Sport Fishing	1,000 angl. days	27,900	4,880	14,100	20,700
	1,000 acres W.S.	NA	NA	NA	NA
Recreational Boating	1,000 boat days	6,110	1,520	3,000	4,830
	1,000 acres W.S.*	1,240	1,240	1,240	1,240
Commercial Fishing	million tons/yr.	NA	NA	NA	NA
Commercial Navigation	million tons/yr.		192	254	318
Related Land Use & Problems					
Agr. Land--Treatment	1,000 acres*	6,380	6,380	6,380	6,380
--Cropland Drainage	1,000 acres*	3,400	3,400	3,400	3,400
Forest Land--Treatment	1,000 acres*	2,230	2,230	2,230	2,230
Shoreland Erosion	miles	105	105	105	105
Streambank Erosion	miles	2,490	2,490	2,490	2,490
	$1,000 AAD[6]	579	579	579	579
Flood Plains--Urban	1,000 acres	121	124	128	133
--Urban	$1,000 AAD	30,600	44,600	74,100	100,000
--Rural	1,000 acres	735	733	728	723
--Rural	$1,000 AAD	7,740	9,650	13,100	17,600
Wildlife Management	1,000 acres		888	2,080	3,460
	1,000 user days	13,900	6,490	10,200	14,400
Aesthetic & Cultural	1,000 acres	NA	NA	NA	NA
Outdoor Rec.--Intensive	1,000 acres		11.9	22.5	38.2
--Extensive	1,000 acres	NA	67.9	127.1	209.0

[1]Asterisk denotes opportunity
[2]Includes problems and opportunities
[3]Additional resource requirements beyond 1970 requirements
[4]Total treatment requirement at each time period; footnote[3] does not apply
[5]Water Surface
[6]Average Annual Damages

of central Lake Erie at certain periods. Total dissolved solids increased markedly in the years prior to 1970. Adequate treatment of industrial and municipal wastes in the basin and non-point source pollution control are essential to prevent excessive amounts of nutrients reaching Lake Erie.

Shore, streambank, and sheet erosion and sediment deposition are locally severe. Particular problems are the deposits in the Maumee Bay and at the mouth of the Cuyahoga River. These deposits are expensive to remove and limit many other resource uses, including commercial navigation, fishing, and recreation. Improved flood plain management and land use are desperately needed to reduce damage from flooding, to reduce excessive rates of runoff from areas on which the vegetative cover has been removed, and to prevent erosion from sites under development.

The western section of Lake Erie, as well as Lake St. Clair, which is part of the Lake Erie basin, contain some of the most valuable wildlife habitat marsh and shoreland in the Basin. These

TABLE 56 Future Water and Related Land Needs and Opportunities, Lake Ontario Plan Area

RESOURCE USE CATEGORIES	UNITS[1]	1970 Supply[2]	Needs and Opportunities[3] Base Year, 1970, to 1980	2000	2020
Water Withdrawals					
Municipally Supplied	mgd	362.1	47.3	220.0	424.4
Self-Supplied Industrial	mgd	388	59	180	519
Rural Dom. & Livestock	mgd	52.2	9.4	17.7	25.9
Irrigation	mgd*	48.1	50.5	126	214
Mining	mgd	17.7	13.2	36	75.4
Thermal Power Cooling	mgd	1,780	3,920	4,110	6,160
Nonwithdrawal Water Uses					
Mun. Wastewater Dischgs.	mgd[4]	368	427	585	773
Ind. Wastewater Dischgs.	mgd[4]	631	572	490	1,000
Hydroelectric Power	mgd	NA	0	4,000	57,900
W.O. Outdoor Recreation	1,000 rec. days	12,700	10,100	21,200	35,600
	1,000 acres W.S.	NA	NA	NA	NA
Sport Fishing	1,000 angl. days	11,800	5,350	9,700	15,200
	1,000 acres W.S.	NA	NA	NA	NA
Recreational Boating	1,000 boat days	4,030	636	1,210	1,940
	1,000 acres W.S.*	750	750	750	750
Commercial Fishing	million tons/yr.	NA	NA	NA	NA
Commercial Navigation	million tons/yr.	0.9	1.5	1.8	2.1
Related Land Use & Problems					
Agr. Land--Treatment	1,000 acres*	2,600	2,600	2,600	2,600
--Cropland Drainage	1,000 acres*	604	604	604	604
Forest Land--Treatment	1,000 acres*	3,840	3,840	3,840	3,840
Shoreland Erosion	miles	186	186	186	186
Streambank Erosion	miles	1,510	1,510	1,510	1,510
	$1,000 AAD	326	326	326	326
Flood Plains--Urban	1,000 acres	16.4	16.8	17.3	17.8
--Urban	$1,000 AAD	339	475	948	1,910
--Rural	1,000 acres	249	249	248	248
--Rural	$1,000 AAD	1,520	2,170	3,440	5,840
Wildlife Management	1,000 acres		78	544	1,050
	1,000 user days	2,110	491	983	1,510
Aesthetic & Cultural	1,000 acres	NA	NA	NA	NA
Outdoor Rec.--Intensive	1,000 acres		1.4	4.2	8.2
--Extensive	1,000 acres	NA	4.3	19.3	40.7

[1]Asterisk denotes opportunity
[2]Includes problems and opportunities
[3]Additional resource requirements beyond 1970 requirements
[4]Total treatment requirement at each time period; footnote[3] does not apply

wetlands are threatened by population pressures and development, and active preservation measures are needed.

Extensive development due to increasing population has resulted in a reduction of other wildlife habitat and in a loss of good quality fisheries available for anglers. Both of these problems detract from the quality of life the people of the Basin have come to expect.

The quantified needs and opportunities for the Lake Erie basin are shown in Table 55 for the present and for 1980, 2000, and 2020.

Lake Ontario Basin Problems and Needs

The significant problems throughout the Lake Ontario basin are water pollution, floods, erosion, underuse of the New York Barge Canal, and lack of emphasis on conservation and wise use of energy resources.

In the Oswego River basin the major need is for central management and control of the Finger Lakes-Oswego River system. Substantial expansion of the hydrologic data network in the basin and modern communication, data processing and analysis, and hydrologic forecasting services are needed for operational decisions. Urban water management problems are significant. Water quality management measures to improve and protect water quality in the lakes are needed. Flood damage reduction through management and structural measures is another important need in the Oswego basin.

In the Black River basin an overall resource management program is needed for the Black River Flats between Lyons Falls and Carthage. Studies are needed to determine the potential for expanding the use of existing reservoirs, including re-regulation of outflows. Other functional needs are water quality management, development of hydroelectric power, agricultural water management, and more effective use of fish and wildlife and outdoor recreation resources.

The environmental quality of the Adirondack portion of the St. Lawrence River basin needs enhancement, as does the economic activity in the valley along the St. Lawrence River. Specifically needed are improved flow regulation, development of the hydroelectric power potential, drainage of agricultural land, measures to increase the availability of fish and wildlife, and additional facilities for water-oriented outdoor recreation.

The needs and opportunities for the Lake Ontario basin for 1970 and projections for 1980, 2000, and 2020 are shown in Table 56.

Section 4

PROPOSED FRAMEWORK AND PROJECTED COSTS

The recommendations of this study are based on the Proposed Framework, public comment, and Commissioner judgment reconciling discrepancies between them.

The Proposed Framework is the Great Lakes Basin Commission view of how to best meet the needs for natural resources in the Basin during the next 50 years in a way that reflects both principles of wise resource use and the desires of the people. It contains general solutions to resource problems and suggests ways to take advantage of the opportunities that were detected and quantified during the course of the study. These selected solutions are in addition to the recommendations listed in Section 1 for further studies, for data collection and research, and for the general orientation of the water resource development of the Basin proposed by the study.

Framework Development

As explained in Section 2, program elements were selected and outputs and costs were estimated for two frameworks, the Normal Framework (NOR) and the Proposed Framework (PRO).

The Normal Framework was developed as a baseline. The use of projections of population and economic factors consistent with the OBERS studies provided by the Water Resources Council, (see "The Data" in Section 2) in the Normal Framework permits comparison between the Great Lakes Basin and other basins for which similar studies have been made. The Normal Framework provided a starting point for the Great Lakes Basin analysis. In general, the Normal Framework seeks the national economic development objective, while the Proposed Framework modifies this objective in specific instances.

The Proposed Framework was designed to reflect public opinion as it was expressed at a series of 15 public meetings in late 1972. Following a presentation of planning results in the Great Lakes Basin and in the local Lake basins, those attending the meetings were asked for written or oral comments indicating what course they would prefer for the Basin in the future. Those at the meetings did not represent the full range of public views known to exist in the Basin. There were relatively few representatives of industry and commerce, while individuals, colleges, universities, environmental groups, and regional planning groups were generally well represented. Although the opinions were not completely representative, they did indicate that many individuals were concerned about energy consumption and natural resource use. The concerns expressed at the meetings suggested a desire for restrained growth and reduced use of resources in the Basin.

In the northern part of the Basin particularly, private citizens seemed to prefer a slow rate of development or no development. Residents also favored the use of the natural recreation resources by local people, and a minimizing of use of resources for recreation by people from other areas. The continued development of an export economy to help support growth in the area was also opposed.

The views of State officials at the meetings did not always coincide with those of the public. The official State position often moved in the direction of a higher rate of economic development than that supported by citizens attending the meetings.

The Commissioners considered the views that private citizens and special interest groups expressed in both meetings and correspondence, and accommodated the apparent lower population growth figure that would result from applying the lower birth rate statistics of the 1970 census. They decided to use the same projections of needs for the Proposed Framework that were used in the Normal Framework. Further, they decided to de-emphasize economic growth to maintain higher environmental quality. The programs selected for meeting the needs and solving the problems were those that tended more toward an enhancement of the environment. One exception to this was that outdoor recreation facilities were to be developed to the maximum practicable extent rather than restricted to the needs of local residents. While the needs and problems in the Normal and Proposed Frameworks remained the same, the kinds of programs selected and the outputs from these programs varied for a number of resource uses.

Framework Selections

The programs selected for the Normal Framework and the Proposed Framework differ in relatively few respects. In some instances, the quantities of outputs or costs differ, but in other cases only the emphasis differs. Tables 57 through 62 tabulate these outputs and costs for the Great Lakes Basin for both the Normal and Proposed Frameworks. To emphasize the differences between the Proposed and Normal Frameworks, PRO figures that differ from NOR figures are shown in italics. Comparison of the tables shows that outputs and costs differ for irrigation, mining, agricultural land treatment, cropland drainage, and forest land treatment. Costs differ for municipal waste treatment and commercial navigation also. Tables 63 through 86 show needs, outputs, and percent needs met, capital costs, and operation, maintenance, and replacement costs for the Proposed Framework for each of the States in the Basin.

Water Withdrawals

The Commissioners considered municipal water supply the most important need, and as a result, programs that would supply this need through year 2020 were given first priority. About 85 to 90 percent of the needs are expected to be met by withdrawals from the Great Lakes. Ground-water sources will supply the next largest amount, followed by supplies from reservoir storage and inland lakes and streams. Cost is the only obstacle to meeting the needs fully at any point. Although a large proportion of the population in the Chicago area lives outside the drainage basin, Lake Michigan furnishes the largest supply for the area. This water, which must be exported to the Upper Mississippi River Basin from the Great Lakes Basin, amounts to 20 to 25 percent of the total Basin withdrawal for municipally supplied water at each of the projection years.

Industrial water is expected to be furnished principally from the Great Lakes, particularly in the period 2000 to 2020. However, where inland lakes and streams and ground water are available in adequate supply, these sources have been selected. In 1980 about half the water supply is projected to come from the Great Lakes and more than half of the remainder from other surface sources. By 2020 nearly 75 percent will come from the Great Lakes. No reservoir storage is projected for self-supplied industrial water. In the Chicago area, much of the self-supplied industrial water will come from sources in the Upper Mississippi River Basin, in contrast to municipal supplies. The need for self-supplied industrial water from the Great Lakes Basin for the Chicago area is therefore reduced considerably. The water that will be supplied from the Great Lakes Basin will come principally from Lake Michigan.

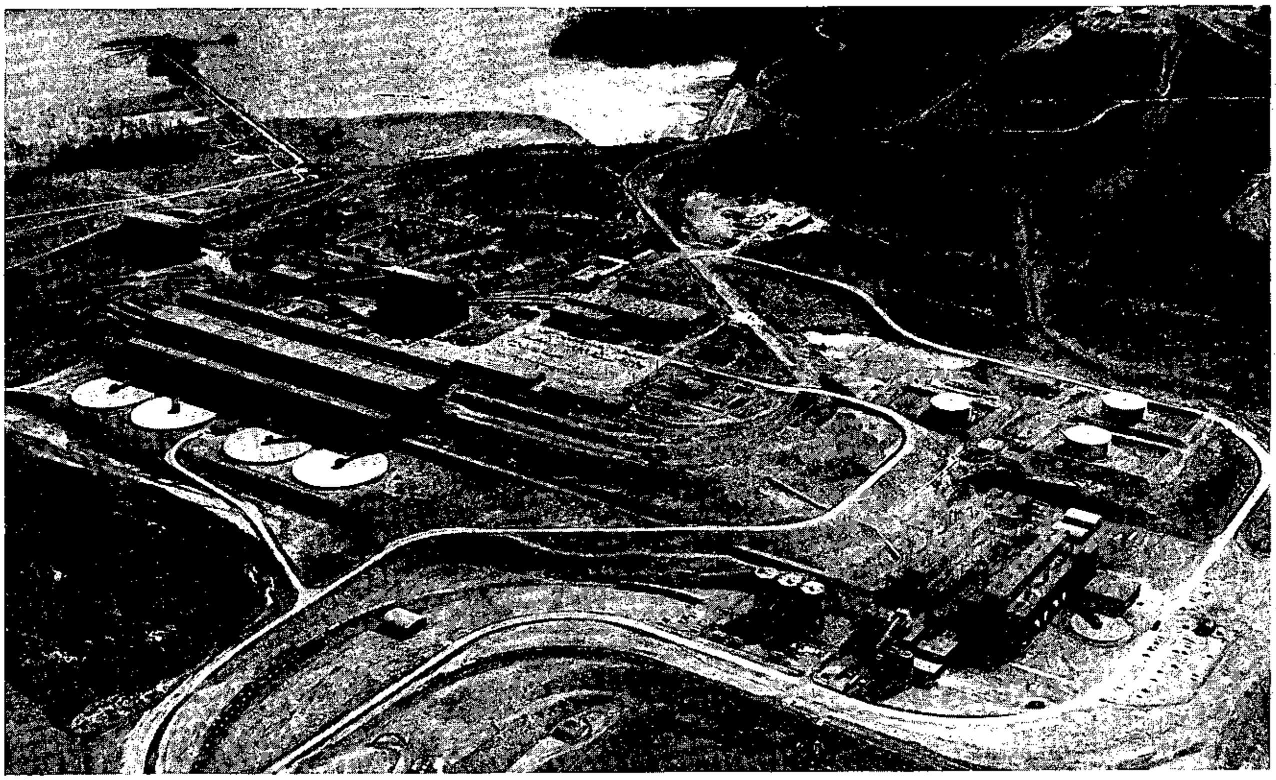
Rural domestic and livestock water will usually come from a nearby source. Both ground water and surface water will be used, with three or four times as much ground water used as surface water. In the Chicago area, some water is provided from the Upper Mississippi River Basin to supply needs projected for the portion of the Region that lies outside the Great Lakes Basin.

In keeping with the desire expressed at the 1972 public meetings, public education, to be conducted largely by public interest groups, is incorporated into the Proposed Framework. Public education regarding municipal supply uses would emphasize lower per capita use of resources and recycling of self-supplied industrial water through in-house treatment, process changes, and other means. It would also suggest that distribution systems should be more efficiently operated, with an increase in metering, some restructuring of rates to induce more careful use, and constant surveillance of the distribution systems to avoid leakage.

The term "irrigation" in the Framework Study includes water applied to both cropland and golf courses. Irrigation water is applied to more than three times as many crop acres as golf course acres. Through the year 2020 supplies will come from local sources with ground water supplying three to four times as much water as surface sources. Because the Proposed Framework favors promoting a high quality of life while not necessarily expanding economic production, the crop irrigation needs in the Cleveland, Ohio, area will not be met by its programs. All golf course irrigation needs will be met in the Proposed Framework, and in the Chicago area some water from the Upper Mississippi Basin will be used for irrigation in the portion of the Great Lakes Region that is outside the Great Lakes Basin.

Additional water for processing minerals will come prinicipally from ground-water sources with a lesser amount from surface-water supplies. Some supplies will be taken from Lake Superior and very small amounts from other Great Lakes. The land having mineral resources in the Cleveland, Ohio, area is considered to be more useful for other purposes, and therefore, the Proposed Framework does not provide water for mining in that area. Some water from the Upper Mississippi Basin will meet mineral processing water needs in the Chicago area and elsewhere in the Great Lakes Basin.

The Proposed Framework projects that water for cooling in thermal power plants will come from the Great Lakes during the study's time periods.



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Increasing amounts of water will be used for industrial purposes, such as mineral processing.

Even though the quantities shown for the Proposed Framework are the same as those developed in the Normal Framework, greater or lesser quantities may be required. If the trend toward secondary cooling measures continues, the withdrawals will be smaller but the consumptive use greater. On the other hand, if plants can be located where flow-through cooling can be used without adverse effects on the water body to which the effluent is returned, then larger quantities of cooling water may be required, with lower consumptive use. Studies of site location, condenser cooling, transmission line location, and the entire range of electric power supply problems have a high priority in the recommendations of the Proposed Framework.

Nonwithdrawal Water Uses

The treatment of municipal and industrial wastewater discharges is not strictly a water use but a program for restoring and maintaining water quality for many uses. Its classification with nonwithdrawal water uses facilitates record keeping and display. In the Normal Framework, the programs selected provided waste treatment that met requirements prior to enactment of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92–500). The programs under the Proposed Framework will meet the requirements of those amendments. There is no change in the quantities of wastewater to be treated, but there is some acceleration in achieving the necessary levels of treatment. A possible increase in quantity due to treatment of urban flood discharges would be offset by improved sewerage, resulting in lower infiltration rates during normal flow conditions.

Although increased reliance will be placed on municipal plants for industrial wastewater treatment, projections were made of industrial wastewater discharges not to be treated in municipal plants. Now that laws require better quality waste discharges, industries are introducing process changes and in-house waste treatment, with recirculation of process water. Thus the forecasts indicate a trend of decreasing quantities of industrial wastewater discharges from the present to the year 2000 and then an increase to the year 2020. The quantities projected are the same for the Proposed Framework as for the Normal Framework, but variously improved facilities, higher standards of treatment, and the accelerated rate of achieving these standards of treatment make the Proposed Framework costs greater than the Normal Framework costs.

For municipal and some self-treated industrial wastewater, the situation in the Lake Michigan basin in the Chicago area is unique. Wastes are diverted into the Upper Mississippi River Basin with only several major discharges from Illinois going into Lake Michigan. Consequently, while waste treatment is projected for this area of the Great Lakes Region, no discharges from Illinois to Great Lakes Basin waters are shown.

Although hydroelectric power will not be a major power contributor in the future, there are a number of places where hydroelectric power is a significant part of the power supply network now. No new conventional hydroelectric plants are projected anywhere in the Great Lakes Basin in the study period, but there are a few places where pumped storage is feasible to meet part of the peak power requirements, and these plants are included in the frameworks. The pumped storage plant at Ludington, Michigan, meets needs projected to 1980. Other pumped storage hydroelectric plants are included in the frameworks to meet needs projected for the 2000 and 2020 time periods in New York State in the Lake Ontario basin. All needs for power generation will be met. Thermal plants are expected to meet by far the greatest part of the needs.

Legislative and institutional changes will be required to meet the need for a sport fishery. Public acquisition of land and water, access easements, and education and information programs will be needed as well. Approximately 10 percent of the total needs will be met by the use of multi-purpose reservoirs in Ohio and New York in the Lake Erie and Lake Ontario basins. Depending on the time period, 8 to 18 percent of the fishing needs will remain unmet.

A few opportunities exist in some parts of the Basin to develop fisheries that will more than meet the projected needs in the area. This will help alleviate shortages in other areas. Though the sites have not been specifically identified, the northern part of the Basin has greater opportunities, generally speaking, than the southern part. The sport fishery involves both inland waters and the Great Lakes, and in both cases there are problems of access, ownership, and availability of the water, and of managing the fishery itself. Techniques for increasing fishing opportunities on inland waters will include cleaning polluted streams and lakes, stocking, management, control of species, and providing access.

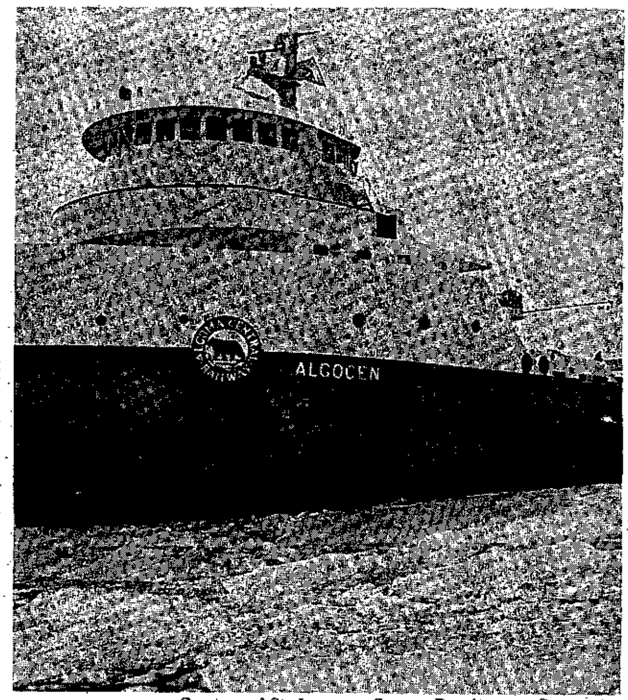
Changes in fishery management are needed for the Great Lakes. This should include substituting species, eliminating undesirable species, and resolving and managing the relationship between the sport fishery and the commercial fishery so that each will complement the other and optimize the resource output.

Recreational boating needs share some characteristics with those of the sport fishery. In both cases needs are met on inland waters and on the Great Lakes. Opportunities are insufficient to provide capacity on inland lakes and streams for all who desire safe, uncrowded boating experiences. Additional capacity could be provided through the construction of multipurpose reservoirs. Improved management practices that will help existing water bodies are water surface zoning and incentives to spread the load more uniformly through the week to relieve weekend peak loads. Cleaning up polluted streams will provide more attractive waters for canoeing. On the Great Lakes the needs will be met by the construction of additional harbors of refuge, marinas, and launching sites. Better storm forecasting techniques and communication systems to warn boaters of impending danger are essential to increased use and safety.

It is anticipated that the commercial fishery, which has declined, will be managed so as to complement the sport fishery, because sport fishing is of greater economic value to the States. Programs will be adopted for the commercial fishery to remove undesirable species, to harvest excesses, and to perform similar functions. Control of the sea lamprey and monitoring and control of the alewife will be continued. The States, individually and in cooperation with the Federal government, will provide ways in which commercial fishermen can be licensed or contracts can be let for specific fish harvesting operations.

Commercial navigation is both a localized and a Basinwide operation. The Lakes and the connecting channels serve the Basinwide needs of navigation and transport. Cargo handling ports are the points where land and water transportation meet. The Normal Framework contains elements to continue the maintenance of navigation improvements such as dredging of harbors and connecting channels and the maintenance of navigation aids. It also includes programs for improving harbors and connecting channels to provide facilities for larger ships carrying iron ore from Lake Superior to the lower Lake ports. The Proposed Framework includes all these elements as well as the possible development of 31-foot depth channels and harbors throughout the four upper Lakes after consideration of economic costs and benefits and environmental impacts.

The Proposed Framework's navigation improvements are: harbors at Silver Bay, Duluth-Superior, Taconite, and Marquette in Lake Superior; the connecting channels in Lake Superior and the St. Marys River; harbors at Escanaba, Milwaukee, Chicago, Calumet, Indiana Harbor, and Port of Indiana in Lake Michigan; the connecting channels in Lake Michigan including the straits of Mackinac;



Courtesy of St. Lawrence Seaway Development Corporation

The navigation season is limited by ice that forms during the cold winters.

Source unknown

Shore erosion poses a problem for those who have built too near the shore.

harbors at Detroit, Toledo, Lorain, Sandusky, Cleveland, Conneaut, Erie, and Buffalo in Lake Erie; channel improvements in the St. Clair and Detroit Rivers and other channels as well as compensating works; and channel dredging and structure modification in the St. Lawrence Seaway.

The Proposed Framework for commercial navigation includes extending the navigation season, if feasible, by six weeks for three segments of the system and by four weeks for one segment of the system. The economic, social and environmental feasibility of season extension and the length of season are being determined by the Navigation Season Extension Study now underway by the Corps of Engineers, assisted by several other agencies.

The system would be extended by six weeks in these areas:

(1) from western Lake Superior through the Soo Locks, the St. Marys River, and to southern Lake Michigan

(2) through the St. Clair and Detroit Rivers and Lakes St. Clair and Erie

(3) through the Welland Canal into Lake Ontario.

The season would be extended four weeks from Lake Ontario through the St. Lawrence River system.

Related Land Use and Problems

Treatment of agricultural and forest lands for conservation and erosion control, and cropland drainage, all make land more useful. Cropland drainage especially may permit increased agricultural production. In many cases land being converted from agricultural to urban use must be drained as a part of the development for urban expansion. In the Normal Framework agricultural and forest land treatment and cropland drainage would be continued at the current rate. In the Proposed Framework, agricultural land treatment for erosion control would be carried out at a higher rate, with 76 percent of the acreage treated by 2020. Drainage of agricultural land would not occur in areas that are not now in high agricultural production, but it would be increased on lands currently in agricultural use with potential for higher productivity if better drainage were provided. Under the Proposed Framework 42 percent of current cropland having wetness problems would be drained. The forest land treatment program would provide improvement to about 75 percent of the land needing some treatment. Many acres would receive more than one treatment measure.

The erosion problems of the shoreland of the Great Lakes were evaluated in 1970. Based on that evaluation, the Normal Framework protects all of the shorelines subject to critical erosion, 17 percent

Photo by Al Curtes, Great Lakes Basin Commission

Streambank erosion protection on Black Creek, Indiana.

of the total length. With higher Lake levels and other changed conditions in 1973, many more miles suffered erosion damage or became susceptible to such damage. A complete inventory for the Basin under 1973 conditions is not yet available, but for the shoreline in Michigan, a total of 715 miles were classed in 1973 as high risk erosion mileage along Lakes Superior, Michigan, and Huron. This compares with 583 miles classed in 1970 as subject to erosion. Because information is not available, no quantification of more effective treatment is shown in the Proposed Framework than in the Normal, but it is apparent that programs 50 to 100 percent greater should probably be considered.

Streambank erosion protection is provided under the Normal Framework for 2,945 bank miles subject to severe erosion or 27 percent of the total 10,934 bank miles having some erosion. The same rate of treatment and total protection is in the Proposed Framework.

The adopted flood plain management programs for the Proposed Framework are the same as for the Normal, and therefore the costs are the same. The rate of increase in flood damage costs, due in part to increased value of property subject to damage, could be slowed or reversed through education, emphasis on flood plain zoning, and use of flood plains for recreation and other activities that have low vulnerability to flood damage.

Wildlife management programs for the Proposed Framework are the same as for the Normal. The programs believed feasible would meet only 35 percent of the habitat needs but would exceed the user day requirements. In the Proposed Framework there is particular emphasis on acquisition of high quality habitat including all of that which is wetland.

Programs to meet aesthetic and cultural needs are proposed in general terms in both the Normal Framework and the Proposed Framework. The Proposed Framework recommends that the zone concept of development be implemented at higher funding levels more rapidly than is the current practice, and that specific feature and site identification and study be emphasized. Acquisition would logically follow. No specific outputs or costs were listed.

Land based, water-oriented outdoor recreation program outputs and costs are the same in the Proposed Framework as in the Normal. Both depend heavily on private enterprise to carry a large part of the total development. In the Proposed Framework, however, the emphases are on governmental funding to urban-oriented recreation facilities and on provision by private developers of facilities removed from urban centers. This latter approach would require greater travel, but the product would be the highest quality recreation. The following priorities were established for public funds in the Proposed Framework:

(1) urban recreation developments and acquisition and retention of unique and natural areas of regional significance.

(2) developments on land now publicly owned

(3) other developments.

Public funds, to the extent they are available for investment in urban lands, may be used where feasible to assist in acquiring flood plain land in rapidly urbanizing areas and in clearing flood plains of damage-prone uses and making them available for recreation use.

Framework Outputs and Costs

Tables 57, 58, and 59 give the Normal Framework outputs and the comparison with needs for the three years for which projections were made, 1980, 2000, and 2020. Capital costs and operation, maintenance and replacement (OM&R) costs for these programs for the Great Lakes Basin as a whole are given.

Tables 60 to 86 show the needs, outputs (amount of resource supplied in meeting needs or opportunities), percent of needs met; the capital costs; and the OM&R costs for the Proposed Framework. Data are presented for the Basin and the States.

Table 87 lists for comparison the total costs (capital costs plus OM&R) for the Normal and Proposed Frameworks for the periods 1971–1980 and 1971–2020. Costs in Tables 57 through 87 are based on 1970 prices.

Some of the costs for "Flood Plains—Urban" are associated with alleviating rural flood damages; however, these are a relatively small part of the total cost, and the basic cost data did not permit distinguishing between urban and rural.

Commercial navigation costs were developed as of 1970 and do not reflect the increased cost figures that evolved from the findings of the Great Lakes-St. Lawrence Seaway Navigation Season Extension Demonstration and Survey studies.

TABLE 57 Great Lakes Basin: Needs, Outputs, and Percent Needs Met, Normal Framework, 1980, 2000, 2020

RESOURCE USE CATEGORY	UNIT	1970 SUPPLY	1980 N	1980 O	1980 %	2000 N	2000 O	2000 %	2020 N	2020 O	2020 %
WATER WITHDRAWALS											
MUNICIPALLY SUPPLIED	MILLION GALLONS PER DAY		870	1,030	over	2,810	2,990	over	5,400	5,550	over
SELF-SUPPLIED INDUSTRIAL	MILLION GALLONS PER DAY		1,110	693	62	4,670	3,500	75	10,300	8,220	80
RURAL DOMESTIC & LIVESTOCK	MILLION GALLONS PER DAY		64.0	58.7	92	179	162	91	267	245	92
IRRIGATION	MILLION GALLONS PER DAY		824	684	83	1,570	1,330	85	2,460	2,100	85
MINING	MILLION GALLONS PER DAY		148	124	84	450	389	86	965	837	87
THERMAL POWER COOLING	" " "		8,210	8,210	100	38,700	38,700	100	96,500	96,500	100
NON-WITHDRAWAL WATER USES											
MUNICIPAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY		3,680	3,680	100	4,940	4,940	100	6,820	6,820	100
INDUSTRIAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY		7,320	7,320	100	6,000	6,000	100	9,210	9,210	100
HYDROELECTRIC POWER	MILLION GALLONS PER DAY		47,300	47,300	100	51,300	51,300	100	105,000	105,000	100
WATER ORIENTED OUTDOOR REC.	1000 RECREATION DAYS		105,000	57,300	55	201,000	132,000	66	329,000	190,000	58
	1000 ACRES WATER SURFACE		---	---	---	---	---	---	---	---	---
SPORT FISHING	1000 ANGLER DAYS		24,800	20,300	82	52,300	46,700	89	79,200	72,800	92
	1000 ACRES WATER SURFACE		---	---	---	---	---	---	---	---	---
RECREATIONAL BOATING	1000 BOAT DAYS		6,820	2,470	36	12,500	6,340	51	19,500	10,800	55
	1000 ACRES WATER SURFACE		7,270	---	---	7,270	---	---	7,270	---	---
COMMERCIAL FISHING	MILLION TONS PER YEAR		---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	MILLION TONS PER YEAR		432	432	100	583	583	100	754	754	100
RELATED LAND USES & PROBLEMS											
AGRIC. LAND-TREATMENT	1000 ACRES		20,500	1,800	9	20,500	5,410	26	20,500	7,570	37
-CROPLAND DRAINAGE	1000 ACRES		6,210	435	7	6,210	858	14	6,210	1,470	24
FOREST LAND-TREATMENT	1000 ACRES		27,900	2,830	10	27,900	8,490	28	27,900	14,100	51
SHORELAND EROSION	MILES		1,200	45.6	4	1,200	125	10	1,200	204	17
STREAMBANK EROSION	MILES		10,900	585	5	10,900	1,760	16	10,900	2,930	27
	$1000 AVE ANNUAL DAMAGES		1,710	252	15	1,710	756	44	1,710	1,260	74
FLOOD PLAINS-URBAN	1000 ACRES		230	78	34	240	139	56	251	199	79
-URBAN	$1000 AVE ANNUAL DAMAGES		67,100	52,200	78	118,000	103,000	87	190,000	177,000	93
-RURAL	1000 ACRES		2,560	532	21	2,560	921	36	2,550	1,220	48
-RURAL	$1000 AVE ANNUAL DAMAGES		18,000	6,580	37	24,200	11,300	47	32,400	18,100	56
WILDLIFE MANAGEMENT	1000 ACRES		2,920	1,170	40	7,990	3,020	38	14,100	4,930	35
	1000 USER DAYS		15,000	2,250	15	23,900	7,230	30	33,300	12,500	38
AESTHETIC & CULTURAL	1000 ACRES		---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	1000 ACRES		30.0	22.2	74	62.0	51.9	84	109	75.3	69
-EXTENSIVE	1000 ACRES		170	151	89	348	319	92	600	453	76

TABLE 58 Great Lakes Basin: Capital Costs, Normal Framework, 1980, 2000, 2020, (in $1,000,000)

RESOURCE USE CATEGORY	1971-1980 Federal	1971-1980 Non-Fed	1971-1980 Private	1971-1980 Total	1981-2000 Federal	1981-2000 Non-Fed	1981-2000 Private	1981-2000 Total	2001-2020 Federal	2001-2020 Non-Fed	2001-2020 Private	2001-2020 Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	125.6	293.0	0	418.6	204.0	476.0	0	680.0	274.8	641.1	0	915.9	2,014.5
SELF-SUPPLIED INDUSTRIAL	0	0	57.5	57.5	0	232.7	0	232.7	0	391.5	0	391.5	681.7
RURAL DOMESTIC & LIVESTOCK	0.3	0	2.3	2.6	0.5	0	4.1	4.6	0.4	0	3.4	3.8	11.0
IRRIGATION	0	0	20.1	20.1	0	0	17.4	17.4	0	0	21.3	21.3	58.8
MINING	0	0	6.5	6.5	0	0	13.9	13.9	0	0	25.1	25.1	45.5
THERMAL POWER COOLING	0	14.4	272.7	287.1	0	54.1	1,032.2	1,086.3	0	101.1	1,921.4	2,022.5	3,395.9
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	1,340.4	446.5	0	1,786.9	1,065.0	354.7	0	1,419.7	1,457.6	485.6	0	1,943.2	5,149.8
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	26.7	45.3	0	72.0	19.1	22.1	0	41.2	28.6	33.7	0	62.3	175.5
RECREATIONAL BOATING	95.4	95.4	81.2	272.0	142.8	142.8	122.4	408.0	122.0	121.9	104.5	348.4	1,028.4

COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	0	0	0	0	395.3	0	0	395.3	0	0	0	0	395.3
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	21.0	0	54.0	75.0	42.1	0	108.3	150.4	25.0	0	64.3	89.3	314.7
-CROPLAND DRAINAGE	34.1	0	79.7	113.8	34.7	0	81.1	115.8	44.5	0	103.8	148.3	377.9
FOREST LAND-TREATMENT	96.8	24.2	0	121.0	195.2	48.8	0	244.0	193.6	48.4	0	242.0	607.0
SHORELAND EROSION	5.7	0	22.1	27.8	9.2	0	36.7	45.9	9.2	0	36.8	46.0	119.7
STREAMBANK EROSION	5.3	0	13.9	19.2	16.3	0	41.4	57.7	26.9	0	69.4	96.3	173.2
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	410.7	0	136.7	547.4	297.3	0	98.8	396.1	84.8	0	28.4	113.2	1,056.7
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	12.1	109.1	0	121.2	22.5	202.1	0	224.6	21.2	190.7	0	211.9	557.7
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	252.8	469.6	0	722.4	297.0	551.5	0	848.5	253.9	471.5	0	725.4	2,296.3
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	2,426.9	1,497.5	746.6	4,671.0	2,744.0	2,092.1	1,557.7	6,383.8	2,542.5	2,485.6	2,380.8	7,408.9	18,459.6

TABLE 59 Great Lakes Basin: Operation, Maintenance, and Replacement Costs, Normal Framework, 1980, 2000, 2020, (in $1,000,000)

	1971-1980				1981-2000				2001-2020				
RESOURCE USE CATEGORY	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	0	192.0	0	192.0	0	1,224.3	0	1,224.3	0	2,713.9	0	2,713.9	4,130.2
SELF-SUPPLIED INDUSTRIAL	0	0	53.5	53.5	0	0	704.7	704.7	0	0	2,015.3	2,015.3	2,773.5
RURAL DOMESTIC & LIVESTOCK	0	0	8.3	8.3	0	0	56.9	56.9	0	0	103.9	103.9	169.1
IRRIGATION	0	0	2.9	2.9	0	0	16.4	16.4	0	0	26.8	26.8	46.1
MINING	0	0	7.7	7.7	0	0	65.7	65.7	0	0	157.0	157.0	230.4
THERMAL POWER COOLING	0	3.7	70.1	73.8	0	42.1	800.6	842.7	0	121.6	2,310.1	2,431.7	3,348.2
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	0	1,381.0	0	1,381.0	0	3,641.8	0	3,641.8	0	4,760.2	0	4,760.2	9,783.0
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	9.4	12.6	0	22.0	21.0	33.2	0	54.2	29.0	42.4	0	71.4	147.6
RECREATIONAL BOATING	0	0	62.9	62.9	0	0	432.0	432.0	0	0	772.5	772.5	1,267.4
COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	0	0	0	0	99.2	0	0	99.2	198.4	0	0	198.4	297.6
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	0	0	1.9	1.9	0	0	14.9	14.9	0	0	27.1	27.1	43.9
-CROPLAND DRAINAGE	0	0	2.8	2.8	0	0	17.2	17.2	0	0	30.3	30.3	50.3
FOREST LAND-TREATMENT	2.5	0.7	0	3.2	18.9	4.4	0	23.3	35.9	8.9	0	44.8	71.3
SHORELAND EROSION	0.5	0	2.2	2.7	4.0	0	16.3	20.3	7.8	0	31.0	38.8	61.8
STREAMBANK EROSION	0	0	1.8	1.8	0	0	17.8	17.8	0	0	49.8	49.8	69.4
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	0.1	1.1	0	1.2	0.5	8.9	0	9.4	0.6	11.6	0	12.2	22.8
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	0	6.0	0	6.0	0	11.2	0	11.2	0	11.2	0	11.2	28.4
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	29.5	117.7	0	147.2	203.3	813.1	0	1,016.4	357.6	1,429.4	0	1,787.0	2,950.6
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	42.0	1,714.8	213.2	1,970.9	346.9	5,779.0	2,142.5	8,268.4	629.3	9,099.2	5,523.8	15,252.3	25,491.6

TABLE 60 Great Lakes Basin: Needs, Outputs, and Percent Needs Met, Proposed Framework, 1980, 2000, 2020

RESOURCE USE CATEGORY	UNIT	1970 SUPPLY	1980 N	1980 O	1980 %	2000 N	2000 O	2000 %	2020 N	2020 O	2020 %
WATER WITHDRAWALS											
MUNICIPALLY SUPPLIED	MILLION GALLONS PER DAY	4,300	870	1,030	over	2,810	2,990	over	5,400	5,550	over
SELF-SUPPLIED INDUSTRIAL	MILLION GALLONS PER DAY	10,600	1,110	695	62	4,670	3,500	75	10,300	8,220	80
RURAL DOMESTIC & LIVESTOCK	MILLION GALLONS PER DAY	471	64.0	58.7	92	179	162	91	267	245	92
IRRIGATION	MILLION GALLONS PER DAY	661	824	684	83	1,570	1,320	84	2,460	2,090	85
MINING	MILLION GALLONS PER DAY	780	148	124	84	450	350	78	965	724	75
THERMAL POWER COOLING	" " " "	17,200	8,210	8,210	100	38,700	38,700	100	96,500	96,500	100
NON-WITHDRAWAL WATER USES											
MUNICIPAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	3,060	3,680	3,680	100	4,940	4,940	100	6,720	6,720	100
INDUSTRIAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	8,580	7,330	7,330	100	6,000	6,000	100	9,210	9,210	100
HYDROELECTRIC POWER	MILLION GALLONS PER DAY	NA	47,300	47,300	100	51,300	51,300	100	105,000	105,000	100
WATER ORIENTED OUTDOOR REC.	1000 RECREATION DAYS	100,000	105,000	57,300	55	201,000	132,000	66	324,000	190,000	58
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
SPORT FISHING	1000 ANGLER DAYS	80,700	24,800	20,300	82	52,300	46,700	89	79,200	72,800	92
	1000 ACRES WATER SURFACE		---	---	---	---	---	---	---	---	---
RECREATIONAL BOATING	1000 BOAT DAYS	29,000	6,820	2,470	36	12,500	6,330	51	19,500	10,800	55
	1000 ACRES WATER SURFACE	7,260	7,260	---	---	7,260	---	---	7,260	---	---
COMMERCIAL FISHING	MILLION TONS PER YEAR		---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	MILLION TONS PER YEAR	343	432	432	100	583	583	100	754	754	100
RELATED LAND USES & PROBLEMS											
AGRIC. LAND-TREATMENT	1000 ACRES	20,450	20,450	4,000	20	20,450	11,400	56	20,450	15,500	76
-CROPLAND DRAINAGE	1000 ACRES	6,210	6,210	695	11	6,210	1,810	29	6,210	2,610	42
FOREST LAND-TREATMENT	1000 ACRES	27,900	27,900	4,370	16	27,900	13,100	47	27,900	21,800	78
SHORELAND EROSION	MILES	1,200	1,200	45.6	4	1,200	125	10	1,200	204	17
STREAMBANK EROSION	MILES	10,900	10,900	585	5	10,900	1,760	16	10,900	2,930	27
	$1000 AVE ANNUAL DAMAGES	1,710	1,710	342	20	1,710	1,026	60	1,710	1,710	100
FLOOD PLAINS-URBAN	1000 ACRES	222	230	78	34	240	139	58	251	199	79
-URBAN	$1000 AVE ANNUAL DAMAGES	46,300	67,100	52,200	78	118,000	103,000	87	190,000	177,000	93
-RURAL	1000 ACRES	2,570	2,560	532	21	2,560	921	36	2,550	1,220	48
-RURAL	$1000 AVE ANNUAL DAMAGES	14,200	18,000	6,580	37	24,200	11,300	47	32,400	18,100	56
WILDLIFE MANAGEMENT	1000 ACRES		2,920	1,170	40	7,990	3,020	38	14,100	4,930	35
	1000 USER DAYS	49,600	15,000	2,250	15	23,900	7,230	30	33,300	12,500	38
AESTHETIC & CULTURAL	1000 ACRES	NA	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	1000 ACRES		30.0	22.2	74	62.0	52.9	84	109	75.3	69
-EXTENSIVE	1000 ACRES	NA	170	151	89	348	319	92	600	453	76

TABLE 61 Great Lakes Basin: Capital Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

RESOURCE USE CATEGORY	1971-1980 Federal	1971-1980 Non-Fed	1971-1980 Private	1971-1980 Total	1981-2000 Federal	1981-2000 Non-Fed	1981-2000 Private	1981-2000 Total	2001-2020 Federal	2001-2020 Non-Fed	2001-2020 Private	2001-2020 Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	125.6	293.0	0	418.6	204.0	476.0	0	680.0	274.8	641.1	0	915.9	2,014.5
SELF-SUPPLIED INDUSTRIAL	0	0	57.5	57.5	0	0	232.7	232.7	0	0	391.5	391.5	681.7
RURAL DOMESTIC & LIVESTOCK	0.3	0	2.3	2.6	0.5	0	4.1	4.6	0.4	0	3.4	3.8	11.0
IRRIGATION	0	0	20.1	20.1	0	0	17.0	17.0	0	0	21.4	21.4	58.5
MINING	0	0	6.2	6.2	0	0	11.6	11.6	0	0	20.7	20.7	38.5
THERMAL POWER COOLING	0	14.4	272.7	287.1	0	54.2	1,032.1	1,086.3	0	101.1	1,921.4	2,022.5	3,395.9
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	3,588.0	1,196.0	0	4,784.0	2,186.2	728.8	0	2,915.0	1,970.2	656.8	0	2,627.0	10,326.0
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	26.7	45.3	0	72.0	19.1	22.1	0	41.2	28.6	33.7	0	62.3	175.5
RECREATIONAL BOATING	95.4	95.4	81.2	272.0	142.8	142.9	122.3	408.0	122.0	121.9	104.5	348.4	1,028.4

RESOURCE USE CATEGORY	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Total
COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	295.6	0	0	295.6	1,386.6	0	0	1,386.6	0	0	0	0	1,682.2
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	40.9	0	105.3	146.2	76.9	0	197.6	274.5	46.7	0	120.0	166.7	587.4
-CROPLAND DRAINAGE	36.2	0	84.4	120.6	60.8	0	141.9	202.7	39.0	0	91.0	130.0	453.3
FOREST LAND-TREATMENT	150.4	9.4	28.2	188.0	301.6	18.9	56.5	377.0	300.0	18.8	56.2	375.0	940.0
SHORELAND EROSION	5.7	0	22.1	27.8	9.2	0	36.7	45.9	9.2	0	36.8	46.0	119.7
STREAMBANK EROSION	5.3	0	13.9	19.2	16.3	0	41.4	57.7	26.9	0	69.4	96.3	173.2
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	410.7	0	136.7	547.4	297.3	0	98.8	396.1	84.8	0	28.4	113.2	1,056.7
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	12.1	109.1	0	121.2	22.5	202.1	0	224.6	21.2	190.7	0	211.9	557.7
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	252.8	469.6	0	722.4	297.0	551.5	0	848.5	253.9	471.5	0	725.4	2,296.3
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	5,045.7	2,232.2	830.6	8,108.5	5,020.8	2,196.5	1,992.7	9,210.0	3,177.7	2,235.6	2,864.7	8,278.0	25,596.5

TABLE 62 Great Lakes Basin: Operation, Maintenance, and Replacement Costs, Proposed Framework, (in $1,000,000)

	1971-1980				1981-2000				2001-2020				
RESOURCE USE CATEGORY	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	0	192.0	0	192.0	0	1,224.3	0	1,224.3	0	2,713.9	0	2,713.9	4,130.2
SELF-SUPPLIED INDUSTRIAL	0	0	53.5	53.5	0	0	704.7	704.7	0	0	2,015.3	2,015.3	2,773.5
RURAL DOMESTIC & LIVESTOCK	0	0	8.3	8.3	0	0	56.9	56.9	0	0	103.9	103.9	169.1
IRRIGATION	0	0	2.9	2.9	0	0	16.3	16.3	0	0	26.6	26.6	45.8
MINING	0	0	7.8	7.8	0	0	61.4	61.4	0	0	139.2	139.2	208.4
THERMAL POWER COOLING	0	3.7	70.1	73.8	0	42.1	800.6	842.7	0	121.6	2,309.8	2,431.4	3,347.9
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	0	4,108.7	0	4,108.7	0	9,955.0	0	9,955.0	0	16,223.9	0	16,223.9	30,287.6
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	9.4	12.6	0	22.0	21.0	33.2	0	54.2	29.0	42.4	0	71.4	147.6
RECREATIONAL BOATING	0	0	62.9	62.9	0	0	432.0	432.0	0	0	772.5	772.5	1,267.4
COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	36.0	0	0	36.0	438.2	0	0	438.2	732.4	0	0	732.4	1,206.6
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	0	0	3.4	3.4	0	0	31.9	31.9	0	0	50.7	50.7	86.0
-CROPLAND DRAINAGE	0	0	3.1	3.1	0	0	25.2	25.2	0	0	38.7	38.7	67.0
FOREST LAND-TREATMENT	0.5	1.0	3.3	4.8	4.3	8.6	30.1	43.0	7.0	14.1	49.3	70.4	118.2
SHORELAND EROSION	0.5	0	2.2	2.7	4.0	0	16.3	20.3	7.8	0	31.0	38.8	61.8
STREAMBANK EROSION	0	0	1.8	1.8	0	0	17.8	17.8	0	0	49.8	49.8	69.4
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	0.1	1.1	0	1.2	0.5	8.9	0	9.4	0.6	11.6	0	12.2	22.8
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	0	6.0	0	6.0	0	11.2	0	11.2	0	11.2	0	11.2	28.4
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	29.5	117.7	0	147.2	203.3	813.1	0	1,016.4	357.6	1,429.4	0	1,787.0	2,950.6
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	76.0	4,442.8	219.3	4,738.1	671.3	12,096.4	2,193.2	14,960.9	1,134.4	20,568.1	4,486.8	27,289.3	46,988.3

TABLE 63 Illinois: Needs, Outputs, and Percent Needs Met, Proposed Framework, 1980, 2000, 2020

RESOURCE USE CATEGORY	UNIT	1970 SUPPLY	1980 N	1980 O	1980 %	2000 N	2000 O	2000 %	2020 N	2020 O	2020 %
WATER WITHDRAWALS											
MUNICIPALLY SUPPLIED	MILLION GALLONS PER DAY	1337	210	490	over	588	1,110	over	1,020	1,810	over
SELF-SUPPLIED INDUSTRIAL	MILLION GALLONS PER DAY	1348	182	---	---	1,130	---	---	2,650	---	---
RURAL DOMESTIC & LIVESTOCK	MILLION GALLONS PER DAY	39.8	3.0	0	0	9.8	0	0	12.4	0	0
IRRIGATION	MILLION GALLONS PER DAY	40.8	129	25.9	19	226	45.1	20	336	67.3	20
MINING	MILLION GALLONS PER DAY	2.2	0.8	0.1	13	2.0	0.2	10	4.2	0.3	7
THERMAL POWER COOLING	MILLION GALLONS PER DAY	580	831	831	100	6,350	6,350	100	17,000	17,000	100
NON-WITHDRAWAL WATER USES											
MUNICIPAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	7	0	0	---	0	0	---	0	0	---
INDUSTRIAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	20	0	0	---	0	0	---	0	0	---
HYDROELECTRIC POWER	MILLION GALLONS PER DAY	0	0	---	---	0	---	---	0	---	---
WATER ORIENTED OUTDOOR REC.	1000 RECREATION DAYS	NA	---	1,200	---	---	3,600	---	---	3,600	---
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
SPORT FISHING	1000 ANGLER DAYS	1617	795	795	100	1,500	1,500	100	1,700	1,700	100
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
RECREATIONAL BOATING	1000 BOAT DAYS	599	284	121	43	468	233	50	673	368	55
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL FISHING	MILLION TONS PER YEAR	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	MILLION TONS PER YEAR		---	---	---	---	---	---	---	---	---
RELATED LAND USES & PROBLEMS											
AGRIC. LAND-TREATMENT	1000 ACRES	65.1	65.1	0	0	65.1	0	0	65.1	0	0
-CROPLAND DRAINAGE	1000 ACRES	13.3	13.3	---		13.3	---	---	13.3	---	---
FOREST LAND-TREATMENT	1000 ACRES	6.4	6.4	0	0	6.4	0	0	6.4	0	0
SHORELAND EROSION	MILES	10.5	10.5	2.1	20	10.5	6.3	60	10.5	10.5	100
STREAMBANK EROSION	MILES	46	46	0	0	46	0	0	46	0	0
	$1000 AVE ANNUAL DAMAGES	29	29	1.7	6	29	5.0	17	29	8.3	29
FLOOD PLAINS-URBAN	1000 ACRES	0	0	0	---	0	0	---	0	0	---
-URBAN	$1000 AVE ANNUAL DAMAGES	0	0	0	---	0	0	---	0	0	---
-RURAL	1000 ACRES	0	0	0	---	0	0	---	0	0	---
-RURAL	$1000 AVE ANNUAL DAMAGES	0	0	0	---	0	0	---	0	0	---
WILDLIFE MANAGEMENT	1000 ACRES		692	0	0	1,370	0	0	2,200	0	0
	1000 USER DAYS		2,510	0	0	3,750	0	0	4,950	0	0
AESTHETIC & CULTURAL	1000 ACRES	NA	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	1000 ACRES		---	0.2	---	---	0.7	---	---	0.7	---
-EXTENSIVE	1000 ACRES	NA	---	1.4	---	---	4.2	---	---	4.2	---

TABLE 64 Illinois: Capital Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

RESOURCE USE CATEGORY	1971-1980 Federal	1971-1980 Non-Fed	1971-1980 Private	1971-1980 Total	1981-2000 Federal	1981-2000 Non-Fed	1981-2000 Private	1981-2000 Total	2001-2020 Federal	2001-2020 Non-Fed	2001-2020 Private	2001-2020 Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	27.9	65.1	0	93.0	48.3	112.8	0	161.1	57.8	134.8	0	192.6	446.7
SELF-SUPPLIED INDUSTRIAL	0	0	0.7	0.7	0	0	8.6	8.6	0	0	39.1	39.1	48.4
RURAL DOMESTIC & LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION	0	0	0.9	0.9	0	0	0.7	0.7	0	0	0.7	0.7	2.3
MINING	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0.0
THERMAL POWER COOLING	0	1.5	27.6	29.1	0	9.7	183.4	193.1	0	18.6	353.6	372.2	594.4
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	0	0	0	0	0	0	0	0	0	0	0	0	0
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	2.5	3.8	0	6.3	1.1	1.6	0	2.7	1.0	1.5	0	2.5	11.5
RECREATIONAL BOATING	6.7	6.7	5.8	19.2	6.5	6.5	5.5	18.5	6.5	6.5	5.7	18.7	56.4

COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	9.9	0	0	9.9	56.4	0	0	56.4	0	0	0	0	66.3
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	0	0	0	0	0	0	0	0	0	0	0	0	0
-CROPLAND DRAINAGE	0	0	0	0	0	0	0	0	0	0	0	0	0
FOREST LAND-TREATMENT	0	0	0	0	0	0	0	0	0	0	0	0	0
SHORELAND EROSION	0.3	0	1.4	1.7	0.7	0	2.6	3.3	0.7	0	2.7	3.4	8.4
STREAMBANK EROSION	0	0	0	0	0	0	0	0	0	0	0	0	0
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	0	0	0	0	0	0	0	0	0	0	0	0	0
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	0	0	0	0	0	0	0	0	0	0	0	0	0
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	4.8	8.9	0	13.7	24.0	44.6	0	68.6	0	0	0	0	82.3
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	52.1	86.0	36.4	174.5	137.0	175.2	200.8	513.0	66.0	161.4	401.8	629.2	1,316.7

TABLE 65 Illinois: Operation, Maintenance, and Replacement Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

	1971-1980				1981-2000				2001-2020				
RESOURCE USE CATEGORY	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	0	52.8	0	52.8	0	395.5	0	395.5	0	802.5	0	802.5	1,250.8
SELF-SUPPLIED INDUSTRIAL	0	0	0.4	0.4	0	0	18.1	18.1	0	0	132.6	132.6	151.1
RURAL DOMESTIC & LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION	0	0	0.1	0.1	0	0	0.7	0.7	0	0	1.1	1.1	1.9
MINING	0	0	0	0	0	0	0.1	0.1	0	0	0.1	0.1	0.2
THERMAL POWER COOLING	0	0.4	7.1	7.5	0	6.6	125.4	132.0	0	20.3	385.6	405.9	545.4
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	0	0	0	0	0	0	0	0	0	0	0	0	0
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	0.1	0.2	0	0.3	0.5	0.7	0	1.2	0.5	0.7	0	1.2	2.7
RECREATIONAL BOATING	0	0	4.4	4.4	0	0	26.3	26.3	0	0	43.7	43.7	74.4
COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	1.0	0	0	1.0	19.0	0	0	19.0	34.0	0	0	34.0	54.0
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	0	0	0	0	0	0	0	0	0	0	0	0	0
-CROPLAND DRAINAGE	0	0	0	0	0	0	0	0	0	0	0	0	0
FOREST LAND-TREATMENT	0	0	0	0	0	0	0	0	0	0	0	0	0
SHORELAND EROSION	0.0	0	0.2	0.2	0.3	0	1.0	1.3	0.5	0	2.2	2.7	4.2
STREAMBANK EROSION	0	0	0	0	0	0	0	0	0	0	0	0	0
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	0	0	0	0	0	0	0	0	0	0	0	0	0
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	0	0	0	0	0	0	0	0	0	0	0	0	0
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	0.5	1.9	0	2.4	4.3	17.1	0	21.4	6.7	26.7	0	33.4	57.2
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	1.6	55.3	12.2	69.1	24.1	419.9	171.6	615.6	41.7	850.2	565.3	1,457.2	2,141.9

TABLE 66 Indiana: Needs, Outputs, and Percent Needs Met, Proposed Framework, 1980, 2000, 2020

RESOURCE USE CATEGORY	UNIT	1970 SUPPLY	1980 N	1980 O	1980 %	2000 N	2000 O	2000 %	2020 N	2020 O	2020 %
WATER WITHDRAWALS											
MUNICIPALLY SUPPLIED	MILLION GALLONS PER DAY	171	36.9	24.5	66	145	93.4	64	314	213	68
SELF-SUPPLIED INDUSTRIAL	MILLION GALLONS PER DAY	3,251	239	---	---	663	---	---	1,180	---	---
RURAL DOMESTIC & LIVESTOCK	MILLION GALLONS PER DAY	40.2	4.7	4.1	87	14.2	12.2	86	20.0	17.6	88
IRRIGATION	MILLION GALLONS PER DAY	53.1	39.0	27.8	71	82.1	62.6	76	131	102	78
MINING	MILLION GALLONS PER DAY	14.3	11.3	3.2	28	30.9	10.6	34	65.8	23.3	35
THERMAL POWER COOLING	MILLION GALLONS PER DAY	1,562	110	110	---	780	780	100	3,200	3,200	100
NON-WITHDRAWAL WATER USES											
MUNICIPAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	223	274	274	100	363	363	100	531	531	100
INDUSTRIAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	2,983	2,600	2,600	100	2,470	2,470	100	4,050	4,050	100
HYDROELECTRIC POWER	MILLION GALLONS PER DAY	NA	0	---	---	0	---	---	0	---	---
WATER ORIENTED OUTDOOR REC.	1000 RECREATION DAYS	NA	---	4,220	---	---	9,670	---	---	22,400	---
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
SPORT FISHING	1000 ANGLER DAYS	1,271	1,690	1,690	100	2,690	2,690	100	3,640	3,640	100
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
RECREATIONAL BOATING	1000 BOAT DAYS	1,170	362	74	20	640	231	36	989	385	39
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL FISHING	MILLION TONS PER YEAR	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	MILLION TONS PER YEAR		---	---	---	---	---	---	---	---	---
RELATED LAND USES & PROBLEMS											
AGRIC. LAND-TREATMENT	1000 ACRES	1,670	1,670	254	15	1,670	728	44	1,670	974	58
-CROPLAND DRAINAGE	1000 ACRES	549	549	53.5	10	549	149	27	549	263	48
FOREST LAND-TREATMENT	1000 ACRES	275	275	28.5	10	275	83.5	30	275	126	46
SHORELAND EROSION	MILES	22.6	22.6	2.6	12	22.6	7.8	35	22.6	13.0	58
STREAMBANK EROSION	MILES	346	346	8.9	3	346	26.6	8	346	44.3	13
	$1000 AVE ANNUAL DAMAGES	75.2	75.2	1.4	2	75.2	4.1	5	75.2	6.9	9
FLOOD PLAINS-URBAN	1000 ACRES	17	17.4	2.7	16	18.2	14.9	82	19.2	19.1	99
-URBAN	$1000 AVE ANNUAL DAMAGES	10,595	15,600	12,200	78	31,500	30,100	96	63,600	61,800	97
-RURAL	1000 ACRES	26	52.7	3.5	7	51.9	7.2	14	50.9	17.6	35
-RURAL	$1000 AVE ANNUAL DAMAGES	123	260	48.0	18	406	128	32	638	348	55
WILDLIFE MANAGEMENT	1000 ACRES		338	14.3	4	726	22.6	3	1,190	30.9	3
	1000 USER DAYS		1,220	101	8	1,840	243	13	2,430	435	18
AESTHETIC & CULTURAL	1000 ACRES	NA	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	1000 ACRES		---	1.1	---	---	2.6	---	---	3.4	---
-EXTENSIVE	1000 ACRES	NA	---	6.1	---	---	14.4	---	---	20.3	---

TABLE 67 Indiana: Capital Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

RESOURCE USE CATEGORY	1971-1980 Federal	1971-1980 Non-Fed	1971-1980 Private	1971-1980 Total	1981-2000 Federal	1981-2000 Non-Fed	1981-2000 Private	1981-2000 Total	2001-2020 Federal	2001-2020 Non-Fed	2001-2020 Private	2001-2020 Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	1.7	3.9	0	5.6	6.8	16.0	0	22.8	12.3	28.8	0	41.1	69.5
SELF-SUPPLIED INDUSTRIAL	0	0	3.5	3.5	0	0	47.5	47.5	0	0	74.5	74.5	125.5
RURAL DOMESTIC & LIVESTOCK	0.0	0	0.2	0.2	0.0	0	0.4	0.4	0.0	0	0.3	0.3	0.9
IRRIGATION	0	0	0.8	0.8	0	0	0.8	0.8	0	0	1.2	1.2	2.8
MINING	0	0	0.1	0.1	0	0	0.4	0.4	0	0	0.6	0.6	1.1
THERMAL POWER COOLING	0	0.2	3.7	3.9	0	1.2	22.3	23.5	0	4.2	80.5	84.7	112.1
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	204.8	68.2	0	273.0	168.8	56.2	0	225.0	168.0	56.0	0	224.0	722.0
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	1.3	2.7	0	4.0	0.2	0.8	0	1.0	0.4	1.3	0	1.7	6.7
RECREATIONAL BOATING	3.0	3.0	2.7	8.7	9.9	9.9	8.3	28.1	7.6	7.6	6.7	21.9	58.7

COMMERCIAL FISHING													
COMMERCIAL NAVIGATION	7.7	0	0	7.7	17.2	0	0	17.2	0	0	0	0	24.9
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	2.9	0	7.6	10.5	5.6	0	14.3	19.9	3.4	0	8.7	12.1	42.5
-CROPLAND DRAINAGE	2.6	0	6.0	8.6	4.7	0	11.0	15.7	3.1	0	7.2	10.3	34.6
FOREST LAND-TREATMENT	1.4	0.1	0.2	1.7	2.6	0.2	0.5	3.3	2.1	0.1	0.4	2.6	7.6
SHORELAND EROSION	0.4	0	1.7	2.1	0.8	0	3.4	4.2	0.8	0	3.3	4.1	10.4
STREAMBANK EROSION	0.1	0	0.2	0.3	0.3	0	0.6	0.9	0.4	0	1.1	1.5	2.7
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	76.3	0	25.5	101.8	41.6	0	13.9	55.5	9.7	0	0.2	0.9	158.2
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	0.2	1.3	0	1.5	0.2	1.8	0	2.0	0.2	2.1	0	2.3	5.8
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	22.6	41.9	0	64.5	16.5	30.7	0	47.2	12.1	22.5	0	34.6	146.3
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	325.0	121.3	52.2	498.5	275.2	116.8	123.4	515.4	211.1	122.6	184.7	518.4	1,532.3

TABLE 68 Indiana: Operation, Maintenance, and Replacement Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

	1971-1980				1981-2000				2001-2020				
RESOURCE USE CATEGORY	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	0	3.3	0	3.3	0	37.9	0	37.9	0	115.1	0	115.1	156.3
SELF-SUPPLIED INDUSTRIAL	0	0	2.0	2.0	0	0	99.9	99.9	0	0	252.7	252.7	354.6
RURAL DOMESTIC & LIVESTOCK	0	0	0.5	0.5	0	0	3.8	3.8	0	0	7.1	7.1	11.4
IRRIGATION	0	0	0.1	0.1	0	0	0.7	0.7	0	0	1.3	1.3	2.1
MINING	0	0	0.0	0.0	0	0	1.6	1.6	0	0	3.9	3.9	5.5
THERMAL POWER COOLING	0	0.1	0.9	1.0	0	0.8	15.2	16.0	0	4.1	78.5	82.6	99.6
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	0	294.0	0	294.0	0	719.2	0	719.2	0	1,186.1	0	1,186.1	2,199.3
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	0.9	1.0	0	1.9	0.2	1.7	0	1.9	1.1	3.7	0	4.8	8.6
RECREATIONAL BOATING	0	0	2.0	2.0	0	0	17.4	17.4	0	0	35.0	35.0	54.4
COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	1.0	0	0	1.0	8.0	0	0	8.0	12.0	0	0	12.0	21.0
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	0	0	0.2	0.2	0	0	2.2	2.2	0	0	3.6	3.6	6.0
-CROPLAND DRAINAGE	0	0	0.2	0.2	0	0	1.4	1.4	0	0	2.3	2.3	3.9
FOREST LAND-TREATMENT	0	0	0	0	0.0	0.1	0.3	0.4	0.1	0.1	0.3	0.5	0.9
SHORELAND EROSION	0.0	0	0.2	0.2	0.3	0	1.4	1.7	0.7	0	2.6	3.3	5.2
STREAMBANK EROSION	0	0	0.0	0.0	0	0	0.1	0.1	0	0	0.0	0.0	0.1
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	0.0	0.2	0	0.2	0.1	1.4	0	1.5	0.1	1.4	0	1.5	3.2
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0.3
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	2.5	9.9	0	12.4	15.2	60.9	0	76.1	23.8	95.4	0	119.2	207.7
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	4.4	308.6	6.1	319.1	23.8	822.1	144.0	989.9	37.8	1,406	387.3	1,831.1	3,140.1

TABLE 69 Michigan: Needs, Outputs, and Percent Needs Met, Proposed Framework, 1980, 2000, 2020

RESOURCE USE CATEGORY	UNIT	1970 SUPPLY	1980 N	1980 O	1980 %	2000 N	2000 O	2000 %	2020 N	2020 O	2020 %
WATER WITHDRAWALS											
MUNICIPALLY SUPPLIED	MILLION GALLONS PER DAY	1,153	282	282	100	960	960	100	1,910	1,910	100
SELF-SUPPLIED INDUSTRIAL	MILLION GALLONS PER DAY	2,374	95.9	95.9	100	726	726	100	1,820	1,820	100
RURAL DOMESTIC & LIVESTOCK	MILLION GALLONS PER DAY	187	27.3	27.3	100	77.7	77.7	100	116	116	100
IRRIGATION	MILLION GALLONS PER DAY	250.6	490	490	100	848	848	100	1,240	1,240	100
MINING	MILLION GALLONS PER DAY	137.8	50.0	50.0	100	181	181	100	407	407	100
THERMAL POWER COOLING	MILLION GALLONS PER DAY	6,149	2,200	2,200	100	14,700	14,700	100	34,900	34,900	100
NON-WITHDRAWAL WATER USES											
MUNICIPAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	1,196	1,400	1,400	100	1,850	1,850	100	2,550	2,550	100
INDUSTRIAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	1,546	1,160	1,160	100	698	698	100	930	930	100
HYDROELECTRIC POWER	MILLION GALLONS PER DAY	NA	47,300	47,300	100	47,300	47,300	100	47,300	47,300	100
WATER ORIENTED OUTDOOR REC.	1000 RECREATION DAYS	NA	---	20,400	---	---	46,400	---	---	67,200	---
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
SPORT FISHING	1000 ANGLER DAYS	26,200	8,460	6,050	72	16,900	14,100	83	27,400	24,000	88
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
RECREATIONAL BOATING	1000 BOAT DAYS	14,400	3,970	1,060	27	7,170	2,820	39	11,100	5,030	45
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL FISHING	MILLION TONS PER YEAR	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	MILLION TONS PER YEAR		---	---	---	---	---	---	---	---	---
RELATED LAND USES & PROBLEMS											
AGRIC. LAND-TREATMENT	1000 ACRES	8,080	8,080	1,790	22	8,080	5,050	63	8,080	6,800	84
-CROPLAND DRAINAGE	1000 ACRES	1,680	1,680	297	18	1,680	782	47	1,680	1,130	67
FOREST LAND-TREATMENT	1000 ACRES	13,900	13,900	2,100	15	13,900	6,310	45	13,900	10,500	76
SHORELAND EROSION	MILES	583	583	20.7	4	583	62.3	11	583	104	18
STREAMBANK EROSION	MILES	6,210	6,210	461	7	6,210	1,380	22	6,210	2,300	37
	$1000 AVE ANNUAL DAMAGES	564	564	60.8	11	564	182	32	564	304	54
FLOOD PLAINS-URBAN	1000 ACRES	105.5	126	46.2	37	129	74.2	58	134	108	81
-URBAN	$1000 AVE ANNUAL DAMAGES	27,557.8	40,600	35,100	86	66,000	60,100	91	85,400	80,400	94
-RURAL	1000 ACRES	818.2	991	213	21	987	359	36	983	507	52
-RURAL	$1000 AVE ANNUAL DAMAGES	3,682.0	6,750	3,050	45	8,170	4,200	51	9,520	5,690	60
WILDLIFE MANAGEMENT	1000 ACRES	NA	959	140	15	2,850	369	13	5,190	551	11
	1000 USER DAYS	NA	5,380	1,620	30	8,740	5,510	63	12,700	9,610	76
AESTHETIC & CULTURAL	1000 ACRES	NA	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	1000 ACRES		---	6.8	---	---	16.0	---	---	24.7	---
-EXTENSIVE	1000 ACRES	NA	---	70.2	---	---	125	---	---	177	---

TABLE 70 Michigan: Capital Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

RESOURCE USE CATEGORY	1971-1980 Federal	1971-1980 Non-Fed	1971-1980 Private	1971-1980 Total	1981-2000 Federal	1981-2000 Non-Fed	1981-2000 Private	1981-2000 Total	2001-2020 Federal	2001-2020 Non-Fed	2001-2020 Private	2001-2020 Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	76.0	177.2	0	253.2	93.5	218.3	0	311.8	136.1	317.7	0	453.8	1,018.8
SELF-SUPPLIED INDUSTRIAL	0	0	7.7	7.7	0	0	51.4	51.4	0	0	87.4	87.4	146.5
RURAL DOMESTIC & LIVESTOCK	0.2	0	1.3	1.5	0.3	0	2.2	2.5	0.2	0	1.7	1.9	5.9
IRRIGATION	0	0	14.3	14.3	0	0	10.2	10.2	0	0	10.9	10.9	35.4
MINING	0	0	2.4	2.4	0	0	6.6	6.6	0	0	11.8	11.8	20.8
THERMAL POWER COOLING	0	3.8	73.1	76.9	0	21.9	415.6	437.5	0	35.4	671.6	707.0	1,221.4
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	740.2	246.8	0	987.0	773.2	257.8	0	1,031.0	858.8	286.2	0	1,145.0	3,163.0
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	5.1	8.3	0	13.4	2.8	6.0	0	8.8	8.8	16.0	0	24.8	47.0
RECREATIONAL BOATING	28.7	28.7	24.5	81.9	51.3	51.3	43.9	146.5	55.6	55.6	47.4	158.6	387.0

COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	108.6	0	0	108.6	831.8	0	0	831.8	0	0	0	0	940.4
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	18.1	0	46.6	64.7	33.8	0	86.9	120.7	20.6	0	52.9	73.5	258.9
-CROPLAND DRAINAGE	17.7	0	41.3	59.0	31.0	0	72.2	103.2	17.7	0	41.2	58.9	221.1
FOREST LAND-TREATMENT	69.1	4.3	13.0	86.4	141.0	8.8	26.4	176.2	141.1	8.8	26.5	176.4	439.0
SHORELAND EROSION	1.9	0	7.7	9.6	3.9	0	15.5	19.4	3.9	0	15.5	19.4	48.4
STREAMBANK EROSION	3.8	0	9.9	13.7	11.5	0	29.7	41.2	19.2	0	49.5	68.7	123.6
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	240.0	0	80.0	320.0	45.7	0	15.3	61.0	59.1	0	19.7	78.8	459.8
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	6.6	59.0	0	65.6	9.6	86.1	0	95.7	6.8	61.8	0	68.4	229.7
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	101.8	189.0	0	290.8	117.8	218.9	0	336.7	119.5	221.8	0	341.3	968.8
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	1,417.8	717.1	321.8	2,456.7	2,147.2	869.1	775.9	3,792.2	1,447.4	1,003.1	1,036.1	3,486.6	9,735.5

TABLE 71 Michigan: Operation, Maintenance, and Replacement Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

	1971-1980				1981-2000				2001-2020				
RESOURCE USE CATEGORY	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	0	102.1	0	102.1	0	474.6	0	474.6	0	1,065.6	0	1,065.6	1,642.3
SELF-SUPPLIED INDUSTRIAL	0	0	13.9	13.9	0	0	230.4	230.4	0	0	706.6	706.6	950.9
RURAL DOMESTIC & LIVESTOCK	0	0	4.8	4.8	0	0	32.2	32.2	0	0	59.3	59.3	96.3
IRRIGATION	0	0	2.1	2.1	0	0	11.0	11.0	0	0	16.7	16.7	29.8
MINING	0	0	3.7	3.7	0	0	32.8	32.8	0	0	82.3	82.3	118.8
THERMAL POWER COOLING	0	1.0	18.8	19.8	0	15.2	289.5	304.7	0	44.5	845.4	889.9	1,214.4
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	0	1,671.9	0	1,671.9	0	3,976.7	0	3,976.7	0	5,857.9	0	5,857.9	11,506.5
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	2.8	4.4	0	7.2	8.3	18.7	0	27.0	12.7	23.4	0	36.1	70.3
RECREATIONAL BOATING	0	0	19.8	19.8	0	0	143.5	143.5	0	0	271.4	271.4	434.7
COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	14.0	0	0	14.0	263.2	0	0	263.2	470.4	0	0	470.4	747.6
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	0	0	0.8	0.8	0	0	6.6	6.6	0	0	12.1	12.1	19.5
-CROPLAND DRAINAGE	0	0	1.5	1.5	0	0	12.7	12.7	0	0	22.3	22.3	37.7
FOREST LAND-TREATMENT	0.2	0.4	1.5	2.1	2.0	4.0	13.5	19.5	3.5	7.0	24.6	35.1	56.7
SHORELAND EROSION	0.2	0	0.7	0.9	1.5	0	6.2	7.7	3.1	0	12.5	15.6	24.2
STREAMBANK EROSION	0	0	1.5	1.5	0	0	12.9	12.9	0	0	36.5	36.5	50.9
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	0.0	0.7	0	0.7	0.2	3.4	0	3.6	0.2	4.3	0	4.5	8.8
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	0	3.2	0	3.2	0	4.8	0	4.8	0	3.5	0	3.5	11.5
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	9.4	37.8	0	47.2	70.8	283.0	0	353.8	133.1	532.5	0	665.6	1,066.6
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	26.6	1,821.5	69.7	1,917.8	346.0	4,780.4	798.7	5,925.1	623.0	7,538.7	2,097.0	10,258.7	18,101.6

TABLE 72 Minnesota: Needs, Outputs, and Percent Needs Met, Proposed Framework, 1980, 2000, 2020

RESOURCE USE CATEGORY	UNIT	1970 SUPPLY	1980 N	1980 O	1980 %	2000 N	2000 O	2000 %	2020 N	2020 O	2020 %
WATER WITHDRAWALS											
MUNICIPALLY SUPPLIED	MILLION GALLONS PER DAY	26	3.0	3.0	100	12.1	12.1	100	23.0	23.0	100
SELF-SUPPLIED INDUSTRIAL	MILLION GALLONS PER DAY	68	+	---	---	+	---	---	15.0	15.0	100
RURAL DOMESTIC & LIVESTOCK	MILLION GALLONS PER DAY	5.2	0.2	0.2	100	1.3	1.3	100	1.8	1.8	100
IRRIGATION	MILLION GALLONS PER DAY	5.9	3.8	3.8	100	9.6	9.6	100	15.2	15.2	100
MINING	MILLION GALLONS PER DAY	542	20.4	20.4	100	42.2	42.2	100	72.8	72.8	100
THERMAL POWER COOLING	MILLION GALLONS PER DAY	250	0	0	---	850	850	100	1,830	1,830	100
NON-WITHDRAWAL WATER USES											
MUNICIPAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	23	28.1	28.1	100	34.2	34.2	100	42.2	42.2	100
INDUSTRIAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	32	23.6	23.6	100	23.6	23.6	100	34.9	34.9	100
HYDROELECTRIC POWER	MILLION GALLONS PER DAY	NA	0	---	---	0	---	---	0	---	---
WATER ORIENTED OUTDOOR REC.	1000 RECREATION DAYS	NA	+	1,710	over	+	4,315	over	+	6,930	over
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
SPORT FISHING	1000 ANGLER DAYS	3,170	710	400	56	1,370	900	66	2,080	1,500	72
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
RECREATIONAL BOATING	1000 BOAT DAYS	1,301.6	193	177	92	306	316	over	424	480	over
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL FISHING	MILLION TONS PER YEAR	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	MILLION TONS PER YEAR		---	---	---	---	---	---	---	---	---
RELATED LAND USES & PROBLEMS											
AGRIC. LAND-TREATMENT	1000 ACRES	216	216	39.8	18	216	114	53	216	158	73
-CROPLAND DRAINAGE	1000 ACRES	57.5	57.5	0	0	57.5	0	0	57.5	0	0
FOREST LAND-TREATMENT	1000 ACRES	3,840	3,840	768	20	3,840	2,300	60	3,840	3,840	100
SHORELAND EROSION	MILES	11.4	11.4	0.1	1	11.4	0.3	3	11.4	0.5	4
STREAMBANK EROSION	MILES	164	179	7.6	4	179	22.8	13	179	38.0	21
	$1000 AVE ANNUAL DAMAGES	3.7	3.7	0.7	20	3.7	2.2	60	3.7	3.7	100
FLOOD PLAINS-URBAN	1000 ACRES	0.1	0.1	0.1	100	0.1	0.1	100	0.1	0.1	100
-URBAN	$1000 AVE ANNUAL DAMAGES	79	102	87.5	86	171	152	89	284	264	93
-RURAL	1000 ACRES	3.4	112	51.3	46	112	55.6	50	112	60.9	54
-RURAL	$1000 AVE ANNUAL DAMAGES	0	63.2	36.2	57	108	44.3	41	189	54.0	29
WILDLIFE MANAGEMENT	1000 ACRES	NA	0	114	over	40	384	over	100	736	over
	1000 USER DAYS	NA	34.8	17.0	49	36.2	35.0	97	42.9	56.1	over
AESTHETIC & CULTURAL	1000 ACRES	NA	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	1000 ACRES		---	1.1	---	---	2.8	---	---	4.5	---
-EXTENSIVE	1000 ACRES	NA	---	0.8	---	---	0.8	---	---	0.8	---

TABLE 73 Minnesota: Capital Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

RESOURCE USE CATEGORY	1971-1980 Federal	1971-1980 Non-Fed	1971-1980 Private	1971-1980 Total	1981-2000 Federal	1981-2000 Non-Fed	1981-2000 Private	1981-2000 Total	2001-2020 Federal	2001-2020 Non-Fed	2001-2020 Private	2001-2020 Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	0.2	0.6	0	0.8	0.8	1.7	0	2.5	0.9	2.1	0	3.0	6.3
SELF-SUPPLIED INDUSTRIAL	0	0	0	0	0	0	0	0	0	0	1.1	1.1	1.1
RURAL DOMESTIC & LIVESTOCK	0	0	0	0	0.0	0	0.1	0.1	0	0	0	0	0.1
IRRIGATION	0	0	0.2	0.2	0	0	0.1	0.1	0	0	0.2	0.2	0.5
MINING	0	0	1.4	1.4	0	0	1.4	1.4	0	0	2.0	2.0	4.8
THERMAL POWER COOLING	0	0	0	0	0	1.5	28.3	29.8	0	1.7	32.7	34.4	64.2
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	24.0	8.0	0	32.0	15.8	5.2	0	21.0	12.0	4.0	0	16.0	69.0
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	0.6	1.4	0	2.0	0.4	0.4	0	0.8	0.3	0.5	0	0.8	3.6
RECREATIONAL BOATING	6.7	6.7	5.7	19.1	5.1	5.1	4.3	14.5	4.5	4.5	4.1	13.1	46.7

COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	33.6	0	0	33.6	17.8	0	0	17.8	0	0	0	0	51.4
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	0.1	0	0.4	0.5	0.3	0	0.9	1.2	0.2	0	0.4	0.6	2.3
-CROPLAND DRAINAGE	0	0	0	0	0	0	0	0	0	0	0	0	0
FOREST LAND-TREATMENT	21.2	1.3	4.0	26.5	43.5	2.7	8.2	54.4	43.5	2.7	8.2	54.4	135.3
SHORELAND EROSION	0.0	0	0.1	0.1	0.1	0	0.2	0.3	0.1	0	0.2	0.3	0.7
STREAMBANK EROSION	0.1	0	0.1	0.2	0.2	0	0.4	0.6	0.3	0	0.7	1.0	1.8
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	2.4	0	0.8	3.2	0.4	0	0.1	0.5	1.0	0	0.4	1.4	5.1
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	0.2	1.8	0	2.0	0.7	6.3	0	7.0	1.2	10.8	0	12.0	21.0
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	10.9	20.2	0	31.1	2.8	5.3	0	8.1	2.8	5.2	0	8.0	47.2
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	100.0	40.0	12.7	152.7	87.9	28.2	44.0	160.1	66.8	31.5	50.0	148.3	461.1

TABLE 74 Minnesota: Operation, Maintenance, and Replacement Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

	1971-1980				1981-2000				2001-2020				
RESOURCE USE CATEGORY	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	0	0.5	0	0.5	0	4.9	0	4.9	0	11.4	0	11.4	16.8
SELF-SUPPLIED INDUSTRIAL	0	0	0	0	0	0	0	0	0	0	2.5	2.5	2.5
RURAL DOMESTIC & LIVESTOCK	0	0	0.1	0.1	0	0	0.5	0.5	0	0	1.1	1.1	1.7
IRRIGATION	0	0	0	0	0	0	0.2	0.2	0	0	0.2	0.2	0.4
MINING	0	0	1.4	1.4	0	0	8.4	8.4	0	0	15.5	15.5	25.3
THERMAL POWER COOLING	0	0	0	0	0	0.8	14.5	15.3	0	2.4	45.8	48.2	63.5
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	0	62.7	0	62.7	0	138.1	0	138.1	0	186.9	0	186.9	387.7
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	0.3	0.7	0	1.0	0.1	0.2	0	0.3	0.3	0.6	0	0.9	2.2
RECREATIONAL BOATING	0	0	5.2	5.2	0	0	32.1	32.1	0	0	54.0	54.0	91.3
COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	6.0	0	0	6.0	28.0	0	0	28.0	32.0	0	0	32.0	66.0
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	0	0	0.0	0.0	0	0	0.1	0.1	0	0	0.2	0.2	0.3
-CROPLAND DRAINAGE	0	0	0	0	0	0	0	0	0	0	0	0	0
FOREST LAND-TREATMENT	2.1	0.1	0.5	0.7	0.6	1.2	4.4	6.2	0.8	1.7	5.9	8.4	15.3
SHORELAND EROSION	0.0	0	0.0	0.0	0.0	0	0.1	0.1	0.1	0	0.2	0.3	0.4
STREAMBANK EROSION	0	0	0	0	0	0	0.2	0.2	0	0	0.6	0.6	0.8
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	0	0	0	0	0.0	0.3	0	0.3	0.0	0.2	0	0.2	0.5
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	0	0.1	0	0.1	0	0.3	0	0.3	0	0.6	0	0.6	1.0
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	0.6	2.5	0	3.1	4.4	17.6	0	22.0	8.3	33.1	0	41.4	66.5
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	7.0	66.6	7.2	80.8	33.1	163.4	60.5	257.0	41.5	236.9	126.0	404.4	742.2

TABLE 75 New York: Needs, Outputs, and Percent Needs Met, Proposed Framework, 1980, 2000, 2020

RESOURCE USE CATEGORY	UNIT	1970 SUPPLY	1980 N	1980 O	1980 %	2000 N	2000 O	2000 %	2020 N	2020 O	2020 %
WATER WITHDRAWALS											
MUNICIPALLY SUPPLIED	MILLION GALLONS PER DAY	635	78.1	78.1	100	333	333	100	644	644	100
SELF-SUPPLIED INDUSTRIAL	MILLION GALLONS PER DAY	1,187	156	156	100	566	566	100	1,240	1,240	100
RURAL DOMESTIC & LIVESTOCK	MILLION GALLONS PER DAY	66	9.4	9.4	100	23.4	23.4	100	38.4	38.4	100
IRRIGATION	MILLION GALLONS PER DAY	65.3	69.9	69.9	100	174	174	100	301	301	100
MINING	MILLION GALLONS PER DAY	25	16.3	16.3	100	48.0	48.0	100	102	102	100
THERMAL POWER COOLING	MILLION GALLONS PER DAY	3,109	3,920	3,920	100	5,900	5,900	100	12,700	12,700	100
NON-WITHDRAWAL WATER USES											
MUNICIPAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	590	630	630	100	841	841	100	1,050	1,050	100
INDUSTRIAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	1,551	1,380	1,380	100	1,020	1,020	100	1,650	1,650	100
HYDROELECTRIC POWER	MILLION GALLONS PER DAY	NA	0	0	---	4,000	4,000	100	57,900	57,900	100
WATER ORIENTED OUTDOOR REC.	1000 RECREATION DAYS	NA	---	13,100	---	---	32,500	---	---	47,700	---
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
SPORT FISHING	1000 ANGLER DAYS	15,410	5,980	4,510	75	11,300	9,390	83	17,100	15,000	88
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
RECREATIONAL BOATING	1000 BOAT DAYS	4,639	850	468	55	1,440	1,210	84	2,270	2,110	93
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL FISHING	MILLION TONS PER YEAR	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	MILLION TONS PER YEAR		---	---	---	---	---	---	---	---	---
RELATED LAND USES & PROBLEMS											
AGRIC. LAND--TREATMENT	1000 ACRES	3,080	3,080	565	18	3,080	1,620	53	3,080	2,260	73
--CROPLAND DRAINAGE	1000 ACRES	762	762	41.5	5	762	119	16	762	166	22
FOREST LAND--TREATMENT	1000 ACRES	4,730	4,730	482	10	4,730	1,450	31	4,730	2,410	51
SHORELAND EROSION	MILES	196	196	3.4	2	196	10.1	5	196	16.8	9
STREAMBANK EROSION	MILES	1,675	1,675	41.3	2	1,675	124	7	1,675	207	12
	$1000 AVE ANNUAL DAMAGES	381	381	72.4	19	381	217	57	381	362	95
FLOOD PLAINS--URBAN	1000 ACRES	32	36.2	16.5	46	39.1	27.7	71	41.9	33.8	81
-URBAN	$1000 AVE ANNUAL DAMAGES	942.3	1,470	755	51	2,990	2,490	83	6,140	5,480	89
--RURAL	1000 ACRES	309.1	339	55.2	16	336	125	37	333	187	56
--RURAL	$1000 AVE ANNUAL DAMAGES	1,620.7	2,750	791	29	4,610	2,280	49	8,170	5,210	64
WILDLIFE MANAGEMENT	1000 ACRES	NA	110	173	over	702	395	56	1,290	619	48
	1000 USER DAYS	NA	795	255	32	1,450	795	55	2,110	1,150	55
AESTHETIC & CULTURAL	1000 ACRES	NA	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION--INTENSIVE	1000 ACRES		---	7.4	---	---	16.6	---	---	22.2	---
-EXTENSIVE	1000 ACRES	NA	---	42.3	---	---	97.0	---	---	131	---

TABLE 76 New York: Capital Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

RESOURCE USE CATEGORY	1971-1980 Federal	1971-1980 Non-Fed	1971-1980 Private	1971-1980 Total	1981-2000 Federal	1981-2000 Non-Fed	1981-2000 Private	1981-2000 Total	2001-2020 Federal	2001-2020 Non-Fed	2001-2020 Private	2001-2020 Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	6.8	15.8	0	22.6	22.6	52.6	0	75.2	26.9	62.8	0	89.7	187.5
SELF-SUPPLIED INDUSTRIAL	0	0	12.7	12.7	0	0	33.7	33.7	0	0	55.4	55.4	101.8
RURAL DOMESTIC & LIVESTOCK	0.0	0	0.3	0.3	0.1	0	0.5	0.6	0.1	0	0.6	0.7	1.6
IRRIGATION	0	0	1.6	1.6	0	0	1.7	1.7	0	0	3.1	3.1	6.4
MINING	0	0	0.9	0.9	0	0	1.5	1.5	0	0	4.0	4.0	6.4
THERMAL POWER COOLING	0	6.9	130.2	137.1	0	4.6	87.3	91.9	0	11.9	226.1	238.0	467.0
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	1,338.8	446.2	0	1,785.0	399.8	133.2	0	533	254.2	84.8	0	339.0	2,657.0
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	8.9	8.9	0	17.8	11.9	5.9	0	17.8	15.9	7.9	0	23.8	59.4
RECREATIONAL BOATING	17.4	17.4	14.8	49.6	18.9	18.9	16.4	54.2	16.3	16.3	14.0	46.6	150.4

COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	92.0	0	0	92.0	320.0	0	0	320.0	0	0	0	0	412.0
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	4.2	0	10.9	15.1	8.0	0	20.6	28.6	4.9	0	12.5	17.4	61.1
-CROPLAND DRAINAGE	1.9	0	4.6	6.5	3.7	0	8.5	12.2	2.2	0	5.2	7.4	26.1
FOREST LAND-TREATMENT	24.8	1.5	4.7	31.0	46.4	2.9	8.7	58.0	46.4	2.9	8.7	58.0	147.0
SHORELAND EROSION	0.6	0	2.6	3.2	1.3	0	5.0	6.3	1.3	0	5.0	6.3	15.8
STREAMBANK EROSION	0.6	0	1.4	2.0	1.7	0	4.2	5.9	2.7	0	7.1	9.8	17.7
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	27.3	0	9.1	36.4	163.3	0	54.5	217.8	0.3	0	0.1	0.4	254.6
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	1.4	12.8	0	14.2	3.9	34.8	0	38.7	2.6	23.7	0	26.3	79.2
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	42.4	78.8	0	121.2	60.7	112.6	0	173.3	54.8	101.9	0	156.7	451.2
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	1,567.1	588.3	193.8	2,349.2	1,062.3	365.5	242.6	1,670.4	428.6	312.2	341.8	1,082.6	5,102.2

TABLE 77 New York: Operation, Maintenance, and Replacement Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

RESOURCE USE CATEGORY	1971-1980				1981-2000				2001-2020				
	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	0	11.1	0	11.1	0	121.7	0	121.7	0	289.0	0	289.0	421.8
SELF-SUPPLIED INDUSTRIAL	0	0	11.5	11.5	0	0	105.9	105.9	0	0	265.3	265.3	382.7
RURAL DOMESTIC & LIVESTOCK	0	0	0.8	0.8	0	0	5.3	5.3	0	0	9.3	9.3	15.4
IRRIGATION	0	0	0.3	0.3	0	0	1.4	1.4	0	0	2.5	2.5	4.2
MINING	0	0	0.6	0.6	0	0	5.1	5.1	0	0	11.9	11.9	17.6
THERMAL POWER COOLING	0	1.8	33.4	35.2	0	8.9	168.1	177.0	0	16.8	317.7	334.5	546.7
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	0	711.6	0	711.6	0	1,725.3	0	1,725.3	0	3,042.2	0	3,042.2	5,479.1
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	3.8	3.9	0	7.7	9.3	4.6	0	13.9	10.6	5.3	0	15.9	37.5
RECREATIONAL BOATING	0	0	12.1	12.1	0	0	77.2	77.2	0	0	132.6	132.6	221.9
COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	10.0	0	0	10.0	80.0	0	0	80.0	120.0	0	0	120.0	210.0
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	0	0	0.3	0.3	0	0	3.3	3.3	0	0	5.4	5.4	9.0
-CROPLAND DRAINAGE	0	0	0.2	0.2	0	0	1.4	1.4	0	0	2.2	2.2	3.8
FOREST LAND-TREATMENT	0.1	0.2	0.6	0.9	0.8	1.5	5.4	7.7	1.1	2.2	7.6	10.9	19.5
SHORELAND EROSION	0.1	0	0.2	0.3	0.5	0	2.1	2.6	1.0	0	4.0	5.0	7.9
STREAMBANK EROSION	0	0	0	0	0	0	1.9	1.9	0	0	4.9	4.9	6.8
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	0.0	0.1	0	0.1	0.1	1.7	0	1.8	0.1	2.6	0	2.7	4.6
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	0	0.7	0	0.7	0	1.9	0	1.9	0	1.3	0	1.3	3.9
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	7.9	31.7	0	39.6	51.5	206.0	0	257.5	88.6	354.3	0	442.9	740.0
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	21.9	761.1	60.0	843.0	142.2	2,071.6	377.1	2,590.9	221.4	3,713.7	763.4	4,698.5	8,152.4

TABLE 78 Ohio: Needs, Outputs, and Percent Needs Met, Proposed Framework, 1980, 2000, 2020

RESOURCE USE CATEGORY	UNIT	1970 SUPPLY	1980 N	1980 O	1980 %	2000 N	2000 O	2000 %	2020 N	2020 O	2020 %
WATER WITHDRAWALS											
MUNICIPALLY SUPPLIED	MILLION GALLONS PER DAY	674	101	101	100	341	341	100	684	684	100
SELF-SUPPLIED INDUSTRIAL	MILLION GALLONS PER DAY	1,605	203	203	100	1,040	1,040	100	2,180	2,180	100
RURAL DOMESTIC & LIVESTOCK	MILLION GALLONS PER DAY	61	9.1	9.1	100	25.0	25.0	100	37.9	37.9	100
IRRIGATION	MILLION GALLONS PER DAY	153.9	0.6	0.6	100	56.0	56.0	100	155	155	100
MINING	MILLION GALLONS PER DAY	42	22.0	22.0	100	78.9	78.9	100	180	180	100
THERMAL POWER COOLING	MILLION GALLONS PER DAY	3,400	0	0	---	6,180	6,180	100	17,000	17,000	100
NON-WITHDRAWAL WATER USES											
MUNICIPAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	674	805	805	100	1,060	1,060	100	1,380	1,380	100
INDUSTRIAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	1,674	1,510	1,510	100	1,190	1,190	100	1,640	1,640	100
HYDROELECTRIC POWER	MILLION GALLONS PER DAY	NA	0	---	---	0	---	---	0	---	---
WATER ORIENTED OUTDOOR REC.	1000 RECREATION DAYS	NA	---	10,600	---	---	21,100	---	---	30,000	---
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
SPORT FISHING	1000 ANGLER DAYS	19,116	2,490	2,490	100	9,350	9,350	100	13,700	13,700	100
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
RECREATIONAL BOATING	1000 BOAT DAYS	1,675	301	224	74	706	677	96	1,130	1,050	93
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL FISHING	MILLION TONS PER YEAR	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	MILLION TONS PER YEAR		---	---	---	---	---	---	---	---	---
RELATED LAND USES & PROBLEMS											
AGRIC. LAND-TREATMENT	1000 ACRES	4,020	4,020	385	10	4,020	1,150	29	4,020	1,620	40
-CROPLAND DRAINAGE	1000 ACRES	2,460	2,460	50.1	2	2,460	218	9	2,460	476	19
FOREST LAND-TREATMENT	1000 ACRES	733	733	59.0	8	733	177	24	733	295	40
SHORELAND EROSION	MILES	52.2	52.2	2.9	6	52.2	8.8	17	52.2	14.6	28
STREAMBANK EROSION	MILES	991	991	29.8	3	991	88.8	9	991	148	15
	$1000 AVE ANNUAL DAMAGES	433	433	79.8	18	433	239	55	433	399	92
FLOOD PLAINS-URBAN	1000 ACRES	26.1	30.1	10.4	35	31.1	16.5	53	32.1	25.4	79
-URBAN	$1000 AVE ANNUAL DAMAGES	3,590.1	5,510	3,710	67	10,700	8,590	80	20,900	18,600	89
-RURAL	1000 ACRES	145.1	394	110	28	393	176	45	392	211	54
-RURAL	$1000 AVE ANNUAL DAMAGES	1,108.9	6,400	2,230	35	8,620	3,860	45	11,300	5,730	51
WILDLIFE MANAGEMENT	1000 ACRES	NA	368	20.4	6	942	64.0	7	1,610	121	8
	1000 USER DAYS	NA	2,790	168	6	4,430	471	11	6,260	914	15
AESTHETIC & CULTURAL	1000 ACRES	NA	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	1000 ACRES		---	3.2	---	---	6.3	---	---	8.8	---
-EXTENSIVE	1000 ACRES	NA	---	19.2	---	---	37.3	---	---	51.5	---

TABLE 79 Ohio: Capital Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

RESOURCE USE CATEGORY	1971-1980 Federal	1971-1980 Non-Fed	1971-1980 Private	1971-1980 Total	1981-2000 Federal	1981-2000 Non-Fed	1981-2000 Private	1981-2000 Total	2001-2020 Federal	2001-2020 Non-Fed	2001-2020 Private	2001-2020 Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	8.8	20.5	0	29.3	24.2	56.4	0	80.6	30.0	70.1	0	100.1	210.0
SELF-SUPPLIED INDUSTRIAL	0	0	15.2	15.2	0	0	63.6	63.6	0	0	87.2	87.2	166.0
RURAL DOMESTIC & LIVESTOCK	0.0	0	0.2	0.2	0.0	0	0.3	0.3	0.0	0	0.4	0.4	0.9
IRRIGATION	0	0	0.0	0.0	0	0	1.6	1.6	0	0	2.9	2.9	4.5
MINING	0	0	1.0	1.0	0	0	3.0	3.0	0	0	5.3	5.3	9.3
THERMAL POWER COOLING	0	0	0	0	0	10.7	204.0	214.7	0	18.9	359.7	378.6	593.3
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	141.0	47.0	0	188.0	290.3	96.8	0	387.1	354.8	118.2	0	473.0	1,048.1
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	5.9	17.4	0	23.3	1.8	5.8	0	7.6	1.3	4.8	0	6.1	37.0
RECREATIONAL BOATING	17.2	17.2	14.8	49.2	34.3	34.3	29.4	98.0	22.2	22.2	19.0	63.4	210.6

COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	18.0	0	0	18.0	70.7	0	0	70.7	0	0	0	0	88.7
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	10.2	0	26.3	36.5	19.3	0	49.6	68.9	11.7	0	30.0	41.7	147.1
-CROPLAND DRAINAGE	9.9	0	23.2	33.1	17.0	0	39.8	56.8	12.7	0	29.8	42.5	132.4
FOREST LAND-TREATMENT	6.9	0.4	1.3	8.6	13.9	0.9	2.6	17.4	13.8	0.7	2.6	17.3	43.3
SHORELAND EROSION	0.3	0	1.2	1.5	0.6	0	2.3	2.9	0.6	0	2.3	2.9	7.3
STREAMBANK EROSION	0.3	0	0.9	1.2	1.0	0	2.7	3.7	1.7	0	4.3	6.0	10.9
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	57.7	0	19.2	76.9	40.7	0	13.6	54.3	3.4	0	1.1	4.5	135.7
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	1.8	16.5	0	18.3	4.6	41.2	0	45.8	6.7	59.9	0	66.6	130.7
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	47.3	87.8	0	135.1	52.7	97.9	0	150.6	37.8	70.1	0	107.9	393.6
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	845.1	380.0	103.0	1,328.1	715.0	392.0	409.8	1,516.8	429.9	363.9	540.3	1,397.1	4,242.0

TABLE 80 Ohio: Operation, Maintenance, and Replacement Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

RESOURCE USE CATEGORY	1971-1980				1981-2000				2001-2020				
	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	0	14.8	0	14.8	0	129.9	0	129.9	0	296.9	0	296.9	441.6
SELF-SUPPLIED INDUSTRIAL	0	0	15.4	15.4	0	0	188.0	188.0	0	0	485.1	485.1	688.5
RURAL DOMESTIC & LIVESTOCK	0	0	0.8	0.8	0	0	5.9	5.9	0	0	10.8	10.8	17.5
IRRIGATION	0	0	0.0	0.0	0	0	0.4	0.4	0	0	1.5	1.5	1.9
MINING	0	0	1.3	1.3	0	0	7.1	7.1	0	0	11.7	11.7	20.1
THERMAL POWER COOLING	0	0	0	0	0	5.6	105.6	111.2	0	20.9	396.4	417.3	528.5
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	0	791.1	0	791.1	0	1,926.9	0	1,926.9	0	3,253.1	0	3,253.1	5,971.1
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	0.4	1.2	0	1.6	1.0	3.2	0	4.2	1.0	3.8	0	4.8	10.6
RECREATIONAL BOATING	0	0	9.6	9.6	0	0	73.3	73.3	0	0	136.0	136.0	218.9
COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	2.0	0	0	2.0	24.0	0	0	24.0	40.0	0	0	40.0	66.0
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	0	0	0.9	0.9	0	0	8.0	8.0	0	0	12.7	12.7	21.6
-CROPLAND DRAINAGE	0	0	0.8	0.8	0	0	7.3	7.3	0	0	11.3	11.3	19.4
FOREST LAND-TREATMENT	0.0	0.1	0.2	0.3	0.2	0.3	1.2	1.7	0.4	0.7	2.5	3.6	5.6
SHORELAND EROSION	0.0	0	0.1	0.1	0.2	0	1.0	1.2	0.5	0	1.9	2.4	3.7
STREAMBANK EROSION	0	0	0.1	0.1	0	0	1.2	1.2	0	0	3.1	3.1	4.4
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	0.0	0.2	0	0.2	0.1	1.8	0	1.9	0.1	2.3	0	2.4	4.5
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	0	0.9	0	0.9	0	2.3	0	2.3	0	3.8	0	3.8	7.0
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	5.5	22.0	0	27.5	33.9	135.8	0	169.7	55.0	220.2	0	275.2	472.4
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	7.9	830.3	29.2	867.4	59.4	2,205.8	399.0	2,664.2	97.0	3,801.7	1,073	4,971.7	8,503.3

TABLE 81 Pennsylvania: Needs, Outputs, and Percent Needs Met, Proposed Framework, 1980, 2000, 2020

RESOURCE USE CATEGORY	UNIT	1970 SUPPLY	1980 N	1980 O	1980 %	2000 N	2000 O	2000 %	2020 N	2020 O	2020 %
WATER WITHDRAWALS											
MUNICIPALLY SUPPLIED	MILLION GALLONS PER DAY	65	8.3	8.3	100	24.7	24.7	100	40.8	40.8	100
SELF-SUPPLIED INDUSTRIAL	MILLION GALLONS PER DAY	147	17.0	17.0	100	68.0	68.0	100	129	129	100
RURAL DOMESTIC & LIVESTOCK	MILLION GALLONS PER DAY	3	0	0	---	1.2	1.2	100	2.5	2.5	100
IRRIGATION	MILLION GALLONS PER DAY	3.3	3.1	3.1	100	7.8	7.8	100	14.1	14.1	100
MINING	MILLION GALLONS PER DAY	1.8	0.5	0.5	100	1.8	1.8	100	4.0	4.0	100
THERMAL POWER COOLING	MILLION GALLONS PER DAY	144	0	---	---	0	---	---	0	---	---
NON-WITHDRAWAL WATER USES											
MUNICIPAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	46	91.0	91.0	100	103	103	100	172	172	100
INDUSTRIAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	147	139	139	100	97.0	97.0	100	116	116	100
HYDROELECTRIC POWER	MILLION GALLONS PER DAY	NA	0	---	---	0	---	---	0	---	---
WATER ORIENTED OUTDOOR REC.	1000 RECREATION DAYS	NA	---	337	---	---	502	---	---	992	---
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
SPORT FISHING	1000 ANGLER DAYS	1,058	278	278	100	427	427	100	794	794	100
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
RECREATIONAL BOATING	1000 BOAT DAYS	44.0	35	11	31	37	29	78	54	48	89
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL FISHING	MILLION TONS PER YEAR	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	MILLION TONS PER YEAR		---	---	---	---	---	---	---	---	---
RELATED LAND USES & PROBLEMS											
AGRIC. LAND-TREATMENT	1000 ACRES	71.7	71.7	6.5	9	71.7	19.4	27	71.7	27.3	38
-CROPLAND DRAINAGE	1000 ACRES	23.6	23.6	2.1	9	23.6	2.1	9	23.6	2.1	9
FOREST LAND-TREATMENT	1000 ACRES	134	134	10.1	8	134	30.4	23	134	50.7	38
SHORELAND EROSION	MILES	38	38.0	6.0	16	38.0	6.0	16	38.0	6.0	16
STREAMBANK EROSION	MILES	157	157	0.4	<1	157	1.2	1	157	2.0	1
	$1000 AVE ANNUAL DAMAGES	1.8	1.8	0.1	4	1.8	0.2	13	1.8	0.4	63
FLOOD PLAINS-URBAN	1000 ACRES	0	0.3	0.0	0	0.3	0.1	33	0.3	0.3	100
-URBAN	$1000 AVE ANNUAL DAMAGES	0	8.5	0.2	2	14.6	2.6	18	26.0	26.0	100
-RURAL	1000 ACRES	0	2.0	0.0	0	2.0	0.0	0	2.0	0.0	0
-RURAL	$1000 AVE ANNUAL DAMAGES	0	10.7	0.0	0	13.7	0.0	0	15.0	0.0	0
WILDLIFE MANAGEMENT	1000 ACRES	NA	3.6	4.5	over	17.5	9.5	54	26.6	9.5	36
	1000 USER DAYS	NA	33.8	4.8	14	52.5	12.1	23	66.2	12.1	18
AESTHETIC & CULTURAL	1000 ACRES	NA	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	1000 ACRES		---	0.1	---	---	0.2	---	---	0.4	---
-EXTENSIVE	1000 ACRES	NA	---	0.6	---	---	1.0	---	---	1.9	---

TABLE 82 Pennsylvania: Capital Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

RESOURCE USE CATEGORY	1971-1980 Federal	1971-1980 Non-Fed	1971-1980 Private	1971-1980 Total	1981-2000 Federal	1981-2000 Non-Fed	1981-2000 Private	1981-2000 Total	2001-2020 Federal	2001-2020 Non-Fed	2001-2020 Private	2001-2020 Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	1.0	2.2	0	3.2	1.7	4.1	0	5.8	1.8	4.1	0	5.9	14.9
SELF-SUPPLIED INDUSTRIAL	0	0	1.4	1.4	0	0	4.1	4.1	0	0	5.0	5.0	10.5
RURAL DOMESTIC & LIVESTOCK	0	0	0	0	0.0	0	0.1	0.1	0	0	0	0	0.1
IRRIGATION	0	0	0.1	0.1	0	0	0.1	0.1	0	0	0.1	0.1	0.3
MINING	0	0	0.0	0.0	0	0	0.1	0.1	0	0	0.2	0.2	0.3
THERMAL POWER COOLING	0	0	0	0	0	0	0	0	0	0	0	0	0
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	18.6	6.2	0	24.8	10.9	3.6	0	14.5	43.9	14.6	0	58.5	97.8
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	0.9	0.6	0	1.5	0.1	0.1	0	0.2	0.1	0.1	0	0.2	1.9
RECREATIONAL BOATING	0.9	0.9	0.7	2.5	1.1	1.1	1.0	3.2	0.8	0.8	0.7	2.3	8.0

COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	0	0	0	0	14.0	0	0	14.0	0	0	0	0	14.0
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	0.1	0	0.1	0.2	0.1	0	0.2	0.3	0.1	0	0.1	0.2	0.7
-CROPLAND DRAINAGE	0	0	0	0	0	0	0	0	0	0	0	0	0
FOREST LAND-TREATMENT	0.8	0.0	0	1.0	1.6	0.1	0.3	2.0	1.6	0.1	0.3	2.0	5.0
SHORELAND EROSION	1.0	0	3.8	4.8	0	0	0	0	0	0	0	0	4.8
STREAMBANK EROSION	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0
FLOOD PLAINS--URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
--URBAN	0	0	0	0	0	0	0	0	0	0	0	0	0
--RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
--RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	0.0	0.4	0	0.4	0.1	0.5	0	0.6	0	0	0	0	1.0
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION--INTENSIVE	0.8	1.6	0	2.4	1.3	2.3	0	3.6	2.5	4.6	0	7.1	13.1
--EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	396.3	135.9	6.3	538.5	144.5	49.7	5.9	200.1	27.1	16.5	6.4	50.0	788.6

TABLE 83 Pennsylvania: Operation, Maintenance, and Replacement Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

	1971-1980				1981-2000				2001-2020				
RESOURCE USE CATEGORY	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Federal	Non-Fed	Private	Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	0	1.6	0	1.6	0	11.2	0	11.2	0	21.3	0	21.3	34.1
SELF-SUPPLIED INDUSTRIAL	0	0	1.2	1.2	0	0	12.4	12.4	0	0	28.5	28.5	42.1
RURAL DOMESTIC & LIVESTOCK	0	0	0	0	0	0	0.1	0.1	0	0	0.4	0.4	0.5
IRRIGATION	0	0	0.0	0.0	0	0	0.1	0.1	0	0	0.1	0.1	0.2
MINING	0	0	0.1	0.1	0	0	1.1	1.1	0	0	2.9	2.9	4.1
THERMAL POWER COOLING	0	0	0	0	0	0	0	0	0	0	0	0	0
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	0	62.8	0	62.8	0	238.6	0	238.6	0	821.8	0	821.8	1,123.2
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	0.3	0.2	0	0.5	0.2	0.0	0	0.2	0.1	0.0	0	0.1	0.8
RECREATIONAL BOATING	0	0	0.5	0.5	0	0	3.1	3.1	0	0	5.3	5.3	8.9
COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	1.0	0	0	1.0	6.0	0	0	6.0	8.0	0	0	8.0	15.0
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	0	0	0.0	0.0	0	0	0.1	0.1	0	0	0.1	0.1	0.2
-CROPLAND DRAINAGE	0	0	0.0	0.0	0	0	0.1	0.1	0	0	0.0	0.0	0.1
FOREST LAND-TREATMENT	0.0	0.0	0	0.0	0.0	0.0	0.2	0.2	0.0	0.1	0.2	0.3	0.5
SHORELAND EROSION	0.1	0	0.4	0.5	0.4	0	1.5	1.9	0.4	0	1.5	1.9	4.3
STREAMBANK EROSION	0	0	0	0	0	0	0	0	0	0	0	0	0
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
--URBAN	0	0	0	0	0	0	0	0	0	0	0	0	0
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.0
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION--INTENSIVE	0.1	0.4	0	0.5	0.7	3.0	0	3.7	1.7	6.9	0	8.6	12.8
--EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	1.5	65.0	2.2	68.7	7.2	253.0	18.5	278.7	10.2	850.0	39.0	399.2	1,246.6

TABLE 84 Wisconsin: Needs, Outputs, and Percent Needs Met, Proposed Framework, 1980, 2000, 2020

RESOURCE USE CATEGORY	UNIT	1970 SUPPLY	1980 N	1980 O	1980 %	2000 N	2000 O	2000 %	2020 N	2020 O	2020 %
WATER WITHDRAWALS											
MUNICIPALLY SUPPLIED	MILLION GALLONS PER DAY	305	152	39.9	26	407	118	29	761	234	31
SELF-SUPPLIED INDUSTRIAL	MILLION GALLONS PER DAY	595	135	---	---	304	---	---	661	---	---
RURAL DOMESTIC & LIVESTOCK	MILLION GALLONS PER DAY	68.9	10.3	8.6	83	26.3	20.7	79	38.1	31.1	82
IRRIGATION	MILLION GALLONS PER DAY	106.6	89.0	63.9	72	171	127	74	265	200	75
MINING	MILLION GALLONS PER DAY	14.4	27.1	11.4	42	65.0	25.7	40	130	47.6	37
THERMAL POWER COOLING	MILLION GALLONS PER DAY	2,044	1,150	1,150	100	3,900	3,900	100	9,820	9,820	100
NON-WITHDRAWAL WATER USES											
MUNICIPAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	308	461	461	100	688	688	100	996	996	100
INDUSTRIAL WASTEWATER DISCHARGES	MILLION GALLONS PER DAY	631	515	515	100	511	511	100	782	782	100
HYDROELECTRIC POWER	MILLION GALLONS PER DAY	NA	0	---	---	0	---	---	0	---	---
WATER ORIENTED OUTDOOR REC.	1000 RECREATION DAYS	NA	---	5,800	---	---	13,800	---	---	20,500	---
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
SPORT FISHING	1000 ANGLER DAYS	13,412	4,410	4,140	94	8,710	8,340	96	12,900	12,500	97
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
RECREATIONAL BOATING	1000 BOAT DAYS	5,113	831	337	41	1,730	817	47	2,910	1,380	47
	1000 ACRES WATER SURFACE	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL FISHING	MILLION TONS PER YEAR	NA	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	MILLION TONS PER YEAR		---	---	---	---	---	---	---	---	---
RELATED LAND USES & PROBLEMS											
AGRIC. LAND-TREATMENT	1000 ACRES	3,250	3,250	476	15	3,250	1,360	42	3,250	1,910	59
-CROPLAND DRAINAGE	1000 ACRES	667	667	99.9	15	667	205	31	667	286	43
FOREST LAND-TREATMENT	1000 ACRES	4,350	4,350	854	20	4,350	2,560	59	4,350	4,240	97
SHORELAND EROSION	MILES	278	278	7.8	3	278	23.4	8	278	39.0	14
STREAMBANK EROSION	MILES	1,310	1,310	52.3	4	1,310	157	12	1,310	262	20
	$1000 AVE ANNUAL DAMAGES	221	221	34	15	221	102	46	221	170	77
FLOOD PLAINS-URBAN	1000 ACRES	12.2	16.6	1.7	10	17.9	5.6	31	19.4	12.9	66
-URBAN	$1000 AVE ANNUAL DAMAGES	2,414.9	3,530	275	8	6,470	1,790	28	12,800	10,100	79
-RURAL	1000 ACRES	202.1	665	99.0	15	664	198	30	662	234	35
-RURAL	$1000 AVE ANNUAL DAMAGES	358.8	1,810	423	23	2,300	832	36	2,560	1,020	40
WILDLIFE MANAGEMENT	1000 ACRES	NA	443	706	over	1,340	1,770	over	2,470	2,860	over
	1000 USER DAYS	NA	2,220	79.7	4	3,560	167	5	4,800	325	7
AESTHETIC & CULTURAL	1000 ACRES	NA	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	1000 ACRES		---	2.3	---	---	6.7	---	---	10.6	---
-EXTENSIVE	1000 ACRES	NA	---	10.3	---	---	39.8	---	---	66.0	---

TABLE 85 Wisconsin: Capital Costs, Proposed Framework, 1980, 2000, 2020, (in $1,000,000)

RESOURCE USE CATEGORY	1971-1980 Federal	1971-1980 Non-Fed	1971-1980 Private	1971-1980 Total	1981-2000 Federal	1981-2000 Non-Fed	1981-2000 Private	1981-2000 Total	2001-2020 Federal	2001-2020 Non-Fed	2001-2020 Private	2001-2020 Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	3.3	7.6	0	10.9	6.1	14.1	0	20.2	8.9	20.8	0	29.7	60.8
SELF-SUPPLIED INDUSTRIAL	0	0	16.3	16.3	0	0	23.8	23.8	0	0	41.8	41.8	81.9
RURAL DOMESTIC & LIVESTOCK	0.0	0	0.4	0.4	0.1	0	0.5	0.6	0.1	0	0.4	0.5	1.5
IRRIGATION	0	0	2.2	2.2	0	0	2.2	2.2	0	0	2.2	2.2	6.6
MINING	0	0	0.7	0.7	0	0	0.9	0.9	0	0	1.2	1.2	2.8
THERMAL POWER COOLING	0	2.0	38.3	40.3	0	4.8	91.5	96.3	0	10.4	196.8	207.2	343.8
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	228.8	76.2	0	305.0	270.0	90.0	0	360.0	306.0	102.0	0	408.0	1,073.0
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	1.7	2.1	0	3.8	0.7	1.5	0	2.2	0.9	1.5	0	2.4	8.4
RECREATIONAL BOATING	14.6	14.6	12.6	41.8	15.8	15.8	13.4	45.0	8.3	8.3	7.2	23.8	110.6

RESOURCE USE CATEGORY	1971-1980 Federal	Non-Fed	Private	Total	1981-2000 Federal	Non-Fed	Private	Total	2001-2020 Federal	Non-Fed	Private	Total	Total
COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	25.8	0	0	25.8	58.7	0	0	58.7	0	0	0	0	84.5
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	5.2	0	13.5	18.7	9.8	0	25.1	34.9	5.9	0	15.3	21.2	74.8
-CROPLAND DRAINAGE	4.0	0	9.4	13.4	4.4	0	10.4	14.8	3.3	0	7.6	10.9	39.1
FOREST LAND-TREATMENT	26.2	1.7	4.9	32.8	52.6	3.3	9.8	65.7	51.4	3.2	9.7	64.3	162.8
SHORELAND EROSION	1.0	0	3.8	4.8	1.9	0	7.6	9.5	1.9	0	7.7	9.6	23.9
STREAMBANK EROSION	0.5	0	1.3	1.8	1.5	0	3.9	5.4	2.5	0	6.6	9.1	16.3
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	6.8	0	2.3	9.1	5.2	0	1.8	7.0	20.4	0	6.8	27.2	43.3
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	1.9	17.3	0	19.2	3.5	31.3	0	34.8	3.6	32.7	0	36.3	90.3
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	22.3	41.3	0	63.6	21.1	39.3	0	60.4	24.6	45.6	0	70.2	194.2
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	342.1	162.8	105.7	610.6	451.4	200.1	190.9	842.4	437.8	224.5	303.3	965.6	2,418.6

TABLE 86 Wisconsin: Operation, Maintenance, and Replacement Costs, Proposed Framework, 1980, 2000, 2020, ($1,000,000)

RESOURCE USE CATEGORY	1971-1980 Federal	Non-Fed	Private	Total	1981-2000 Federal	Non-Fed	Private	Total	2001-2020 Federal	Non-Fed	Private	Total	Total
WATER WITHDRAWALS													
MUNICIPALLY SUPPLIED	0	5.8	0	5.8	0	48.6	0	48.6	0	112.1	0	112.1	166.5
SELF-SUPPLIED INDUSTRIAL	0	0	9.1	9.1	0	0	50.0	50.0	0	0	142.0	142.0	201.1
RURAL DOMESTIC & LIVESTOCK	0	0	1.3	1.3	0	0	9.1	9.1	0	0	15.9	15.9	26.3
IRRIGATION	0	0	0.3	0.3	0	0	1.8	1.8	0	0	3.2	3.2	5.3
MINING	0	0	0.7	0.7	0	0	5.2	5.2	0	0	10.9	10.9	16.8
THERMAL POWER COOLING	0	0.5	9.9	10.4	0	4.6	86.5	91.1	0	12.4	234.6	247.0	348.5
NON-WITHDRAWAL WATER USES													
MUNICIPAL WASTEWATER DISCHARGES	0	514.6	0	514.6	0	1,230.2	0	1,230.2	0	1,875.9	0	1,875.9	3,620.7
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	0.8	1.0	0	1.8	1.5	4.0	0	5.5	2.6	5.0	0	7.6	14.9
RECREATIONAL BOATING	0	0	9.3	9.3	0	0	59.1	59.1	0	0	94.5	94.5	162.9
COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	1.0	0	0	1.0	10.0	0	0	10.0	16.0	0	0	16.0	27.0
RELATED LAND USES & PROBLEMS													
AGRIC. LAND-TREATMENT	0	0	0.6	0.6	0	0	4.3	4.3	0	0	6.4	6.4	11.3
-CROPLAND DRAINAGE	0	0	0.4	0.4	0	0	2.4	2.4	0	0	3.5	3.5	6.3
FOREST LAND-TREATMENT	0.1	0.2	0.5	0.8	0.7	1.4	5.1	7.2	1.2	2.3	8.2	11.7	19.7
SHORELAND EROSION	0.1	0	0.4	0.5	0.8	0	3.0	3.8	1.5	0	6.1	7.6	11.9
STREAMBANK EROSION	0	0	0.2	0.2	0	0	1.5	1.5	0	0	4.7	4.7	6.4
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	0.0	0.0	0	0.0	0.0	0.3	0	0.3	0.0	0.9	0	0.9	1.2
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	0	1.0	0	1.0	0	1.8	0	1.8	0	1.9	0	1.9	4.7
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	2.9	11.6	0	14.5	22.4	89.7	0	112.1	40.1	160.6	0	200.7	327.3
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	4.9	534.7	32.7	572.3	35.4	1,380.6	228.0	1,644.0	61.4	2,171.1	530.0	2,762.5	4,978.8

TABLE 87 Great Lakes Basin: Comparison of Total Costs, Normal and Proposed Framework, (in $1,000,000)

RESOURCE USE CATEGORY	1971-1980						1971-2020					
	NORMAL			PROPOSED			NORMAL			PROPOSED		
	Capital	OM&R	TOTAL	Capital	OM&R	TOTAL	Capital	OM&R	TOTAL	Capital	OM&R	TOTAL
WATER WITHDRAWALS												
MUNICIPALLY SUPPLIED	418.6	192.0	610.6	418.6	192.0	610.6	2,014.5	4,130.2	6,144.7	2,014.5	4,130.2	6,144.7
SELF-SUPPLIED INDUSTRIAL	57.5	53.5	111.0	57.5	53.5	111.0	681.7	2,773.5	3,455.2	681.7	2,773.5	3,455.2
RURAL DOMESTIC & LIVESTOCK	2.6	8.3	10.9	2.6	8.3	10.9	11.0	169.1	180.1	11.0	169.1	180.1
IRRIGATION	20.1	2.9	23.0	20.1	2.9	23.0	58.8	46.1	104.9	58.5	45.8	104.3
MINING	6.5	7.7	14.2	6.2	7.8	14.0	45.5	230.4	275.9	38.5	208.4	246.9
THERMAL POWER COOLING	287.1	73.8	360.9	287.1	73.8	360.9	3,395.9	3,347.9	6,743.8	3,395.9	3,347.9	6,743.8
NON-WITHDRAWAL WATER USES												
MUNICIPAL WASTEWATER DISCHARGES	1,786.9	1,381.0	3,167.9	4,784.0	4,108.7	8,892.7	5,149.8	9,783.0	14,932.8	10.326.0	30,287.6	40,613.6
INDUSTRIAL WASTEWATER DISCHARGES	---	---	---	---	---	---	---	---	---	---	---	---
HYDROELECTRIC POWER	---	---	---	---	---	---	---	---	---	---	---	---
WATER ORIENTED OUTDOOR REC.	---	---	---	---	---	---	---	---	---	---	---	---
SPORT FISHING	72.0	22.0	94.0	72.0	22.0	94.0	175.5	147.6	323.1	175.5	147.6	323.1
RECREATIONAL BOATING	272.0	62.9	334.9	272.0	62.9	334.9	1,028.4	1,267.4	2,295.8	1,028.4	1,267.4	2,295.8
COMMERCIAL FISHING	---	---	---	---	---	---	---	---	---	---	---	---
COMMERCIAL NAVIGATION	0	0	0	295.6	36.0	331.6	395.3	297.6	692.9	1,682.2	1,206.6	2,888.8
RELATED LAND USES & PROBLEMS												
AGRIC. LAND-TREATMENT	75.0	1.9	76.9	146.2	3.4	149.6	314.7	43.9	358.6	587.4	86.0	673.4
-CROPLAND DRAINAGE	113.8	2.8	116.6	120.6	3.1	123.7	377.9	50.3	428.2	453.3	67.0	520.3
FOREST LAND-TREATMENT	121.0	3.2	124.2	188.0	4.8	192.8	607.0	71.3	678.3	940.0	118.2	1,058.2
SHORELAND EROSION	27.8	2.7	30.5	27.8	2.7	30.5	119.7	61.8	181.5	119.7	61.8	181.5
STREAMBANK EROSION	19.2	1.8	21.0	19.2	1.8	21.0	173.2	69.4	242.6	173.2	69.4	242.6
FLOOD PLAINS-URBAN	---	---	---	---	---	---	---	---	---	---	---	---
-URBAN	547.4	1.2	548.6	547.4	1.2	548.6	1,056.7	22.8	1,079.5	1,056.7	22.8	1,079.5
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---
-RURAL	---	---	---	---	---	---	---	---	---	---	---	---
WILDLIFE MANAGEMENT	121.2	6.0	127.2	121.2	6.0	127.2	557.7	28.4	586.1	557.7	28.4	586.1
AESTHETIC & CULTURAL	---	---	---	---	---	---	---	---	---	---	---	---
OUTDOOR RECREATION-INTENSIVE	722.4	147.2	869.6	722.4	147.2	869.6	2,296.3	2,950.6	5,246.9	2,296.3	2,950.6	5,246.9
-EXTENSIVE	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	4,671.1	1,970.9	6,642.0	8,108.5	4,738.1	12,846.6	18,459.6	25,491.3	43.950.9	25,596.5	46,988.3	72,584.8

Section 5

CONTINUING STUDY REQUIREMENTS

Studies Completed and in Progress

Before and during the work on the Framework Study several detailed studies were made of portions of the Basin. The information available from these studies was considered in the selection of framework programs, but specific programs were not always included. This was because the Framework Study does not use all the detail provided in the other studies and also because the area under detailed study was not coincident with a planning subarea or river basin group. Some of the studies were conducted under the leadership of Federal agencies and others were under State management.

The following studies are completed or under way:

Indiana:	Elkhart River Basin
	Maumee River Basin (also in Michigan and Ohio)
Michigan:	Grand River Basin
	Kalamazoo-Black-Macatawa-Paw Paw Rivers
	Maumee River Basin (also in Indiana and Ohio)
Minnesota:	Duluth-Superior (partly in Wisconsin)
New York:	Genesee River Basin
	Erie-Niagara area
	Oswego River Basin
	Black and St. Lawrence River Basins
Ohio:	Northeast Ohio Water Development Plan
	Northwest Ohio Water Development Plan
	Maumee River Basin (also in Indiana and Michigan)
Pennsylvania:	Erie County, Water Supply and Wastewater Management
Wisconsin:	Duluth-Superior (partly in Minnesota)
	Southeast Wisconsin

Studies to be Undertaken

In February 1975 the Commission recommended that the following studies should receive priority consideration.

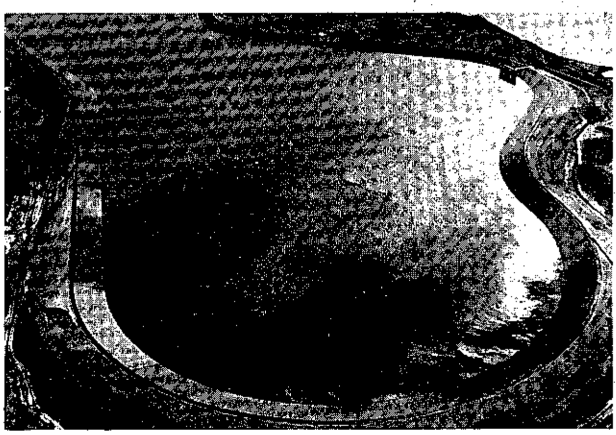
Fox-Wolf River Basin Level B Study
Great Lakes Regional Water and Energy Study
Great Lakes Regional Lake Levels Study
Great Lakes Environmental Planning Study
Lake Superior Basin

Studies of the following are being considered for accomplishment sometime in the future, but no priorities have been set.

Southern Michigan River Basins
Northern Indiana River Basins
Eastern Lake Erie River Basins
Northern Michigan River Basins
New York River Basins
Southeast Wisconsin River Basins
Regional Planning Studies

Future Plans

Now that the immense task of compiling the Framework Study is completed, the question arises, where do we go from here? Of what value will the Framework Study be to the Great Lakes



Courtesy of Federal Power Commission

New fuel sources and new methods of electrical energy production, such as the pumped storage reservoir at Ludington, Michigan (above) are expected to develop in the Basin.

Basin and its residents? How does the Commission plan to use the Framework Study so that the vast amount of time and expertise that have been invested in it produce the maximum return?

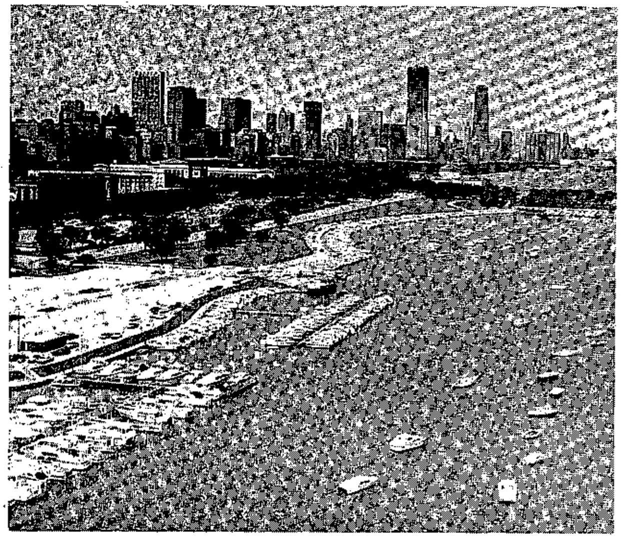
The Water Resources Planning Act (P.L. 89–80), which directs the river basin commissions to conduct Level A framework studies, contains a definite purpose for the framework studies, and does not in any way treat these studies as ends in themselves. Congress was concerned that water resources planning be coordinated and comprehensive, so the most efficient use of human resources would be involved, and the wisest resource use result. Thus Congress authorized the creation of regional river basin commissions that would guide and coordinate water resource planning in their entire respective regions. Congress perceived what it terms a framework study as the best first step in establishing coordinated planning, by assessing of the status of our resources and their ability to meet expected natural and human needs. This would provide the basic knowledge needed to progress intelligently toward effective, wise planning.

It is clear, therefore, that although the completion of this Framework Study is a major accomplishment that unifies for the first time basic data about the entire Great Lakes Basin, it only opens the door on resource planning and points the way in which to proceed. Accordingly, the Great Lakes Basin Commission has begun work on the next steps of comprehensive planning.

As was briefly pointed out in the introduction to this report, these next steps are indicated in the law and in Water Resources Council policy statements to lead toward the development of a comprehensive coordinated joint plan (CCJP) for water and land resource use and conservation. Section 1, Recommendations and Their Implementation, discusses the CCJP in detail.

Earlier in this section are listed studies on the Great Lakes Basin, either completed or under way, that are likely to be used in developing the CCJP. Also found are a list of studies that the Commission feels should be given immediate consideration and a list of studies of less urgency that should be accomplished in the future. Determination of what studies should be undertaken, where, and in what order was based in part on the information derived from the Framework Study. Thus, the Framework Study has already been useful in providing planners with a direction for the future, and it will continue to be so.

The growing population and economic development of the Great Lakes Basin and the resultant demand for greater total and per capita use of resources for manufacturing, convenience, and recreation, and the growing need to protect the environment and conserve energy, all make planning and expanded public involvement essential. If unplanned growth is allowed, there will soon be a deficiency of many resources in many areas, and a serious decline in environmental quality. Modern-day transportation and communication, the fact that natural topographic, climatic, or habitat boundaries seldom coincide with political boundaries, and the interrelatedness and interdependence of our natural resources dictate that this planning proceed on a regional basis with coordination among agencies and individuals concerned with various specific resources. This approach will enable planning that is truly comprehensive to occur.

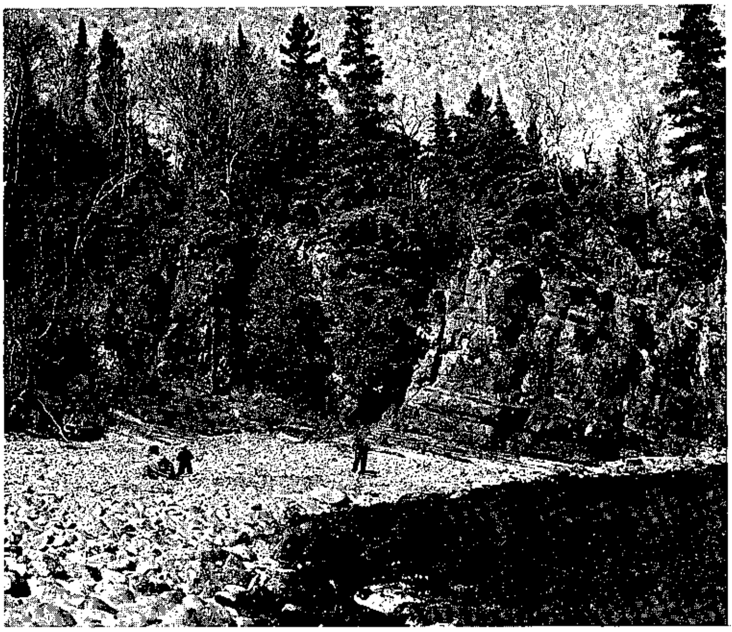


Courtesy of Chicago Park District

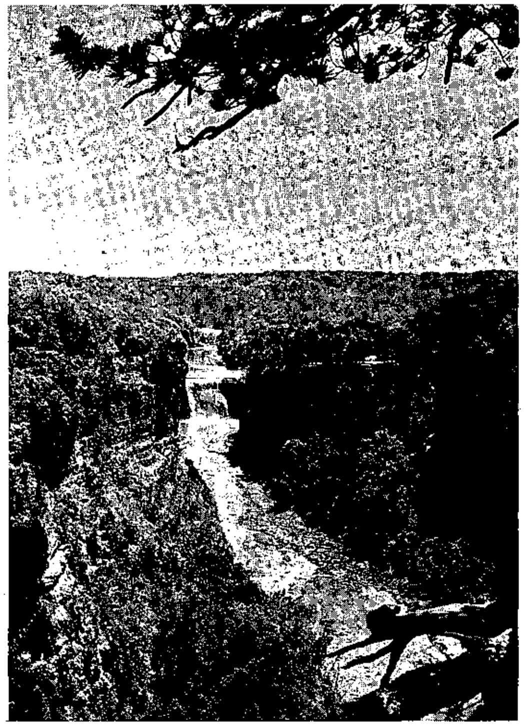
Competition for shoreline use is intense among various interests in major urban areas.

The development of a CCJP will be a major aid to vital comprehensive planning. The CCJP can ensure close coordination of public and private efforts to preserve and enhance the resources of the Great Lakes to meet the future needs of the Basin's inhabitants. The CCJP will help decisionmakers and the public to evaluate future courses of action. It will provide a means for utilizing the wide variety of knowledge which has seldom been comprehensively applied to evaluating management programs and policies for our nation's resources. This will encourage wise assessment of what we must do to preserve and enhance our water resources.

The Great Lakes Basin Commission expects to continue its active role in developing the CCJP, fostering public response, and performing or promoting the investigation and planning necessary for contributing elements to the CCJP and for ensuring that it is a working and acceptable plan for both the users and the managers of the Basin's water and related land resources.



Courtesy of National Park Service



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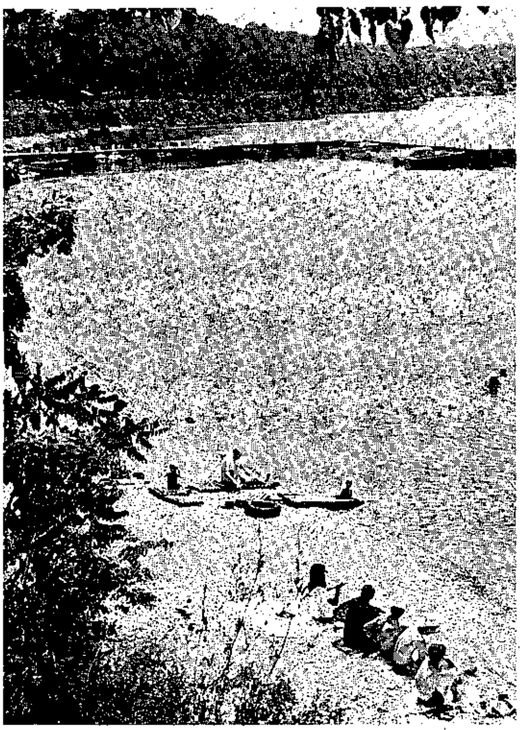

Source unknown

Courtesy of Pennsylvania Department of Natural Resources

Comprehensive planning is necessary to preserve recreational and scenic areas such as these.

Institutional Changes

Current institutional arrangements are lacking in the ability to foster and enforce a political consensus and in Basinwide jurisdiction over the development and conservation of water and related land resources in the Great Lakes Basin. Thus, the integration required for resolving Basin conflicts in resource use is accomplished on a piecemeal basis.

The political and institutional aspects of resource management in the Basin are very complex. The Basin encompasses one province in Canada and eight States in the United States, each of which has specific rights, privileges, and responsibilities concerning the Lakes. In addition, the Federal governments of both countries, and the county and local governments are concerned with the Lakes. The resource use policies of governmental units and agencies often conflict. Overlapping jurisdictions frequently result in overlapping programs and duplication of effort.

In attempts to solve these problems, regional planning agencies and intergovernmental councils coordinate some of the activities of local governments. Interstate agencies coordinate research, planning, and other activities of two or more States. Although organizations such as these are beneficial and their work a step in the right direction, they do not completely provide for Basinwide coordination of resource use.

One reason for this is that the Great Lakes are a single physical system in which activities in one part ultimately affect the other parts of the system. In many cases, improvements in one location can be negated by actions in another location, and beneficial actions in one area may have adverse effects on conditions upstream or downstream. The problem requires integration at the policy-making level to permit determination of mutually acceptable goals and objectives. Such integration is difficult to achieve because government at all levels must be involved. Another problem is the fact that the Great Lakes Basin is in two countries. A more effective working relationship, unencumbered by the usual demands of international protocol is needed.

The Great Lakes Basin Commission is an agency that provides Basinwide coordination of the activities of the States and local governments, and coordinates Federal government activities in the Great Lakes States. A few international agencies also exist, of which the Great Lakes Fishery Commission and the International Joint Commission (IJC) are the best-known and have the broadest reach. The IJC is an international investigative, deliberative, regulative, and semi-adjudicative body with monitoring and surveillance authority. The IJC can at any time be assigned additional responsibilities agreed upon by the U.S. and Canadian governments. As currently constituted, the IJC prerogatives are not broad enough to accommodate the initiatives needed. The IJC prerogative could be expanded to permit it to investigate on its own the matters of urgent concern to both governments. The Great Lakes Basin Commission could readily assist the IJC, for it is designed to manage multiagency planning programs. The Commission should be considered for future activities.

There are several things to consider when planning additional institutional arrangements that would provide the needed integration. First, any mechanism that purports to deal with Basinwide resource issues must be capable of dealing with the problems of multiple-use resources.

Second, a vast range of research, data collection, and analysis must be accomplished to support the decision-making process. Any organizational structure that fails to coordinate information generation and planning will necessarily be handicapped in its ability to identify problems and formulate policy goals.

Third, any institution that attempts to deal with the entire Great Lakes should have the authority to set priorities. Without such authority, there is a great probability that any agreement on policy goals and objectives would be a hollow gesture. Such an agreement might offer enough platitudes to satisfy everyone, but in the face of a limited budget it would be incapable of supporting hard decisions regarding program priorities. The Great Lakes Basin Commission has the responsibility to recommend priorities, but the effectiveness of this authority is weakened by the provision that decisions must be made by consensus.

Finally, establishment of an agency that would integrate public authorities would be difficult because such an agency would have to resolve conflicts between goals supported by different political constituencies. Those issues could only be solved through the political process.

The institutional arrangements affecting water resources will continue to be evaluated during the development of the Comprehensive Coordinated Joint Plan, and recommendations will be included when appropriate. When forwarding the CCJP, the Great Lakes Basin Commission will submit recommendations for implementing the plan, including the management adjustments needed for formulation of new organizations or the realignment of existing organizations.

Education

When the Framework Study was reviewed at public meetings in 1972 and 1976, it became obvious that a more comprehensive effort is needed to increase public understanding of and participation in water and related land resources utilization, development, and conservation. Compared to the number of people in the Great Lakes Basin who feel the effects of resources decisions, a relatively small number participated in the public meetings. Those who did participate expressed a desire for more information in the form of easily understandable materials describing the planning process and Great Lakes Basin resources. Many educators have verified this need for education by requesting such information from the Basin Commission staff offices for elementary school through university class levels.

Filling such a need would provide planners with educated assistants among the public. Educated citizens are more likely to recognize incompatibilities between how they actually use resources and their stated conservation goals. They are also more likely to participate in the planning process, which will enable them to recognize problems in resource use and development.

There must be education that will permit individuals to see the whole resource picture. While it is true that special interest groups are important in pointing out needs, differing viewpoints, and opportunities, it is equally true that they must not be allowed to exercise unrestricted influence on the planning, legislative, and construction process. There are always tradeoffs and compromises, and the public must be provided adequate information to determine which route it wishes to take.

Educational programs are closely associated with the need for public participation. Educational programs concerning resource use, conservation, and development could be provided. Accordingly, adequate funds to design and implement programs for the public's continuing education and special study are needed. Education is not exclusively or even primarily the job of the Commission. Rather, it is a necessary adjunct to all programs. The Commission can act as a catalyst to encourage public education, working with existing State and Federal agencies, local groups, public interest groups, special interest groups, school systems, the news media, and others.

The efforts of these agencies, groups, organizations, and media are in dire need of support if the quantity and quality of public participation are to continue to improve.

AUTHOR

TITLE GREAT LAKES BASIN FRAMEWORK STUDY - REPORT

DATE DUE	BORROWER'S NAME
GAYLORD 45	

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