COMPREHENSIVE WATER POLLUTION CONTROL PROGRAM

FOR THE

LAKE MICHIGAN BASIN

GRAND RIVER BASIN, MICHIGAN

FOREWORD

This report on the Grand River Basin is the third in a series of seven documents describing a water pollution control program for the Lake Michigan Basin. Two prior reports : entitled "Milwaukee Area, Wisconsin" and Green Bay Area, Michigan and Wisconsin" have already been published and presented publicly at conferences called by Governor Warren P. Knowles of Wisconsin. These conferences on pollution of Lake Michigan were held in Milwaukee and Green Bay on June 28, and 30, 1966, respectively.

The Federal Water Pollution Control Administration, Department of the Interior is gratified by the interest in these first two reports . The Administration is also pleased to note that steps have already been taken to implement certain recommendations contained in the two prior reports.

The recommended actions set forth in this document when implemented will protect and enhance the water of the Grand River Basin. It will increase their usefulness for recreational purposes. It will provide a more suitable environment for fish and aquatic life. It will improve the quality and usefulness of the Basin's waters for municipal and industrial purposes, esthetic enjoyment and many other beneficial uses.

Working together as a team the agencies involved with the control of water pollution at all levels of government can and will bring the program for water pollution control to fruition for the benefit of the people and the nation.

For the Administration

James M. Quigley

TABLE OF CONTENTS

Chapter No.		Page No.
	Foreward	
	Summary	i
	Recommended Actions	iii
1.	INTRODUCTION	
	Purpose	1-1
	Scope	1-1
	Great Lakes-Illinois River Basins Project	1-1
2.	DESCRIPTION OF AREA	
	Geography	2-1
	Population	2-2
	Economy	2-2
3.	WATER USES AND WATER QUALITY GOALS	
	Water Uses	3-1
	Water Quality Goals	3-6
4.	WATER SOURCES	
	General	4-1
	Municipal	4-1
	Industrial	4-2
	Combined Sewers	4-2
	Steam Power Plants	4-3
	Agriculture and Land Runoff	4-3
	Ships and Boats	4-3
	Dredging	4-4
	Phosphates	4-5
5.	LAKE CURRENTS	
	Background	5-1
	Findings	5-1
	Summary	5-2
6.	PRESENT WATER QUALITY AND PROBLEMS	
	General	6-1
	Summary	6-1
	Grand River Mouth Sampling	6-1
	Grand River Intensive Studies	6-3
	Waste Assimilation	6-5

TABLE OF CONTENTS (Continued)

Chapter No.		Page No.
7.	WATER QUALITY IMPROVEMENT MEASURES	
	General	7-1
	Municipal Waste Treatment	7-1
	Industrial Waste Treatment	7-1
	Combined Sewers	7-2
	Reduction of Nutrients	7-2
	Plant Operation	7-3
	Monitoring	7-3
	Dredging	7-4
	Thermal Discharge	7-4
	Flow Regulation	7-4
	State Water Pollution Control Program	7-4
8.	PROGRAM IMPLEMENTATION	
9.	BENEFITS	
	BIBLIOGRAPHY	

LIST OF TABLES

Table Number	Title	On or After Page Number
1-1	Program Reports	1-1
1-2	Technical Committee to the GLIRB Project	1-3
2-1	Drainage Areas	2-1
2-2	Streamflows of Record at Specific Gage Locations	2-1
2-3	Present and Projected Populations	2-2
2-4	Value Added by Manufacture and Manufacturing Employment-Eleven County Area	2-3
3-1	Principal Water Uses	3-1
3-2	Total Water Intake-Municipal Water Systems	3-1
3-3	Municipal Water Demands 1962 and Projections to 1980 and 2020	3-2
3-4	Self-supplied Industrial Water Demands 1959 and Projections to 1980 and 2020	3-2
3-5	Water Intake-Steam Power Plants	3-5
3-6	Lake Michigan Basin Water Quality Criteria for Specific Water Uses	3-7
4-1	Municipal Waste Inventory of Major Communities	4-1
4-2	Industrial Waste Inventory (Major Industries)	4-2
4-3	Types of Municipal Sewer Systems - Major Municipal Waste Sources	4-2
6-1	Water Quality - Grand River at Mouth, March 1963 - April 1964	6-2
6-2	Radioactivity - Grand River at Mouth 1963 Average	6-3
7-1	Municipal Waste Treatment Construction Needs (Major Communities)	7-1
7-2	Plant Waste Reduction Needs for Major Industrial Waste Sources	7-1

LIST OF FIGURES

Figure Number	Title	On or After Page Number
1-1	Grand River Basin, Michigan	1-1
1-2	Great Lakes and Illinois River Basins	1-1
5-1	Annual Water Movements at Grand Haven, Michigan	5-1
6-1	DO and BOD Profiles - Grand River Below Jackson	6-4
6-2	DO and BOD Profiles - Grand River Below Lansing	6-4

SUMMARY

General

The waters of the Grand River Basin are degraded in quality particularly below Jackson, Lansing, Grand Rapids and the mouth of the Grand River. This degradation in quality is evidenced by low dissolved oxygen levels, high stream temperatures and other biological, chemical, microbiological and physical parameters analyzed by the Great Lakes-Illinois River Basins Project.

Pollution of the waters of the Grand River is further evidenced by the impairment of legitimate water uses. Whole and partial body contact recreation is potentially hazardous ~~due to~~ because of high coliform and fecal streptococci densities below Jackson and Lansing. The fishery of the Grand River is harmed by low dissolved oxygen levels and high stream temperatures. Esthetic enjoyment is impaired by the unsightly appearance of the Grand River at Jackson and certain other areas.

Sources of Pollution

Municipal waste treatment plants of the Grand River Basin serve a present population (1962) of 540,000. The combined effluents from these municipal treatment facilities discharge a total of 17,000 pounds of 5 day biochemical oxygen demand (BOD_5) daily to the waters of the Grand River Basin. These wastes are equivalent in oxygen-consuming power to the untreated wastes of over 100,000 persons. Other municipal waste sources include the overflows from combined sewer systems.

Industrial wastes discharging directly to the waters of the Grand River Basin put an additional 15,000 pounds of BOD_5 into the streams daily. These wastes are equivalent in oxygen-consuming power to the untreated wastes of over 90,000 persons.

In addition to the organic waste load discharged from industries and municipalities, thermal discharges also have a significant bearing on water quality. For example, cooling water discharges from steam electric generating stations at Lansing affect desirable water uses adversely. which uses?

How much being used?

Future Conditions

Growth projections made by the Great Lakes-Illinois River Basins Project economists indicate that the 1960 Grand River Basin population of 949,000 may increase more than two-fold by 2020. Industrial activity due primarily to productivity and increased demands, is expected to double by 1980 and continue to expand in the decades that follow. Water

demands and waste flows will increase at a more moderate pace due to water reuse and other efficiencies. These and other related factors indicate that the untreated waste load received by all municipal sewerage systems in the Basin will increase to about 2,500,000 PE by 2020. By comparison, the present estimated untreated waste load received by all municipal sewerage systems of the Grand River Basin is approximately 540,000 PE.

Need for Comprehensive Program

The present severe impairment of water uses in the Basin and the increasing waste loads which will be imposed on the waste treatment facilities point out the need for the adoption and implementation of a comprehensive program for water pollution control in the Grand River Basin. The program of necessity must emphasize construction of new and enlarged sewerage facilities, proper operation of new and existing facilities, and intensive and continuous monitoring of operation, waste treatment efficiency and water quality.

RECOMMENDED ACTIONS

1. All municipal waste treatment facilities should be designed and operated to provide secondary (biological) waste treatment and to achieve an overall reduction in untreated BOD_5 of 90 percent or higher, on a continuous basis. The major municipal plants and needed improvements are listed in Table 7-1.

2. Continuous disinfection should be provided for all municipal waste treatment plant effluents in the Grand River Basin.

3. All separately discharging industrial wastes should receive the equivalent of secondary treatment, as described above. Where practicable, industrial wastes should be discharged to municipal sewerage systems. The major industries needing improvements are listed in Table 7-2.

4. Sanitary sewage discharged from industries should receive the same treatment as recommended for municipal wastes.

5. Maximization of phosphate removal, through modification in the operation and/or design of existing and newly constructed secondary waste treatment facilities should be an immediate objective. Records of phosphorus removal at the treatment plants of the Grand River Basin should be carefully evaluated after one year to determine if significant phosphorus removals have been achieved. If such removals are not achieved, consideration should be given to the installation of chemical precipitation facilities at such plants.

6. Combined sewers should be prohibited in all newly developed urban areas and should be separated in coordination with urban renewal projects. Existing combined sewer systems should be patrolled and overflow regulating devices should be adjusted to convey the maximum practicable amount of combined flow to treatment facilities.

7. Even with well operated secondary sewage treatment facilities at Jackson and Lansing present waste loads and increasing waste loads in the future make it impossible to maintain desirable water quality conditions in the Grand River under natural streamflow conditions. Because of the limitation of streamflows and storage sites, low flow augmentation for water quality control will not alone solve these water quality problems. It is, therefore, recommended that the cities of Jackson and Lansing provide some form of advanced waste treatment beyond existing secondary treatment. (See Table 7-1)

1. What about Kampe Bloomfield?
2. Boat Pollution - problem
3. [illegible]
4. What research needs for [illegible]
5. What is cost of program.
6. [illegible]

It is further recommended that work begin, as soon as possible, on a demonstration project to determine the best combination of advanced waste treatment methods and streamflow augmentation which will achieve a desirable water quality downstream from these two cities. The Federal Water Pollution Control Administration will be available to assist in this matter.

8. Streamflow regulation may be necessary in the Grand River Basin even after a high degree of waste treatment is provided, if the desired water quality goals are to be met. However, streamflow regulation is not to be considered as a substitute for the waste treatment improvement measures recommended herein.

9. Agricultural practices should be reviewed to ensure the maximum protection of the waters of the Grand River Basin from the improper application of fertilizers and pesticides. The use of pesticides and herbicides should be more closely scrutinized. At a minimum, accurate estimates of quantities utilized on a county basis should be developed. This will aid in pinpointing potential problem areas. who does this

10. Increased thermal discharges at Lansing and other critical water quality sites in the Grand River Basin should be prohibited. Where practicable, steps should be taken to reduce the existing thermal discharges to the Grand River at Lansing.

11. The off-shore disposal of dredgings from harbor and channel areas which contain residues from the sewage of cities and industries is a poor practice, if the quality of the water of Lake Michigan is to be maintained. It is recommended that those involved in such practices provide other means of disposal which will not adversely effect the water quality of the Lake.

12. Monthly reports covering the operation of all municipal and industrial waste treatment plants including the quality and quantity of discharged effluent should be submitted to the Michigan Water Resources Commission and other appropriate State agencies.

13. The operation of all streamflow regulation facilities should be reviewed to ensure the availability of the maximum practicable streamflow at all times.

14. All industries and municipalities and others discharging wastes into the waters of the Grand River Basin or otherwise affecting the water quality of the Basin should submit, within six months to the appropriate State agency, a report containing a time schedule for the completion of any new construction, modifications to any existing structures, process changes or operating procedures necessary to meet the above recommendations.

15. The water quality monitoring program of the Michigan Water Resources Commission in the Grand River Basin should be strengthened. The program should be geared to indicate change or trends in water quality and the need for additional quality improvement measures.

16. The Michigan Water Resources Commission or other appropriate State agency should conduct waste treatment plant inspections at least annually for small and medium-sized plants, and at least twice annually for the larger plants.

17. It is recommended that the water pollution control activities in Michigan be strengthened in terms of staffing and budget. With additional resources and the support available from the Federal Water Pollution Control Administration the implementation of the program outlined herein and similar programs in other Basins throughout the State can be accelerated to meet the growing need for clean water.

CHAPTER I

INTRODUCTION

Purpose

This report presents an action program of water pollution control, geared to provide high quality waters in the Grand River Basin,Michigan through abatement of existing pollution, and to provide continuing control of pollution through preventive actions scheduled in anticipation of future problems. This report and resulting program have been developed from both extensive and intensive information on present water quality, water uses and trends in water usage, present and anticipated future waste loads, the existing and projected population and economic growth, and other relevant facts. The information was gathered by the Great Lakes-Illinois River Basins (GLIRB) Project, Federal Water Pollution Control Administration, Department of the Interior, during its study of the Great Lakes Basin.

Scope

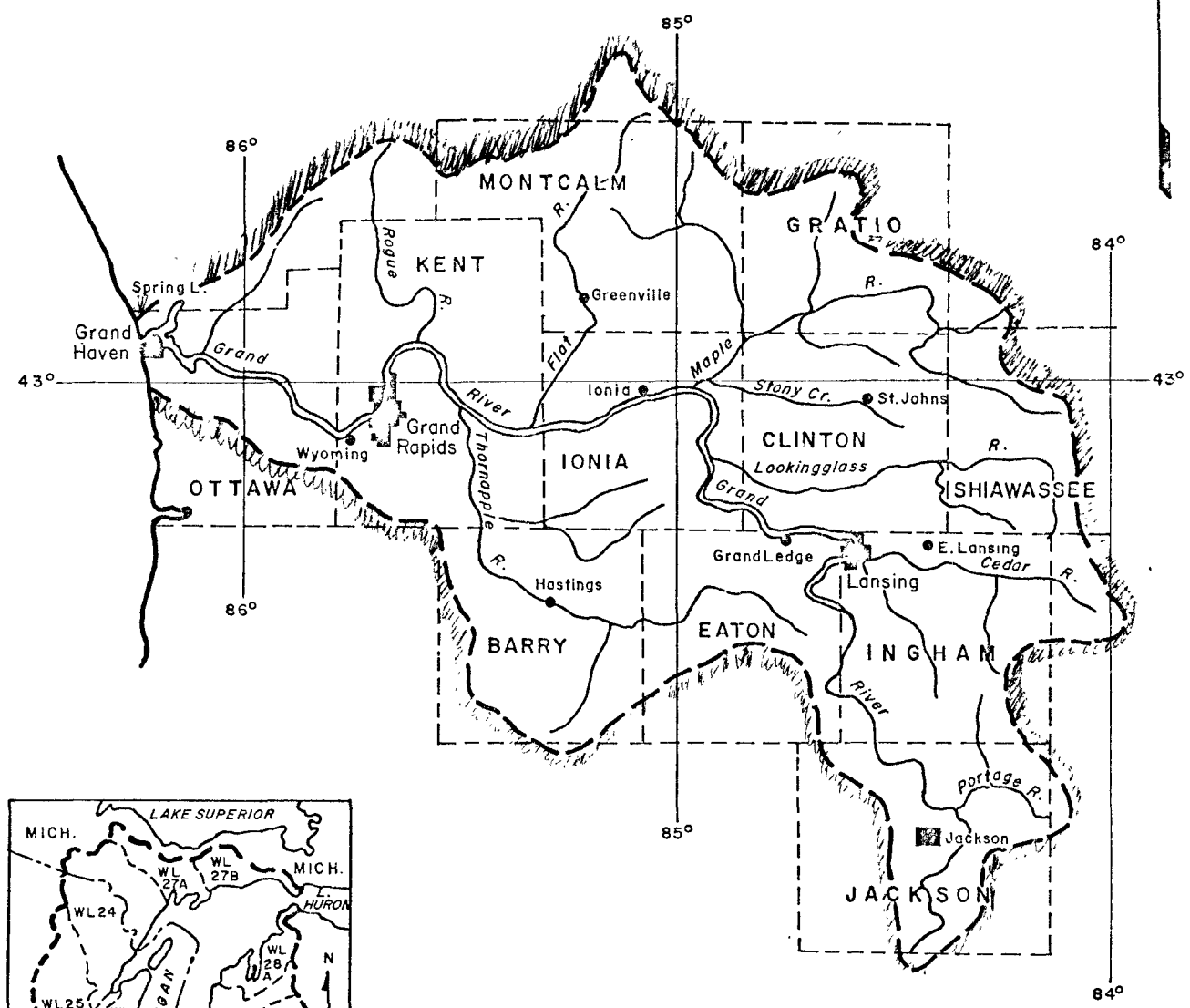
The area (See Figure 1-1) within the scope of this report includes the Grand River and the entire watershed tributary to the Grand River. Water quality conditions in the adjacent water of Lake Michigan at the mouth of the Grand River are also considered.

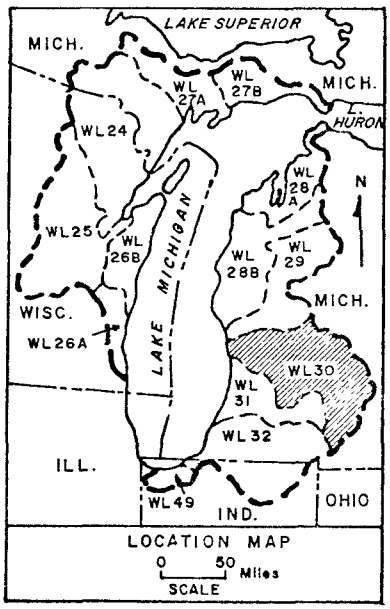
Great Lakes -Illinois River Basins Project

This report is one in a series of 7 documents (Table 1-1) being prepared by the GLIRB Project at Chicago,Illinois. When completed these 7 reports will present a comprehensive program for water pollution control in the entire Lake Michigan Basin. In addition to the Lake Michigan Basin, GLIRB Project, with Program Offices currently located at Cleveland, Ohio, Rochester, New York and Detroit, Michigan, is developing similar programs for the watersheds of Lakes Erie, Ontario, Huron and Superior and the Illinois River Basin (Figure 1-2).

Authority

Comprehensive water pollution control studies were authorized by the Federal Water Pollution Control Act of 1956, as subsequently amended. Inititation of the Great Lakes -Illinois River Basins Comprehensive Program Activity followed an appropriation of funds by the 86th Congress late in 1960. In accordance with the provisions of the Act the Secretary of Health, Education, and Welfare delegated the responsibility for the comprehensive study to the Division of Water Supply and





0 10 20 Miles
Scale

GREAT LAKES & ILLINOIS RIVER BASINS PROJECT

GRAND RIVER BASIN - MICHIGAN

U.S DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMIN
Great Lakes Region Chicago, Illinois

FIGURE 1-1

TABLE 1-1

GREAT LAKES -ILLINOIS RIVER BASINS PROJECT

COMPREHENSIVE WATER POLLUTION CONTROL PROGRAM

FOR THE

LAKE MICHIGAN BASIN

Program Reports

Green Bay Area, Michigan and Wisconsin

Milwaukee Area, Wisconsin

Grand River Basin, Michigan

Kalamazoo River Area, Michigan

St. Joseph River Area, Indiana and Michigan

Calumet Area, Illinois and Indiana

Lake Michigan and Tributary Areas (Summary Report)

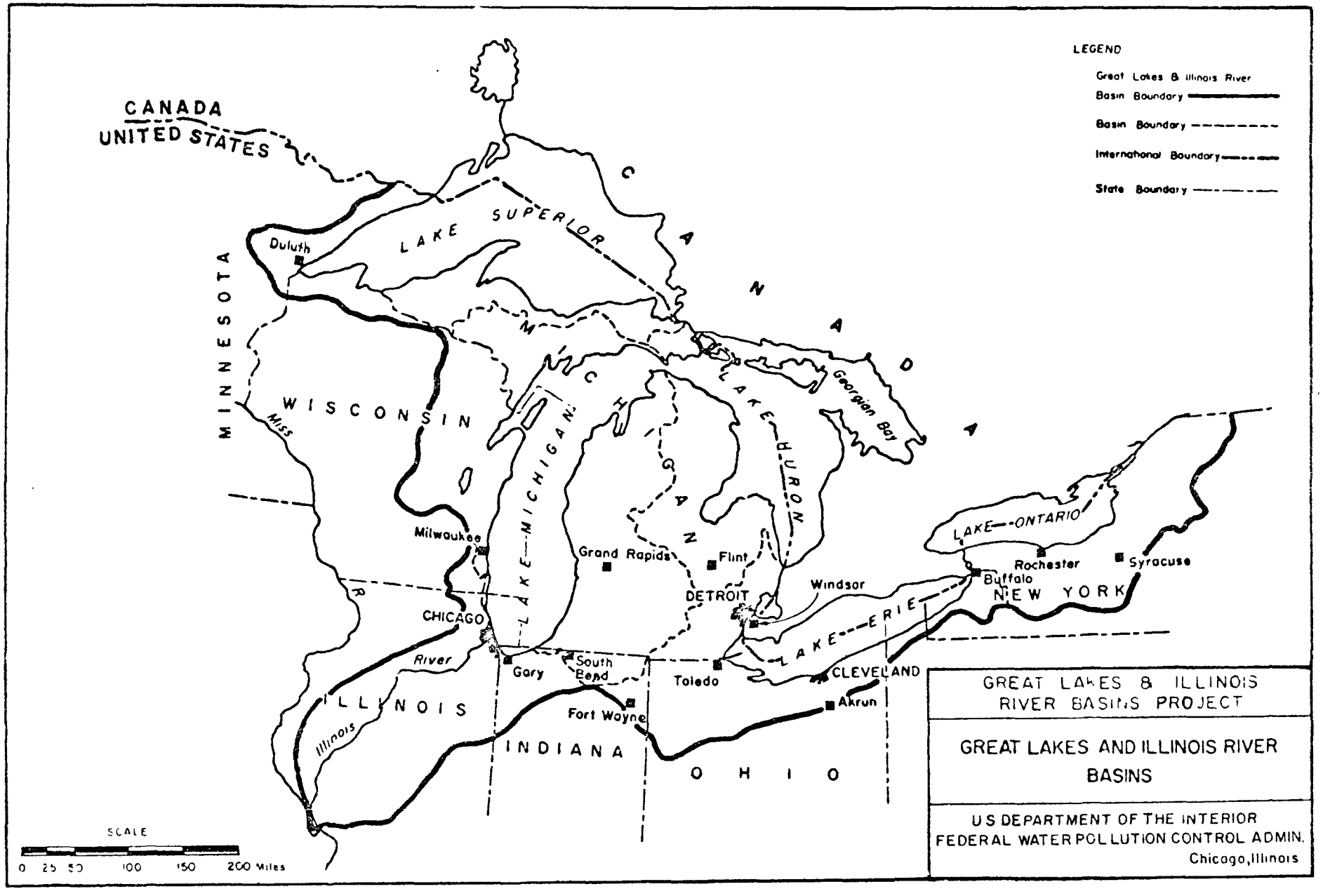

LEGEND
Great Lakes & Illinois River Basin Boundary
Basin Boundary
International Boundary
State Boundary
CANADA
UNITED STATES
CANADA
LAKE SUPERIOR
Duluth
MINNESOTA
WISCONSIN
Miss
R
Milwaukee
CHICAGO
River
Illinois
ILLINOIS
LAKE MICHIGAN
MICHIGAN
Grand Rapids
Flint
DETROIT
Windsor
LAKE HURON
Georgian Bay
LAKE ERIE
Gary
South Bend
Fort Wayne
INDIANA
Toledo
OHIO
CLEVELAND
Akron
LAKE ONTARIO
Rochester
Buffalo
Syracuse
NEW YORK
SCALE
0 25 50 100 150 200 Miles
GREAT LAKES & ILLINOIS RIVER BASINS PROJECT
GREAT LAKES AND ILLINOIS RIVER BASINS
U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMIN.
Chicago, Illinois

FIGURE I-2

Pollution Control of the Public Health Service. Passage of the "Water Quality Act of 1965" gave the responsibility for these studies to the Federal Water Pollution Control Administration (FWPCA).
As a result of Reorganization Plan No. 2 of 1966 the FWPCA was transferred from the Department of Health, Education and Welfare to the Department of the Interior effective May 10,1966.

Organization

Following the initial appropriation of funds by Congress in 1960, a task force designated the GLIRB Project was organized to conduct the comprehensive study. The Project headquarters are located at 1819 West Pershing Road, Chicago, Illinois. The permanent staff of The Project includes specialists covering a broad gamut of professional skills, including sanitary and hydraulic engineers, chemists, biologists, bacteriologists, radiochemists, oceanographers, and economists. The Project has drawn freely on the resources of the Robert A. Taft Sanitary Engineering Center at Cincinnati, Ohio. Valuable counsel and advice have been received from a Technical Committee appointed by the Surgeon General of the Public Health Service. This Committee is composed of men in responsible positions in State water resource and water pollution control agencies, municipal water and sewer departments, private research organizations, conservation groups and industry. Table 1-2 gives the names and positions of the Technical Committee Members.

Cooperative Program

As required by the authorizing legislation the GLIRB Project has worked closely with other Federal, State and local agencies to develop a comprehensive water pollution control program. A list of the principal agencies which have participated through preparation of special reports or through their release of supporting information is as follows:

Illinois

State Sanitary Water Board
Department of Public Health

Indiana

Stream Pollution Control Board
State Board of Health

Michigan

State Water Resources Commission
Department of Health

Wisconsin

State Committee on Water Pollution
State Board of Health

U.S. Federal Power Commission

U.S. Department of the Army

Corps of Engineers

U.S. Department of the Interior

Bureau of Commercial Fisheries
Bureau of Outdoor Recreation
Bureau of Sport Fisheries and Wildlife
Geological Survey

U.S. Department of Commerce

Weather Bureau
Office of Business Economics

TABLE 1-2

TECHNICAL COMMITTEE TO THE GLIRB PROJECT

MEMBERS

Norval E. Anderson
Consulting Engineer
The Metropolitan Sanitary District
of Greater Chicago
100 East Erie Street
Chicago, Illinois 60611

Burton H. Atwood
National Treasurer
Izaak Walton League
Crystal Lake, Illinois

Albert G. Ballert
~~Acting Executive Director~~ and
Director of Research
Great Lakes Commission
Rackham Building
Ann Arbor, Michigan

K. W. Bauer
Executive Director
Southeastern Wis. Reg. Plann. Comm.
Old Court House
Waukesha, Wisconsin 53187

R. M. Billings
Assistant to Vice President
Research and Engineering
Kimberly-Clark Corporation
Lakeview Mill
Neenah Wisconsin 54957

Dr. C. S. Boruff
Technical Director
Hiram Walker & Sons, Inc.
Peoria 1 Illinois

James A. Kelly
Waste Control Department
628 Building
The Dow Chemical Company
Midland Michigan

C.W. Klassen
Technical Secretary
State of Illinois
Sanitary Water Board
Springfield, Illinois 62706

B.J. Leland
Engineer in Charge of Chicago Office
Illinois Sanitary Water Board
1919 West Taylor Street
Chicago, Illinois 60612

Edward C. Logelin
Vice President
U.S. Steel Corporation
208 South La Salle Street
Chicago, Illinois 60690

R. C. Mallatt
Technical Service Superintendent
American Oil Company
2831 Indianapolis Blvd
Whiting, Indiana 46394

P. J. Marschall
Vice President in Charge of
Engineering
Abbott Laboratories
14th and Sheridan Road
North Chicago, Illinois

TABLE-1-2 (Con't)

TECHNICAL COMMITTEE TO THE GLIRB PROJECT

MEMBERS

Horace R. Frye
Supt. Water and Sewer Department
City of Evanston
Evanston, Illinois

H.H. Gerstein
Chief Water Engineer
Bureau of Water
City Hall
Chicago, Illinois 60602

Ross L. Harbaugh
Assistant to the Vice President
Manufacturing and Research
for Environmental Technology
Inland Steel Company
Indiana Harbor Works
East Chicago, Indiana

R. A. Hirshfield
Staff Engineer
Commonwealth Edison Company
Chicago, Illinois 60690

O.J. Muegge
State Sanitary Engineer
The State of Wisconsin
Board of Health
State Office Building
Madison 2, Wisconsin

Loring F. Oeming
Executive Secretary
State of Michigan
Water Resources Commission
200 Mill Street
Lansing, Michigan 48912

B. A. Poole
Technical Secretary
Indiana Stream Pollution Control
Board
1330 West Michigan Street
Indianapolis 7, Indiana

CHAPTER 2

DESCRIPTION OF AREA

Geography

The Grand River Basin is located in the south-central part of the lower peninsula of Michigan (Figure 1-2). The Basin contains a drainage area of 5572 square miles. It is approximately 135 miles long and 70 miles at its maximum upstream width. All or part of 19 counties are contained within the area. The Grand River Basin is bounded on the north by the Muskegon River and Saginaw River watersheds; and on the south by the Kalmazoo River watershed.

Hydrology

The Grand River originates in the northeast corner of Hillsdale County some 15 miles south of Jackson,Michigan. Six major tributaries are the principal contributors to runoff in the Grand River Basin. The Flat, Rogue and Maple Rivers enter the main stream from the north, the Thornapple River from the south, and the Lookingglass and Cedar Rivers from the east. These six streams together with the Portage River near Jackson comprise a total of some 3,500 square miles of drainage area. The remaining drainage area is accounted for by about 30 minor tributary creeks, ranging in size from 65 square miles down to 2 square miles. The gradients (slopes) of the tributary streams range from $2\frac{1}{2}$ to $5\frac{1}{2}$ feet to the mile.

Table 2-1

Drainage Areas - Grand River Basin

River	Drainage Area (Square Miles)
Grand	5,572
Portage	186
Cedar	463
Lookingglass	312
Maple	775
Flat	562
Thornapple	845
Rouge	255

Streamflows at specific gage locations are given in Table 2-2.

CHAPTER 2

DESCRIPTION OF AREA

Geography

The Grand River Basin is located in the south-central part of the lower peninsula of Michigan (Figure 1-2). The Basin contains a drainage area of 5572 square miles. It is approximately 135 miles long and 70 miles at its maximum upstream width. All or part of 19 counties are contained within the area. The Grand River Basin is bounded on the north by the Muskegon River and Saginaw River watersheds; and on the south by the Kalmazoo River watershed.

Hydrology

The Grand River originates in the northeast corner of Hillsdale County some 15 miles south of Jackson,Michigan. Six major tributaries are the principal contributors to runoff in the Grand River Basin. The Flat, Rogue and Maple Rivers enter the main stream from the north, the Thornapple River from the south, and the Lookingglass and Cedar Rivers from the east. These six streams together with the Portage River near Jackson comprise a total of some 3,500 square miles of drainage area. The remaining drainage area is accounted for by about 30 minor tributary creeks, ranging in size from 65 square miles down to 2 square miles. The gradients (slopes) of the tributary streams range from $2\frac{1}{2}$ to $5\frac{1}{2}$ feet to the mile.

Table 2-1

Drainage Areas - Grand River Basin

River	Drainage Area (Square Miles)
Grand	5,572
Portage	186
Cedar	463
Lookingglass	312
Maple	775
Flat	562
Thornapple	845
Rouge	255

Streamflows at specific gage locations are given in Table 2-2.

Topography and Soils

The ground surface of the entire Basin is covered with glacial deposits with bedrock outcropping at only two or three locations. The glacial debris consists primarily of sands and gravels on the terminal moraines, the outwash plains and the till plains. Clay, fine sand, silt and finely ground lime are found in the old glacial lake beds. The loamy sands, clays and muck soils are prominant throughout the valley and, because of their fertility and favorable texture, produce high yields of crops.

Climate

The average annual temperature throughout the watershed is about 49°F. Mean monthly temperatures range from a low of approximately 25°F in January to 72°F in July. Mean monthly precipitation ranges from a low of about 1.9 inches in December to a high of 4 inches in June, with an average annual precipitation of 32.9 inches. Most of the precipitation occurs from April to September. The period of December through February is the time of lowest precipitation (3).

Population

The Grand River Basin had a 1960 population of approximately 949,000. It has grown at a faster rate than the Nation since 1940, increasing by more than 300,000 in that period. In 1960, 67 percent of the Basin's population was municipal. The major cities in the Basin include: Grand Rapids (173,300), Lansing (107,800), Jackson (50,700), and Wyoming (45,800). Table 2-3 shows the 1960 total and municipal population of the Basin and the projected populations for the years 1980 and 2020.

Table 2-3

Present and Projected Populations
Grand River Basin

1960		1980		2020	
Total	Municipal	Total	Municipal	Total	Municipal
949,000	636,000	1,260,000	940,000	2,300,000	1,980,000

Economy

The Grand River Basin includes all or major parts of eleven Michigan Counties (Berry, Clinton, Eaton, Gratiot, Ingham, Ionia, Jackson, Kent, Montcalm, Ottawa and Shiawasee). Manufacturing is the predominant economic activity in the eleven county area which approximates the Basin(4). In 1963, value added by manufacture totalled $1.7 billion. Major industries

TABLE 2-2

Streamflow of Record at Specific Gage Location in the Grand River Basin (1,2)

River	Location	Drainage Area (Square Miles)	Minimum	Streamflow (cfs) 7 day, 1-in-10 yr. Low Flow	Mean Flow
Grand	Jackson	174	9.2*	20	113
Grand	Eaton Rapids	661	14.0*	73	407
Cedar	East Lansing	355	3.0	-	197
Grand	Lansing	1,230	2.8*	75	803
Lookingglass	Eagle	281	11	-	160
Maple	Maple Rapids	434	4.6	-	227
Grand	Ionia	2,840	105*	175	1,576
Flat	Smyrna	528	7.4*	-	385
Thornapple	Caledonia	773	-	-	482
Rogue	Rockford	234	30	-	202
Grand	Grand Rapids	4,900	-	630	3,370

*Regulation due to upstream control structures.

in the area include transportation equipment, fabricated metals and furniture and fixtures. Table 2-4 shows trends in value added and manufacturing employment.

Table 2-4

Value Added by Manufacture (In 1957-1959 Constant Dollars) and Manufacturing Employment for the Eleven County Area

	1947	1954	1958	1963
VAM($1000s)	840,000	1,250,000	1,140,000	1,680,000
Mfg.Employment	121,622	127,865	113,954	130,056

Projections of population, manufacturing employment and productivity increases indicate that industrial activity in the Basin may be expected to increase six to seven-fold by the year 2020.

Agriculture is diversified in the Grand River Basin with dairying, livestock raising and cash grain farming, all relatively important.

CHAPTER 3

WATER USES AND WATER QUALITY GOALS

Water Uses

The principal water uses in the Grand River Basin include:

Municipal Water Supply
Self-supplied Industrial Water
Recreation
Irrigation
Fish and Aquatic Life
Wildlife and Stock Watering
Hydropower
Commercial Shipping
Cooling Water Supply
Waste Assimilation
Esthetics

Present and anticipated future water uses for the main stem of the Grand River have been determined, in cooperation with the Michigan Water Resources Commission (5). Water use stream sectors were established on the basis of a consideration of changing water quality and changes in water uses or certain physical features of the area. The principal water uses in each of the stream sectors are presented in Table 3-1. The principal water uses in the Basin are discussed in the following sections of this Chapter.

Municipal Water Supply

In 1963 there were 54 communities in the Grand River Basin served by community water supply systems. These facilities served an estimated population of 534,000 and supplied water at the average rate of 88 million gallons per day (mgd). Of this total, approximately 45 mgd were supplied for domestic, public and commercial uses and 43 mgd were supplied for industrial use. Table 3-2 summarizes municipal water use data for the Grand River Basin.

TABLE 3-2

Total Water Intake - Municipal Water System, Grand River Basin

Source	Population Served	Water Intake (mgd)	Per Capita Water Intake (gal./day)
Surface Water	214,000	35.2	165
Ground Water	320,000	52.9	165
Totals	534,000	88.1	165

TABLE 3-1

Principal Water Uses
Grand River Basin

Water Use	Grand River Sectors								
	1	2	3	4	5	6	7	8	9
Municipal Water Supply	-	-	-	P	-	-	A	-	A
Industrial Process Water	P	A	P	P	P	A	P	-	A
Recreation									
Whole Body Contact	P	P	-	P	P*	-	P	-	P
Limited Body Contact	P	P	P	P	P	P*	P	P*	P
Irrigation	-	P	P	P	P	P	P	P	P
Fish and Aquatic Life									
Pollution Tolerant	P	P	P	P	P*	P*	P	P*	P
Pollution Facultative	P	P	P	P	P*	P	P	-	P
Pollution Intolerant	-	-	-	-	-	-	-	-	-
Wildlife and Stock Watering	P	P	P	P	P	P*	P	P*	P
Hydropower	-	-	-	-	P	P	P	P	-
Commercial Shipping	P	-	-	-	-	-	-	-	-
Cooling Water Supply	P	A	P	P	P	P	P	-	-
Waste Assimilation	P	P	P	P	P	P	P	P	P
Esthetics	P	P	P	P	P	P*	P	P*	P

NOTE: P = Present use and anticipated future use.
A = Anticipated future use.
- = Insignificant present and anticipated use.
* = Use presently adversely effected by pollution.

Sector	Sector Description
1	Lake Michigan to the upstream end of commercial shipping (Mile Pt. 2.6).
2	Upstream end of commercial shipping to Eastmanville (Mile Pt. 19.3).
3	Eastmanville to Interstate Highway 196 (Mile Pt. 35.8).
4	Interstate Highway 196 to the confluence with Thornapple River (Mile Pt. 61.4).
5	Confluence with Thornapple River to Grand Ledge (Mile Pt.139.5).
6	Grand Ledge to Moores Park Dam at Lansing (Mile Pt. 155.4).
7	Moores Park Dam at Lansing to Onandaga (Mile Pt. 187.6).
8	Onandaga to immediately upstream of Jackson (Mile Pt. 222.0).
9	Immediately upstream of Jackson to headwaters.

Municipal water demands for the major water service areas and projections to the years 1980 and 2020 are presented in Table 3-3. The projections are based upon considerations of population growth, anticipated industrial expansion and industrial water use efficiency factors.

TABLE 3-3

Municipal Water Demands 1962 and Projections to 1980 and 2020

Service Area	Source of Water***	Population Served(1962)	1962 Demand	1980 Demand	2020 Demand
Grand Rapids*	S,G	252,000	40.7	68	131
Lansing**	G	127,000	22.4	40	112
Jackson	G	55,000	10.5	16	30
Grand Haven	G	11,000	3.3		
Greenville	G	7,450	1.3		
Hastings	G	7,320	0.8		
Ionia	G	6,700	0.2		
Saint Johns	G	5,900	1.0		
Grand Ledge	G	5,770	0.6		

* Includes Wyoming, Grandville, and East Grand Rapids.
** Includes East Lansing and Lansing Township.
*** S = surface water source, G = ground water source.

Self-supplied Industrial Water

Based on County data provided by the U. S. Bureau of the Census in a special tabulation for the GLIRB Project, it has been determined that the major demand for self-supplied industrial water occurs in the Grand Rapids, Lansing, and Jackson areas as shown in Table 3-4. Projections contained in the Table were developed following consideration of anticipated increases in industrial output and water use efficiency factors.

TABLE 3-4

Self-Supplied Industrial Water Demands 1959 and Projections to 1980 and 2020

Service Area	1959 Demand(mgd)	1980 Demand(mgd)	2020 Demand(mgd)
Grand Rapids	5	8	14
Lansing	2	3	6
Jackson	6	9	14

Recreation

The study area abounds with natural resources capable of satisfying the needs of residents for water-oriented outdoor recreation. However, many of the streams and lakes within the study area are degraded in water quality to the point where clean water is not available for all recreational pursuits.

There are many lakes in the study area which provide excellent recreational potential. The eastern shore of Lake Michigan around Grand Haven offers a great opportunity for water-oriented recreation.

The Bureau of Outdoor Recreation has identified areas of serious water recreation impairment due to water pollution(6). In general the impaired areas are the harbor water at Grand Haven, the downstream end of the Portage River, and the Grand River below Jackson, Lansing, and Grand Rapids.

In metropolitan areas such as Jackson and Lansing the demand for water-oriented recreation exerts heavy pressure on the waters of high quality which are available for recreational purposes such as swimming. At the present time the demands are largely satisfied by city parks and public and private pools. Residents of the Grand Rapids area find the eastern shore of Lake Michigan inviting and within reasonable driving distance.

The State of Michigan has identified potential parks and camp grounds and is contemplating the construction of reservoirs for recreational purposes (6,7). The need to control water pollution at all such facilities is paramount since such pollution could well jeopardize the water uses contemplated at such facilities.

Irrigation

The soils in the Basin which require irrigation are located, for the greater part, adjacent to Lake Michigan.

In the Upper Grand River Basin, above Ionia, specialized crops such as mint account for the greatest acreage in agricultural irrigation. These are followed by potatoes, field crops, cucumbers, pickles, and melons. Non-agricultural irrigation (golf courses, cemeteries, parks, etc.) accounted for 740 of the 4800 acres irrigated in this part of the Basin. The overall results of Michigan Water Resources Commission irrigation surveys indicate that there were 23% more irrigation systems and 28% more acres irrigated in the Upper Grand River Basin during 1960-61 than there were in 1957-58(7).

In the Lower Grand River Basin truck crops accounted for about 35% of the agricultural irrigated acres with rasberries, blueberries, flowers and nurseries also having significant acreage in irrigation.

Of the estimated total of 6500 acres in irrigation, cemeteries, parks and golf courses accounted for about 800 acres(8).

Present (1960) water usage for irrigation in the Grand River Basin is estimated to be an average of 3.5 mgd during the growing season(9). Using a straight line projection it is anticipated that this usage will increase threefold by 1980. Increasing demands by the rapidly growing population for more fibers and foods will be one of important factors influencing the demand for irrigation. However, the demand on existing water resources will be minor compared to the total water usage in the Basin.

Fish and Aquatic Life

There are about 260 miles of main stream channels in the Upper Grand River Basin above Ionia. This includes the Grand, Maple, Lookingglass, Cedar, and Portage Rivers. Although not generally known, this stream system offers many opportunities in fishing and even duck hunting. A number of reservoirs at power dams furnish expanded fishing and hunting opportunities(7).

In the Grand River Basin there are 12 State Game Project Areas where public hunting and fishing opportunities are provided. Fishing opportunities exist at the Grand Haven State Park. Public fishing sites are available at 48 lakes and streams in the Basin with an area of about 2,100 acres and frontage of about 21,600 ft. Over 250,000 fish, including trout, bass, pike and bluegills were planted during 1962 in 10 of the 19 counties of the Basin(10).

Wildlife and Stock Watering

The present (1960) agricultural water use for stock watering in the Grand River Basin is about 3.5 mgd(9). Projections of this usage indicate that the demand will increase $1\frac{1}{2}$ times by 1980. The use of water for wildlife and stock watering does not play a significant role in the water quality problems of the Basin.

Hydropower

As of 1965 there were 12 hydroelectric power plants in the Basin, with a total installed capacity of 13,500 kilowatts(KW) and a total average annual generation of 46,400 megawatt hours (MWH). Five of the plants are located on Thornapple River, two are located on the Flat River, one is located on Spring Brook and four are located on the main stem of the Grand River. Five potential future hydroelectric sites on the Grand River have been identified by the Federal Power Commission. The sites are located at Grand Rapids, Saranac, Portland, McGee and Danby and would have a total potential capacity of 18,700 KW and a total average annual generation of 65,400 MWH(11).

The use of water for hydroelectric power generation is not considered to be a major use in the Basin. However, water quality problems may develop from the operation of such plants, particularly below dams during off-peak power demands when water releases may be drastically reduced. This can be seen in reviewing Table 2-2.

Commercial Shipping

Grand Haven is one of Lake Michigan's major commercial harbors currently handling in excess of 2½ million tons of commerce annually. Harbor vessel traffic has averaged 2.9 million tons for the period 1955-64, while during 1964 the traffic was 2.6 million tons. The harbor is located at the mouth of the Grand River. A shallow-draft barge channel extends about 15 miles up the Grand River serving commercial sand and gravel deposits, located near the channel's upper end(12).

By 1980 through 2020 the traffic tonnage may be expected to increase somewhat, however, the actual number of ship movements may be expected to remain approximately the same due to an anticipated increase in vessel size.

Cooling Water

As of 1965 the Federal Power Commission reported that there are 14 thermal electric power plants in the Basin. Table 3-5 summarizes data relating to capacity and cooling water intake, when operating at capacity, at each of the 10 steam plants. There are also 4 internal combustion plants in the Basin with an installed capacity of 28,800 KW.

TABLE 3-5

Water Intake-Steam Power Plants
Grand River Basin

Location	Installed Capacity(KW)	Est. Water Intake (Gal./KWH)	Est. Cooling Water Intake(mgd)
Grand Haven	20,000	56.3	27
Grand Rapids	20,000	56.3	27
Grand Rapids	4,050	56.3	6
Grand Rapids	1,250	56.3	2
Lansing	81,500	56.3	110
Lansing	136,000	56.3	184
Lansing	50,000	56.3	68
Lansing	75,000	56.3	101
East Lansing	12,000	56.3	16
Eaton Rapids	1,250	56.3	2
Totals	401,050		543

The use of water for cooling purposes in steam power plants is considered to be significant in the study area with concentrated uses at Lansing. Most cooling waters are returned to streams or lakes 12 - 13 F° warmer than at intake. Stream temperatures as high as 90°F have been recorded below the power stations at Lansing(13).

Waste Assimilation

Use of streams in the Grand River Basin for waste assimilation is one of the predominant present day uses, and in several locations it is the cause of extreme water quality problems as discussed in Chapter 4 and 6.

Esthetics

The use of water for esthetic enjoyment is an intangible benefit which is directly related to the availability of clean water. It is a very important factor in determining the recreational potential of the Grand River Basin. Camping, picnicking, and sightseeing are all the more enjoyable when accompanied by esthetically pleasing lakes and streams. Pollution robs the water of its esthetic value for such water related activities. Since this Basin will be called upon to provide recreation for many people living both within and outside the Basin, it is very important that the area and waters of the area be kept esthetically pleasing.

Water Quality Goals

The preceding discussion of water uses now being practiced as well as the anticipated growth of these uses presupposes that adequate water, both in quantity and quality, will be available to accommodate them. Quantity factors have been described in Chapter 2. Quality factors require consideration of both technical needs of the water uses to be accommodated and judgment with respect to compatibility of water quality requirements of competing water uses. The development of water quality criteria is a first step in the development of the quality factors needed in water pollution control.

The establishment of water quality criteria for the significant water uses of the Lake Michigan Basin was accomplished through the organization of four water quality work groups chaired by a member of the Technical Committee shown in Table 1-2. These work groups consisted of representatives of the States, municipalities and industries of the Lake Michigan Basin.

These four work groups, The Municipal Work Group; The Industrial Work Group; The Fish, Aquatic Life, and Recreation Work Group; and the General Work Group considered water quality needs to support eleven specific water uses, namely:

Municipal Water Supply
Industrial Water Supply
Recreation - Whole and Partial Body Contact
Irrigation
Fish and Aquatic Life
Wildlife and Stock Watering
Hydropower
Commercial Shipping
Cooling Water Supply
Waste Assimilation
Esthetics

The criteria developed by the four work groups give maximum or minimum desirable concentrations of various water quality parameters, above or below which the stated water uses would be adversely affected. Limits were not set for all water quality parameters but rather for those parameters which are generally most significant in the Lake Michigan Basin. The findings of the water quality work groups are summarized in Table 3-6. Minimum dissolved oxygen requirements and maximum coliform, phosphate, and ammonia nitrogen concentrations are most pertinent to water quality problems within the Basin.

There are certain sectors in the Basin in which specific uses discussed in this Chapter are being jeopardized. The affected are indicated on Table 3-1 by means of an asterick. In these sectors, where pollution is adversely affecting water quality to the extent that the established water quality criteria are not met, the criteria become the water quality goals to be met by pollution control measures. Further discussion of the water quality problems in the study area is contained in Chapter 6. These areas will be protected through the comprehensive water pollution control action program for the Grand River Basin outlined in Chapter 9.

TABLE 3-6

LAKE MICHIGAN BASIN - WATER QUALITY CRITERIA FOR SPECIFIC WATER USES (5)

Numerical Values in Columns

WATER USE	WATER QUALITY PARAMETER (Maximum or Minimum Concentrations For Any One Sample)																	
	DO (min) mg/l or % Saturation	pH (Range)	Phenolics (max) mg/l	Chloride (max) mg/l	MBAS (Max) mg/l	Turbidity Units (max)	Temperature °F (max)	Color Units (max)	Coliform Guide (1) (max)	BOD_5 (max) mg/l	NH_3-N (max) mg/l	Dissolved Solids (max) mg/l	Cyanide CN^- (max) mg/l	Iron (Fe^{++}) (max) mg/l	Manganese (max) mg/l	Odors (max) (Threshold No.)	Phos. Soluble (PO_4) (max) mg/l	Sulfate (SO_4) (max) mg/l
Municipal Water Source	80	7.7 9.0	.003	20	0.2			15	C		0.1	186	0.1	0.3		(2)	.03	50
Industrial Process Water	1.0	5 9	1.0	250	1.0	250	80	100	D	10	5	750		0.2	0.1			
Recreational-Whole Body Contact	3.0					50	90	50	A									
Recreational-Limited Body Contact			1.0			250	90		B									
Irrigation																		
Fish and Aquatic Life-Tolerant	3.0	6 9	0.2	500	1.0	50	90											
Fish and Aquatic Life-Facultative	4.0	6 9	0.2	500	1.0	50	87											
Fish and Aquatic Life-Intolerant	6.0	6 9	0.2	500	1.0	50	68											
Wildlife and Live-Stock Watering		5 9		2000		250												
Hydroelectric Power		5 9				250												
Commercial Shipping		5 9				250												
Cooling		5 9		700		250	90											
Esthetics	1.0				1.0													
Waste Water Assimilation	1.0	5 9					110											

(1)
(2) See Following Pages

TABLE 3-6 (Continued)

(1) Coliform Guides

Coliform Guide A - Recreational whole body contact use. The water uses for which this guide is intended are those that entail total and intimate contact of the whole body with the water. Examples of such use are swimming, skin diving, and water skiing, in which the body is totally immersed and some ingestion of the water may be expected. Recommended guide value for coliforms is 1,000 per 100 milliliters (1,000/100 ml). For all waters in which coliform levels are below the guide value of 1,000/100 ml, the water is considered suitable provided there is proper isolation from direct fecal contamination as determined by a sanitary survey. Situations may arise wherein waters having coliform counts somewhat higher than the guide value can be used, provided supplemental techniques are used to determine safe bacterial quality. The analysis for fecal streptococci is more definitive for determing the presence of organisms of intestinal origin, and is suggested as the supplemental technique to be employed. Based on a very limited amount of information, a limit for fecal streptococci of about 20/100 ml is suggested providing there is an accompanying limit on the coliform level. As a provisional limit, it is suggested that a coliform level of 10,000/100 ml be permitted provided the fecal streptococcus count is not more than 20/100 ml, and provided also that there is proper isolation from direct fecal contamination as determined by a sanitary survey.

Coliform Guide B - Recreational, limited body contact use and commercial shipping (barge traffic). The water uses for which this guide is intended are those that entail limited contact between the water user and the water. Examples of such uses are fishing, pleasure boating, and commercial shipping. Recommended guide value for coliforms is 5,000/100 ml. For all waters in which coliform levels are below this guide value, the water is considered suitable for use, provided there is proper isolation from direct fecal contamination as determined by a sanitary survey.

For waters which have coliform levels above the guide value and such levels are evidently caused primarily by organisms of other than fecal origin, the limiting count may be as high as 50,000/100 ml, provided the fecal streptococci count is not more than 100/100 ml. The provisional coliform limit of 50,000/100 ml is based on an examination of reported and measured data for the Illinois River Basin streams. It is believed to be an acceptable limit for taking into consideration, and providing for the occurrence of, background coliform levels. With the accompanying limit on fecal streptococci, it is reasonable to expect that the danger of infection by enteric organisms

will be remote. It is understood that the provisional limit would be subject to modification as more analytical data are accumulated and critically reviewed.

Coliform Guide C - Applies to Municipal Water Source. Where municipal water treatment includes complete rapid-sand filtration or its equivalent, together with continuous postchlorination, source water may be considered acceptable if the coliform concentration (at the intake) averages not more than 5,000 per 100 ml in any one month, and the count exceeds this number in not more than 20 percent of the samples in any one month. Samples should be tested at least once daily.

Coliform Guide D - Applies to Industrial Process Water at the source. Although the requirements of this use will vary widely with the processes of a particular industry, Coliform Guide C, for municipal source, is considered generally applicable. As covered by food and drug acts and other regulations, water incorporated into products for human ingestion should, of course, meet finished drinking water standards.

(2) Odors, Threshold Number

The differences in type of odors makes it difficult to assign numbers for water quality goals with respect to this parameter. For some types of odors the difficulty of removal is greater than for others. To reach acceptable treated levels, experience has shown that it is more difficult to reduce a "hydrocarbon" type odor of 6 threshold units than an algae-type odor of 15 units. It is therefore felt that a maximum limit on hydrocarbon odors be 6, and the average daily odor be less than 4 units.

CHAPTER 4

WASTE SOURCES

General

The Grand River and the streams tributary to it receive an estimated organic waste load of 32,000 pounds of 5-day 20°C biochemical oxygen demand (BOD_5) per day. Approximately 15000 pounds are from industries with separate discharges. The most significant waste loads in terms of water use impairment are discharged at Jackson, Lansing and Grand Rapids.

The following paragraphs summarize the major waste sources in the basin. Consequences of these discharges are discussed in Chapter 6.

Approximately 540,000 people (14) served by 47 municipal sewerage systems discharge an estimated 17,000 pounds of BOD_5 per day to the streams of the Grand River Basin. This is discharged as treated sewage from an untreated load of approximately 90,000 pounds of BOD_5 per day. This represent an overall reduction of approximately 80%.

Of the 47 municipal sewerage systems 18 provide minor or no treatment. Of the remaining 29 systems, 9 provide only primary treatment, (sedimentation and sludge disposal) and 20 provide secondary treatment (primary treatment plus filtration or activated sludge). Major municipal sewerage facilities having connected populations of 5,000 or more are listed in Table 4-1. Their locations are shown on Figure 1-1.

By 1980 the total untreated waste load received by municipal sewerage facilities is projected to reach 175,000 pounds of BOD_5 per day. This assumes that by 1980 the total municipal population (See Table 2-3) will be served by municipal waste treatment plants. With the attainment of a minimum overall 90% waste treatment efficiency in terms of BOD_5 reduction (See recommendations) the discharged waste load would be approximately 18,000 pounds of BOD_5 per day. This is approximately the same as the current (1962) estimated load discharged to the streamsof the Grand River Basin.

Projecting waste loads to the year 2020 indicates that the untreated load received by municipal waste treatment facilities may increase to 410,000 pounds of BOD_5 per day. With the attainment of a minimum overall 95% waste treatment efficiency in terms of BOD_5 reduction (See recommendations) the waste load discharged to the Grand River Basin streams would reach approximately 20,000 pounds of BOD_5 per day.

TABLE 4-1

MUNICIPAL WASTE INVENTORY OF MAJOR COMMUNITIES
GRAND RIVER BASIN, (14)

Community	Receiving Stream	Miles Above Mouth of Grand River	Treatment	Population Connected	Estimated Untreated	PE * Treated
Jackson	Grand River	216.4	Secondary	51,000	53,000	3,600
Jackson State Prison	Grand River	214.2	Secondary	6,500	11,400	1,600
East Lansing	Cedar River	160.0	Secondary	35,000	50,000	5,000
Lansing	Grand River	150.5	Secondary	130,000	170,000	17,000
Grand Ledge	Grand River	138.6	Primary	5,100	6,600	4,300
Saint Johns	Stony Creek	121.3	Secondary	5,600	7,300	1,415
Hastings	Thornapple River	102.8	Primary	6,350	8,250	5,350
Greenville	Flat River	98.1	Primary	7,400	9,600	6,250
Ionia	Grand River	89.2	None	6,600	8,600	8,600
Grand Rapids	Grand River	40.6	Secondary	220,000	285,000	28,500
Grand Haven	Grand River	1.0	Primary	11,000	14,300	9,200

* Note
P. E. (Population Equivelant) : 1 P.E. = 1/6 pound of BODs per day Treatment efficiencies assumed as follows: No treatment 0% , primary treatment 35%, secondary treatment (trickling filter) 80%, secondary treatment (activated sludge) 90%.

Industrial

Industries with separate outfalls discharge approximately 15,000 pounds of BOD_5 daily to the streams of the Grand River Basin(15). Major industrial waste sources are listed in Table 4-2.

Industrial waste load projections have been made to the years 1980 and 2020. The untreated waste loads are expected to increase 1.5 times by 1980 and 3.0 times by 2020. Increases in industrial waste treatment efficiencies are expected to reach 90% by 1980 and 95% by 2020, as compared to the present overall removal efficiency of 30% of the 5 day BOD. The increases in removal efficiency will reduce the BOD_5 loads discharged direct to streams to approximately 4,000 lbs./day in 1980 and 2020.

Combined Sewers

It has been estimated that a quantity, equivalent to 3 to 5 percent of all untreated waste-water flow in combined sewer systems, is annually discharged to streams by overflows(16). It is also known that a far greater percentage of the solids are discharged to streams from overflows. This is due to the fact that the sludge deposited in the sewers is flushed out by the storm flow.

Of the 47 communities with public sewer systems in the Area only about 8 have completely separate sewer systems. The types of sewer systems of the major municipal waste source are listed in Table 4-3.

TABLE 4-3

Types of Municipal Sewer Systems
Major Municipal Waste Sources
Grand River Basin(17)

Municipality	Type of Sewer System
Jackson	Combined
East Lansing	Separate and Combined
Lansing	Separate and Combined
Grand Ledge	Separate and Combined
Saint Johns	Separate and Combined
Hastings	Combined
Greenville	Combined
Ionia	Separate and Combined
Grand Rapids	Separate and Combined
Grand Haven	Combined

TABLE 4-2

INDUSTRIAL WASTE INVENTORY (MAJOR INDUSTRIES)
GRAND RIVER BASIN, MICHIGAN (15)

Company Name	Location	Receiving Stream	Miles Above Mouth of Grand River	Treament	Discharge Flow MGD	Charac-teristic BOD5 lbs/day	After Treatme Suspended Solids lbs/da
Saranac Milk	Saranac	Grand River	77.0	None	0.07	575	-
Wolverine World Wide (Shoes Tanning)	Rockford	Rogue River	56.2	Sedmentation	0.68	2590	2210
Packaging Corporation of America	Grand Rapids	Grand River	40.6	None	2.3	4925	5105
Whitehall Leather Company	Grand Haven		1.0	Lagoon	0.9	1615	920

Steam Power Plants

Thermal discharges from two steam electric generating stations at Lansing, Michigan are particularly significant from a water quality standpoint. The temperature of 90°F reported by the Michigan Water Resources Commission(13 was measured prior to the installation of additional generating capacity at Lansing. With the increased generating capacity in operation, stream temperatures in the Grand River at Lansing will reach well above 100 °F under average stream conditions for August.

Agriculture and Land Runoff

Fertilizer

Present estimates of fertilizer use for the Grand River Basin show that approximately 8,000 tons of nitrogen and 15,000 tons of phosphate have been used annually. The applications of these are projected to increase four and two fold respectively by 2020.

Phosphates

During 1963 - 1964 the GLIRB Project conducted a rural land runoff sampling study to assess the relative amounts of phosphate and other substances transported to streams by rural runoff in the Lake Michigan Watershed. Based upon the results of this study, it is estimated that there is an annual total soluble phosphate runoff from rural land of about 940,000 pounds per year in the Grand River Basin(18). Estimates of the total amount of phosphate discharged to Lake Michigan from the Grand River Basin are discussed under the separate heading "Phosphates."

Pesticides and Herbicides

Pesticide contamination of streams is a matter of growing concern. Agricultural activity is considered to be the major source of the pesticides which have been found in water(19). Pesticides and Herbicides used in the Grand River Basin include D.D.T., Diazimon, Guthion, Malathion, Parathion, Sevin, Thiodan, and Toxaphene. Unfortunately, there is little or no information available as to the amounts that are used in the Grand River Basin.

Ships and Boats

Commercial Ships

The large number of vessels plying Grand Haven Harbor represents a considerable potential for pollution of the Harbor waters. Among the possible sources of pollution are cargo spillage, dunnage, bilge waste, ballast water, fuel spills, garbage and sanitary wastes. Uncontrolled

discharges of these wastes can result in serious pollution problems to beaches, shore property, recreational waters, fish and aquatic life, and municipal and industrial water supplies.

Commercial shipping has increased significantly since the opening of the St. Lawrence Seaway in 1959. While all new vessels built since 1952 specifically for use on the Great Lakes have been equipped with waste treatment facilities, ocean-going ships generally have no provision for waste treatment. The majority of these ocean-going vessels are designed to discharge sanitary wastes from multiple outlets making onboard waste collection and treatment an expensive and complex installation.

The U. S. Public Health Service has established regulations governing vessel waste discharges in the Great Lakes based upon their legal responsibility for the interstate control of communicable diseases. Restricted areas have been established in which the discharge of sewage, or ballast or bilge water, from vessels is prohibited. Restricted areas include the water within a three mile radius of domestic water intakes. These restrictions apply to the waters within a three mile radius of the water intakes for Grand Rapids and Grand Haven(20).

Recreational Boats

In addition to the heavy commercial traffic, Grand Haven Harbor is also an important recreational boating center. About 4000 recreational craft annually are passed through the Spring Lake Bridge which joins Ferrysburg and Spring Lake. There are numerous marinas and boat clubs along the lower part of the Grand River. Many of the larger recreational craft are equipped with galley and toilet facilities which may discharge untreated or inadequately treated wastes to the Harbor or Lake waters. Oil and gasoline wastes, as well as garbage and sewage from onboard cooking and toilet facilities, are the major potential sources of pollution.

Dredging

Maintenance dredging is done by the Corps of Engineers to maintain authorized navigation depths in Grand Haven Harbor. Dredged materials are disposed of in the deep waters of Lake Michigan.

Water quality surveys made in 1963 by the Great Lakes-Illinois River Basins Project, showed significant evidence of pollution material in the bottom deposits of Grand Haven Harbor. Transfer of this pollutional material to Lake Michigan via the dredging process creates an additional zone of pollution in the Lake.

Phosphates

Transport to Streams and Lakes from Rural Lands

The GLIRB Project conducted a sampling study of eight streams draining small rural watersheds(18). The purpose of this study was to assess the relative amounts of phosphate and other substances transported to streams by rural runoff in the Lake Michigan Watershed.

The amount of total soluble phosphate reaching streams from land runoff, in the Grand River Basin, as estimated from samples taken on the eight pilot watersheds, is about 940,000 pounds annually or approximately 0.3 pound per acre of watershed.

Municipal Sources

Domestic sewage is relatively rich in phosphorus compounds. Most of this phosphorus comes from human excreta and synthetic detergents. The amount of phosphorus released by human metabolic processes is a function of protein intake and for the average person in the United States, this release is considered to be about 1.5 grams per day(21). Synthetic detergent formulations contain large amounts of phosphates. It is estimated that 2.5 grams of phosphorus per capita-day are discharged to sewer systems as a result of the use of synthetic detergents.

When the above per capita figures for phosphorus from human excreta and detergents are expanded to cover the entire sewered population of the Grand River Basin the quantity becomes quite large. The GLIRB Project municipal waste inventory shows that 540,000 people are served by sewer systems in the Basin.

From a study of five sewage treatment plants in Illinois and Indiana it was found that the average phosphate removal was 38 percent. Using the above figures on population and the per capita phosphorus discharged, along with the average percent removal, it is estimated that a total of approximately 3,300,000 pounds of soluble phosphate from humans and detergents are discharged to the waters of the Basin each year. However, not all of the amount reaches Lake Michigan.

Tributary Mouth Sampling

In addition to the land runoff sampling from the eight small subbasins discussed above, sampling stations were established at the mouth of the Grand River. These stations were sampled intermittently for one year during the same period in which the land runoff stations were sampled (See Chapter 6).

Sampling at the mouth made it possible to estimate the total soluble phosphate load reaching Lake Michigan from the Grand River. It was determined that atotal of approximately 2,000,000 pounds of soluble PO_4 being discharged to the Lake annually.

CHAPTER 5

LAKE CURRENTS

WHAT IS CORRECT VELOCITY RANGE? IS WHAT IS WANT TO SAY FROM THE FIELD?

Background

The GLIRB Project studied currents in Lake Michigan adjacent to the Grand Haven area from 1963 through the summer of 1964. Instruments used in this continuous study included automatic recording current meters, anemometers and thermographs. The objectives of the study were to obtain information relative to the fate and movement of pollutants.

Prior to the field effort previous Lake Michigan current studies were reviewed. These studies utilized drift cards and bottles floating at the surface and were conducted only during summer periods.

Findings

The primary factors which influence Lake Michigan currents adjacent to Grand Haven are the winds and the configuration of the shoreline. Winds represent the principal energy source for putting the waters in motion, while the shore line maintains the north-south orientation of currents in the area. Water movements tend to parallel the shore as the water depth decreases. Patterns of current flow near Grand Haven were typical of this phenomenon.

Density, due to temperature differences, plays a role in the movement of pollutants entering the Lake. During the summer stratification a pollutant, depending on its initial density, will rise, sink or come to rest on the thermocline. Under winter iso-thermal conditions in the lake the pollutant, being of lower density than the lake water, would normally rise toward the surface. Grand Haven is located on the windward side of the lake and consequently experiences more downwelling than the western side of the Lake. The effect of downwelling would be to disperse an effluent into the main portion of the Lake more rapidly than would occur by ordinary transport.

Water motion, such as transport or the net movement of a water mass, can also effect the discharge of a pollutant. If the current is extremely small then a pollutant may build up into a nearly stationary mass. The eastern shore of the Lake however, rarely has periods of low transport speeds. Thus, discharged wastes are normally diluted by the moving water.

Water transport adjacent to the city of Grand Haven was to the north or the south depending on the effect of the windstress prevailing at the time of the study. The net flow or residual current appears to be periodic at Grand Haven. The net flow during 1963-64 appeared normally to be to the north except for October and November (Figure 5-1). The eastern shore of the Lake, which includes the Grand Haven area, experienced prolonged periods of winds from the north quadrant during these two months.

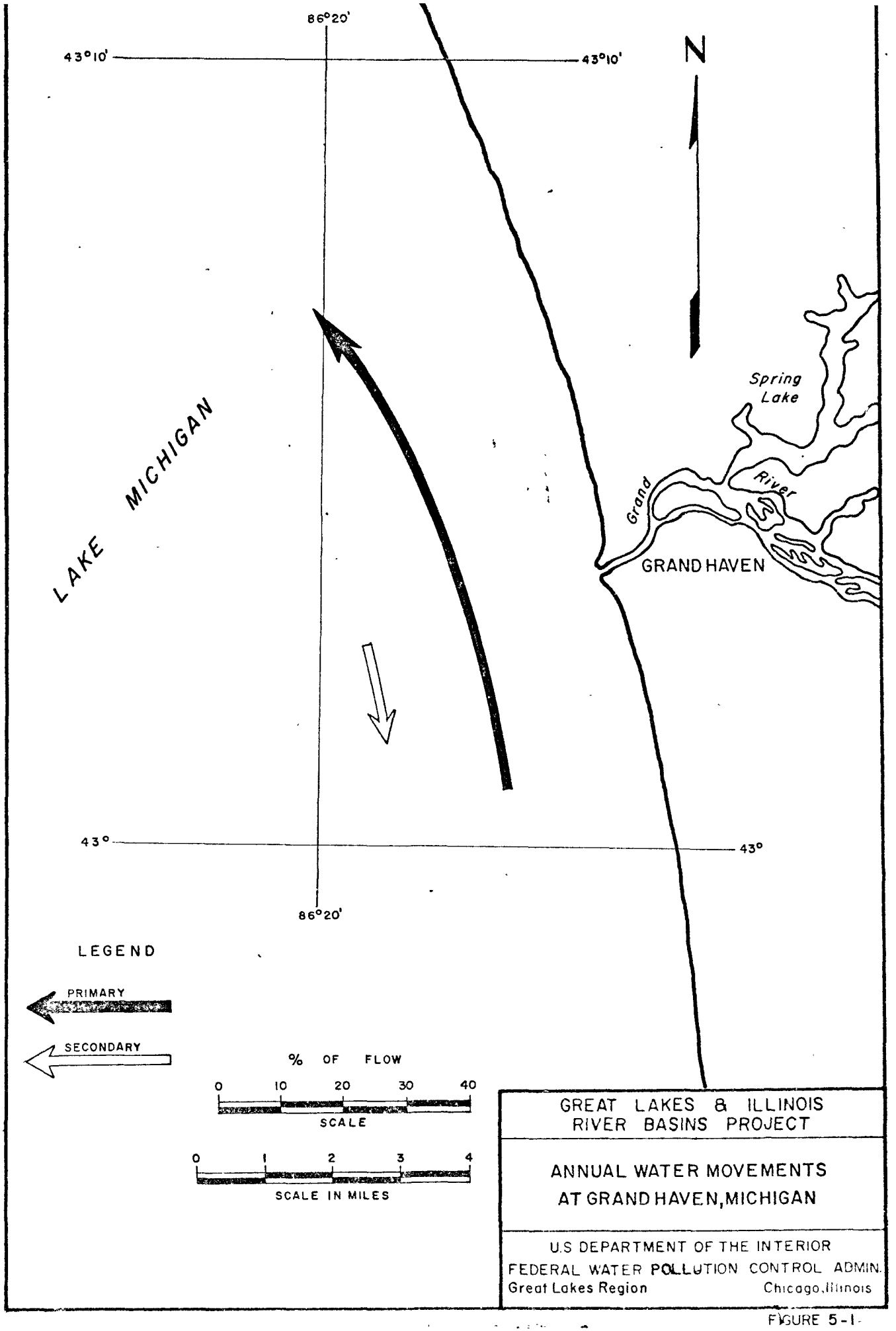

86°20'
43°10'
43°10'
N
Spring Lake
LAKE MICHIGAN
Grand
River
GRAND HAVEN
43°
43°
86°20'
LEGEND
PRIMARY
SECONDARY
% OF FLOW
0 10 20 30 40
SCALE
0 1 2 3 4
SCALE IN MILES
GREAT LAKES & ILLINOIS RIVER BASINS PROJECT
ANNUAL WATER MOVEMENTS AT GRAND HAVEN, MICHIGAN
U.S DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMIN.
Great Lakes Region
Chicago, Illinois

FIGURE 5-1

Summary

The general flow in the winter, spring and summer shows a decided northward flow in response to the prevailing southerly winds. In the fall the northerly winds reverse the normal northward flow and the flow becomes southerly. Because of the long fetch over the Lake the response of flow direction to the prevailing wind is excellent. This response produces swift currents and unusual downwelling conditions during the summer. Both downwelling and fast-moving currents tend to increase the rate of dispersion near the Grand Haven area. Since downwelling is characteristic of this area, pollutants will be mixed into the main body of the northern basin rather quickly and normally will escape detection.

CHAPTER 6

PRESENT WATER QUALITY AND PROBLEMS

General

The information and interpretations presented in this discussion are based on data collected by the GLIRB Project during its water quality studies of the Lake Michigan Basin (1962-1964). The GLIRB Project studies have been supplemented by data obtained from other Federal agencies, the State of Michigan and local agencies. Two programs of study were carried out by the GLIRB Project with respect to water quality of Lake Michigan tributaries. The first consisted of weekly sampling of tributary mouths to determine average annual loadings discharged to the Lake and water quality variability. The second consisted of intensive studies of stretches of certain tributaries to determine the effect of organic wastes on stream oxygen resources.

Summary

The chemical, biological, bacteriological and radiochemical data presented in subsequent pages form the basis for the following conclusions with respect to water quality effects:

1. The Grand River for a 25 mile stretch below Jackson is polluted. The principal waste source causing pollution is the effluent from the Jackson sewage treatment plant.

2. The Grand River for a 20 mile stretch below Lansing is polluted. The principal waste sources causing pollution are the effluent from the Lansing and East Lansing sewage treatment plants. Cooling water discharges from Thermal-electric power plants in Lansing intensify the adverse effects on water quality.

3. The Bureau of Outdoor Recreation has reported impairment of water recreation in the Grand River for a 30 mile stretch below Grand Rapids.(6) However, the GLIRB Project did not conduct intensive sampling in this sector of the stream since the Michigan Water Resources Commission had definite plans for such sampling. The report of the Michigan Water Resources Commission has not been published.

Grand River Mouth Sampling

Physical and Chemical Findings

During the period from March 1963 through April 1964 the GLIRB Project collected samples at the mouth of the Grand River to determine

loadings of various substances being carried into Lake Michigan. The analytical results of this sampling are shown below in Table 6-1. Of all the chemical parameters reported, the two nutrients, total soluble phosphate and ammonia nitrogen, are most illustrative of the waste inputs discharged to Lake Michigan by the Grand River.

Considering all Lake Michigan tributaries, the Grand River is one of the greatest contributors of soluble phosphate and ammonia nitrogen with inputs of 5300 and 7000 pounds per day, respectively. In general, the chemical parameters for given streams in the Lake Michigan Basin follow definite patterns. In the Grand River phosphate and ammonia nitrogen concentrations are high and a pattern of high values is also seen for the other chemical parameters as shown in Table 6-1. With respect to loadings the Grand River is one of the major contributors of dissolved substances to the Lake.

TABLE 6-1
Water Quality - Grand River at Mouth
March 1963 - April 1964

Parameter	No. of Samples	Concentration(mg/l) Average	Concentration(mg/l) Range	Loading (lbs./day)
Total Soluble				
PO_4	52	0.52	0.12-1.1	5330
NH_3-N	52	0.68	0.05-1.5	6970
NO_3-N	51	0.72	0.04-2.4	
Org-N	52	0.77		
Total Dissolved Solids	51	350	275-570	
Total Suspended Solids	44	24	6-84	
SO_4	52	74	56-100	
Cl	52	42	19-67	
SiO_2	52	5.3	2.5-17	
Ca	52	72	51-85	
Mg	52	26	16-30	
Na	52	28	7.1-43	
K	52	2.8	2.1-3.9	
ABS	52	0.28	0.11-0.73	
Cu	52	0.14		
Cd	52	*		
Ni	52	0.04		
Zn	52	*		
Cr	52	0.04		
Pb	52	0.11		

* Not Detectable at Test Sensitivity.

The maximum phenol concentration on the eastern side of Lake Michigan was 7.2 micrograms per liter (mg/l) close to the mouth of the Grand River. BOD_5 values as high as 8.6 mg/l were recorded near the mouth. An average total chromium concentration of 0.04 mg/l was found at the mouth of the Grand River. This concentration is less than the Public Health Service Drinking Water Standards(22) mandatory limit of 0.05 mg/l for hexavalent chromium.

Biological Findings

During 1962 and 1963 samples were collected at the mouth of the Grand River. Amphipods were the principal organisms observed and sand was the bottom type. Total populations of 10,000 - 15,000 benthic animals per square meter were found as far as several miles from the shore.

Radiochemical Findings

Fallout is the most significant source of radioactive contamination in the Lake Michigan Basin because of the potential hazards of the radioisotopes produced. However, naturally occurring radionuclides are probably the major contributors to the total radioactivity of the surface waters in the Basin.

The analytical results from 1963 sampling in the Grand River at the mouth are shown below in Table 6-2.

TABLE 6-2

Radioactivity
Grand River at Mouth
1963 Average

Portion	Gross Alpha Concentration (pc/l)	Gross Beta Concentration(pc/l)
Suspended Solids	<1	4
Dissolved Solids	<1	12
Total Solids	<1	16

In relation to the Public Health Service Drinking Water Standards, the concentrations reported above meet the Standards. [However, a specific determination of the Strontium -90 concentration would be necessary in order to verify that the concentration was equal to or less than 10 picocuries per liter (pc/l)].

Grand River Intensive Studies

Physical and Chemical Findings

The effects of organic loadings on the oxygen resources of the Grand River below Jackson and Lansing are indicated in typical profiles of

the dissolved oxygen (DO) and biochemical oxygen demand (BOD) shown in Figures 6-1 and 6-2.

In Figure 6-1 the apparent effects of effluent aeration at the Jackson sewage treatment plant are shown with a rise in the stream DO from about 0.4 mg/l to 3 mg/l in a distance of about 0.5 mile below the plant discharge. The stream DO concentration then decreases rapidly to a low of about 0.2 mg/l at a point about 7 miles below the plant discharge. The highest DO concentration in the study reach, 3.5 mg/l, was found at a point about 19 miles below the Jackson plant discharge. Desirable fish and aquatic life cannot survive under such degraded oxygen conditions and the stream sector is unsuitable for other uses as shown in Table 3-1.

In Figure 6-2 the high BOD levels, reaching a maximum of 29 mg/l about 3 miles below the Lansing Sewage treatment plant discharge, result in DO levels below 3 mg/l for a 19 mile stretch below the Lansing plant. The minimum DO, about 0.6 mg/l, occurs about 10.5 miles below the Lansing plant. As was the case below Jackson, desirable fish and aquatic life cannot survive below Lansing due to the degraded oxygen conditions. The stream is also unsuitable for other beneficial uses as shown in Table 3-1.

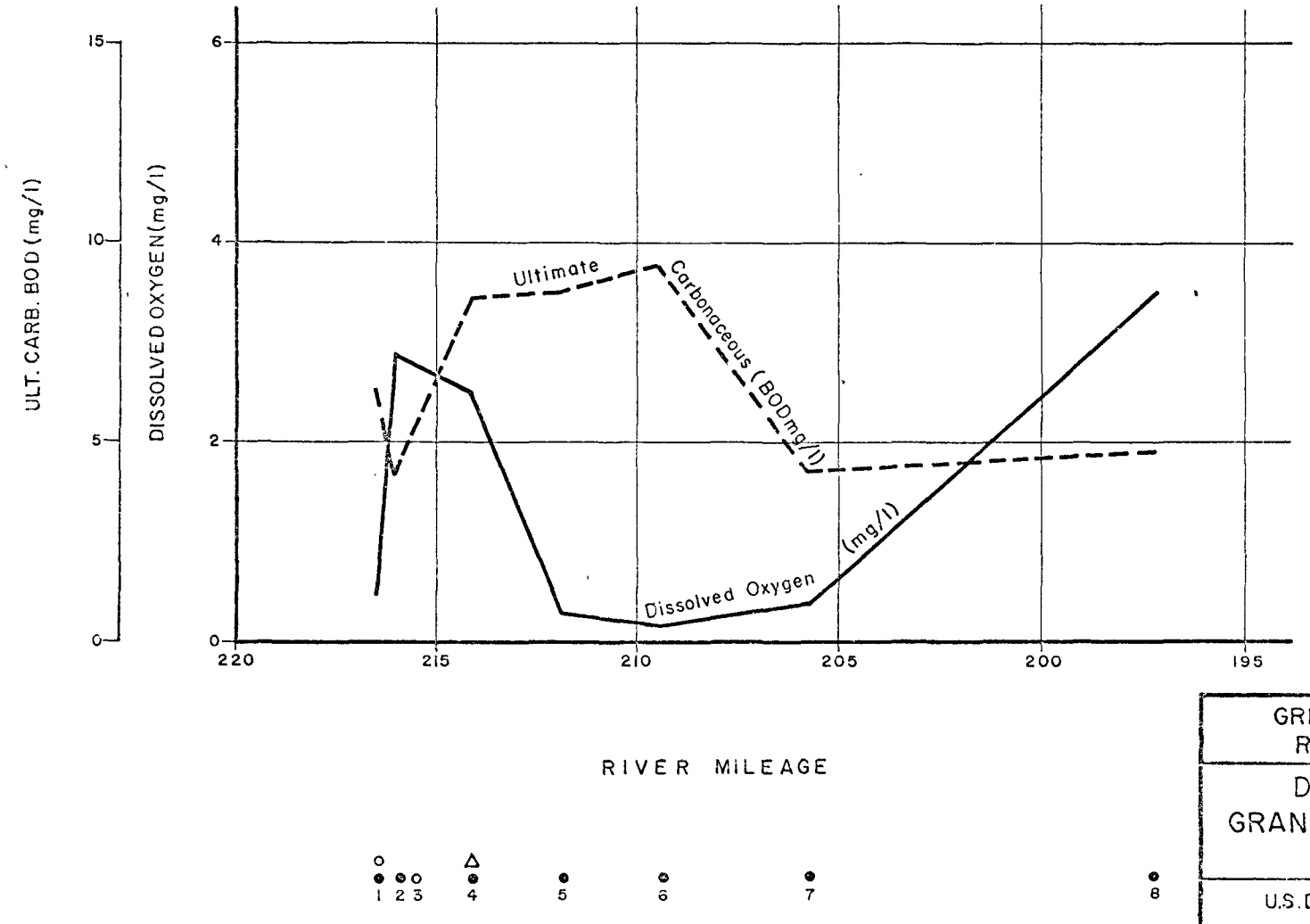
Further demand on the oxygen resources of the Grand River below Lansing results from the Thermal discharges of the steam electric generating stations at Lansing. Increases in stream temperatures below the stations result in a higher rate of biological activity and a more rapid uptake of dissolved oxygen. The increased temperatures also limit the total amount of dissolved oxygen available for waste assimilation due to a lowering of oxygen saturation values. As discussed in Chapter 4 the stream temperatures below Lansing, under certain conditions, can easily rise above 100°F. These temperatures, in themselves, impair water uses at Lansing (see Table 3-6).

The Grand River in the stream reaches below Jackson and Lansing was also found to be esthetically undesirable and objectionable for recreational uses such as boating, water skiing, and similar aquatic sports. The organic loadings causing these polluted conditions originate from the discharges of municipal sewage treatment plants. The major municipal waste discharges are listed in Table 4-1.

Microbiological Findings

Limited microbiological studies were conducted in conjunction with the intensive DO - BOD studies below Jackson and Lansing. Analyses for both total coliform and fecal streptococci organisms were made.

Below Jackson 11 samples were collected at eight stations and analyzed for coliform and fecal strep. Total coliform organisms reached a maximum density of 233,000 per 100 ml. At a point about 1.5 miles below the Jackson sewage treatment plant discharge and 0.5 mile below the Prison



LEGEND

- ● Sampling Station
- O Sewage Treatment Plant
- Δ Tributary

1. Jackson Sewage Treatment Plant
2. Parnell Rd.
3. Jackson State Prison STP.(Wading Sta)
4. Portage River
5. Maple Grove Rd.
6. Berry Rd. Bridge
7. Churchill Rd. Bridge
8. Tompkins Rd. Bridge

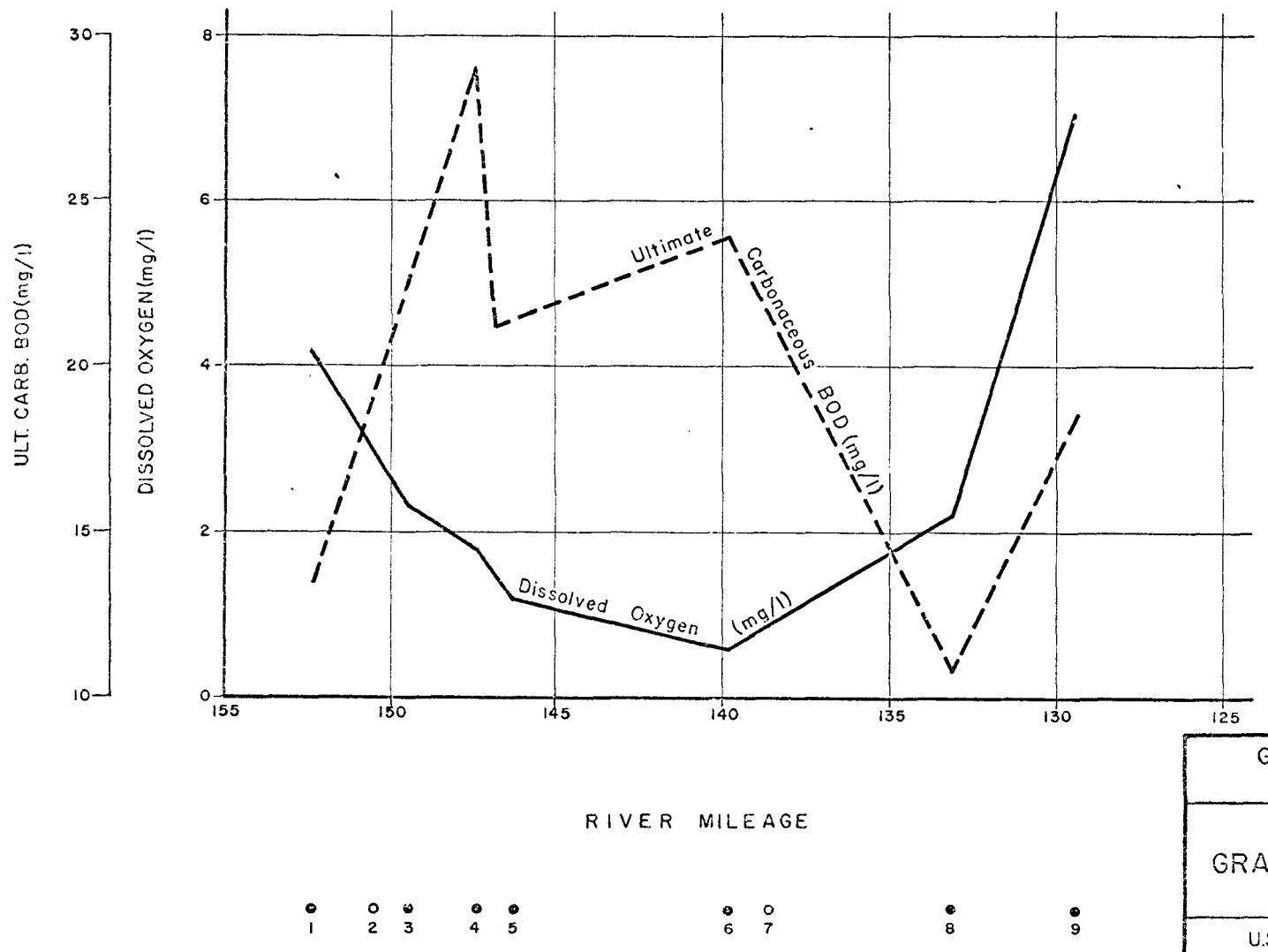
NOTE:
Analytical Results Plotted Are Mean Values From Intensive Sampling (5:00 to 7:00AM)

GREAT LAKES & ILLINOIS RIVER BASINS PROJECT

DO & BOD PROFILES
GRAND RIVER BELOW JACKSON
July 9, 1964

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMIN.
Great Lakes Region Chicago, Illinois

FIGURE 6-1



LEGEND

● Sampling Station

O Sewage Treatment Plant

1. Grand River Ave.
2. Lansing Sewage Treatment Plant
3. North Waverly Rd.
4. Wading Station
5. Canal Rd. Bridge
6. Highway M-100
7. Grand Ledge Sewage Treatment Plant
8. Jones Rd. Bridge
9. Turner Rd. Bridge

NOTE:
Analytical Results Plotted Are Mean Values From Intensive Sampling (5:00 to 7:00 AM)

GREAT LAKES & ILLINOIS RIVER BASINS PROJECT

DO & BOD PROFILES
GRAND RIVER-BELOW LANSING
July 15, 1964

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMIN.
Great Lakes Region Chicago, Illinois

FIGURE 6-2

plant discharge. The maximum fecal streptococci density was 6400 organisms per 100 ml. About 0.5 mile below the Jackson plant discharge, the maximum densities were found in samples collected October 14, 1964.

Below Lansing 17 samples were collected at eight stations. Total coliform organisms reached a maximum density of 930,000 per 100 ml during the May 13, 1964 sampling, at a point approximately 1 mile below the Lansing sewage treatment plant discharge. The maximum fecal streptococci density was found at a point about 5.5 miles below the Grand Ledge sewage treatment plant discharge, reaching 11,700 organisms per 100 ml during the October 14, 1966 sampling.

The bacterial densities reported above indicate a high degree of pollution most likely resulting from the discharge of wastes from the municipal sewage treatment plants at Jackson, the State Prison, Lansing and Grand Ledge. The densities are of such magnitude as to seriously impair beneficial water uses such as body-contact recreation and municipal and industrial water supply. The densities present a definite hazard to the health of humans coming in contact with the waters effected.

Waste Assimilation

Based on consideration of the location of principal municipal and industrial waste discharges in the Grand River Basin and the quantitative and qualitative characteristics of the receiving waters, two reaches of the main stem of the Grand River below Jackson and Lansing were selected for waste assimilation studies.

Waste assimilation stream studies were conducted by the GLIRB Project to determine the total streamflow required to meet a range of water quality goals in the Grand River below Jackson and Lansing. During 1964 intensive stream investigations, as described in the previous section of this Chapter, were conducted on these reaches during May, July and October.

A computer program was utilized to develop a mathematical model which reproduced the stream conditions observed during these intensive sampling periods. Using projected flow and quality data for the waste inputs within the study reaches of the stream, the model was used to compute the total streamflows required for flow regulation for water quality control. It has been assumed that a 90% BOD_5 removal will be provided by 1980 and a 95% BOD_5 removal will be provided by 2020 for both municipal and industrial waste discharges.

Based on the desired uses of the Grand River below Jackson and Lansing are given in Table 3-1 (Sectors 5, 6 and 8) and a consideration of the water quality criteria necessary to support these uses, dissolved oxygen concentrations of 3.0 and 4.0 mg/l are the minimum water quality goals below Jackson and Lansing, respectively. The maintenance of these minimum goals will assure the absence of nuisance odor conditions; permit recreational use involving body contact (when municipal waste treatment

plants provide effluent disinfection); support fish and other aquatic life; and in general provide for the esthetic enjoyment of clean surface waters.

The estimated ranges of total streamflow required to maintain a D. O. concentration of 3.0 mg/l below Jackson are 50 to 270 cfs in 1980 and 90 to 540 cfs in 2020. Below Lansing the streamflows required to maintain a D.O. of 4 mg/l are 60 to 480 cfs in 1980 and 160 to 1760 cfs in 2020. Ranges in streamflow requirements are presented primarily due to the wide variation in stream temperatures over the year.

The ability of existing streamflows to meet the above demands is assessed by comparing the estimated maximum required flows in 1980 and 2020 with the 7 day once-in-10-year low flows as shown in Table 2-2. The comparison indicates that existing low flows will not be adequate to assimilate the treated waste discharges at Jackson and Lansing in 1980 and 2020. Thus, it is concluded that some combination streamflow regulation and advanced waste treatment, beyond 95% BOD_5 removal, will be required to achieve the water quality goals of 3 mg/l DO bdlow Jackson and 4 mg/l below Lansing.

CHAPTER 7

QUALITY IMPROVEMENT MEASURES

General

The problems of water pollution control in the Grand River Basin are complex. Solutions to these problems will of necessity involve a comprehensive program which includes construction of new sewerage facilities; and continuous and intensive monitoring of operating procedures, treatment plant efficiency, and water quality conditions to determine necessary additional construction and operation needs as they arise. In addition, some combination of advanced waste treatment and flow regulation may be required to attain the desired water quality below Jackson and Lansing. These phases of the comprehensive program for pollution control in the Grand River Basin are discussed in the following paragraphs.

Municipal Waste Treatment

The immediate goal in the treatment of municipal wastes is the provision of biological (secondary) treatment at each waste treatment plant. Such treatment is considered adequate in terms of present technology and provides 90 percent BOD_5 removal. Adequate effluent disinfection is also considered to be a necessity in the Grand River Basin particularly where recreational use of the receiving waters is prevalent. There is also a present need for increased phosphate removal.

There are approximately 47 municipal sewerage facilities in the Grand River Basin. Of these,20 provide secondary biological waste treatment. Municipal waste treatment construction needs for the major communities of the Grand River Basin are shown on Table 7-1. These needs are based on waste flow and waste load projections to the year 1980.

Industrial Waste Treatment

Minimum treatment needs for major industries with separate outfalls are listed in Table 7-2. In developing this list it was considered that the equivalent of secondary waste treatment as described in the preceding section would be required. The recommended BOD_5 load limits shown on Table 7-2 were arrived at by estimating the present untreated waste load and projecting this figure to 1980 by using an industrial growth multiplier. Then a 90% BOD_5 removal of the 1980 untreated waste load was applied. The present untreated waste load used in the above calculation was estimated from a knowledge of the existing discharged waste load and existing treatment practices.

TABLE 7-1

MUNICIPAL WASTE TREATMENT CONSTRUCTION NEEDS (MAJOR COMMUNITIES)
GRAND RIVER BASIN - MICHIGAN

Community	Present Status	Population Connected	Needs
Jackson	Sec. Tr.	51,000	Advanced Waste Treatment*
East Lansing	Sec. Tr.	35,000	Expansion, Chlorination
Lansing	Sec. Tr.	130,000	Advanced Waste Treatment*
Grand Ledge	Pri. Tr.	5,100	Secondary Treatment
Saint Johns	Sec. Tr.	5,600	-
Hastings	Pri. Tr.	6,350	Secondary Treatment
Greenville	Pri. Tr.	7,400	-
Ionia	No Tr.	6,600	Secondary Treatment, Chlorination
Grand Rapids	Sec. Tr.	220,000	Expansion, Chlorination
Grand Haven	Pr. Tr.	11,000	Secondary Treatment

* Advanced waste treatment - chemical precipitation, filtration, adsorption or other unit treatment processes, singly or in combination following conventional secondary waste treatment to provide a treated waste effluent of extremely high quality.

TABLE 7-2

PLANT WASTE REDUCTION NEEDS FOR MAJOR INDUSTRIAL WASTE SOURCES
GRAND RIVER BASIN

Company	Location	Waste Discharge Stream Loading Rate (lbs. 5-day BOD/DAY)		Estimated Present Treatment Efficiency
		Present	Recommended Limit	
Saranac Milk	Saranac	575	50	0
Wolverine World Wide (Shoes, Tanning)	Rockford	2590	400	30
Packaging Corporation of America	Grand Rapids	4925	500	30
Whitehall Leather Company	Grand Haven	1615	250	30

Combined Sewers

Historically, the development of our Nation's sewer system followed a general pattern. Diversion of storm water was the earliest concern of communities. Discharges were made directly to water-courses, usually at many points. Later these sewer systems were used to carry sanitary sewage also. As the public became increasingly aware of the need for treatment of sanitary wastewater, the many short sewers discharging untreated domestic waste to various points in streams were provided with interceptors and the collection system was modified to deliver the waste to a single point - the treatment plant. When sanitary and storm water are combined it is necessary, in times of storm flow, for the sewers to overflow directly to the stream.

Studies of combined sewer systems have indicated that the combined overflows contain from 3 to 5 percent of the average annual untreated domestic sewage flow. During storms as much as 95 percent of the sewage flow is discharged with the storm water runoff. Storm water alone was demonstrated to carry significant amounts of pollution load, particularly in the early portions of storms when a flushing action occurs in the sewers. The storm water washes large amounts of deposited sludge out of the sewers. For example, data from Buffalo, New York some years ago indicated that one-third of the City's annual production of sewage solids overflowed without treatment, although only 2 to 3 percent of the sewage volume actually overflowed(16).

The need for solutions to the problems caused by overflows from combined sewer systems is pressing and is receiving much current attention(23). The Water Quality Act of 1965 established a four-year program of grants and contract authority to demonstrate new or improved methods to eradicate the problems of combined sewer overflows.

Until economically feasible methods for solving the problems are developed, existing combined sewer systems should be patrolled. Overflow regulating structures should be adjusted to convey the maximum practicable amount of combined flows to and through waste treatment facilities. Combined sewers should be prohibited in all newly developed urban areas and in coordination with urban renewal projects.

Reduction of Nutrients

The degree of phosphate removal attained by the municipal and industrial treatment plants in the Grand River Basin is not known. However, the removal of phosphates is known to vary among plants of similar design for reasons that are not always evident. Research in progress shows promise of accomplishing substantial removals at nominal cost. It may be necessary in the future to use some form of advanced waste treatment to further remove phosphates.

Plant Operation

Proper plant operation must follow proper plant design in order to efficiently reach the goals of water pollution control. The importance and value of proper plant operation must be emphasized at all levels of public authority. Effective operation can be encouraged by means of a routine inspection program. Inspections should be conducted by the appropriate State agencies on at least an annual basis for the small and medium-sized plants, and at least, bi-annually for the larger plants.

The Michigan Department of Health, administers a mandatory sewage treatment plant operators' certification program. State-sponsored operator training programs are also a useful tool for elevating the level of overall plant performance. Today, with increasing activity in the field of water pollution control at the Federal, State and local levels, operator training courses should be conducted at least annually. The Michigan program, consisting of annual training on a regional basis, compares favorably with the training programs sponsored by other states.

Monthly operation reports should be submitted to the appropriate State water pollution control agencies from each municipal and industrial waste treatment facility. These reports should contain sufficient information to describe waste treatment efficiency and the quality and quantity of the effluent discharged to the waters of the Grand River Basin. Monthly operational reports would provide the State with more current information and would enable them to take much quicker action concerning needed improvements.

Monitoring

The maintenance of desirable water quality on a continuing basis calls for a routine monitoring program covering the significant water quality parameters at strategic points.

The existing water quality monitoring program of the Michigan Water Resources Commission currently consists of one station in the Grand River Basin at Grand Haven. The monitoring program of the Commission needs expansion to include stations at critical points in the Basin, such as below Jackson, Lansing and Grand Rapids. The Federal Water Pollution Control Administration will cooperate and assist the Commission to the fullest extent of its resources and personnel in expanding its monitoring program.

The industries, municipalities and others, discharging wastes within the Grand River Basin, should submit monthly reports to the appropriate State agency concerning the quality and quantity of the wastes discharged. These reports could, in many cases, be combined with the monthly operational report which was discussed under Treatment Plant Operation.

The overall monitoring program should be geared to provide an adequate picture of all wastes being discharged to the waters of the Basin and adjacent waters of Lake Michigan and serve to indicate trends in water quality or the need for additional water quality improvement measures.

As part of an overall monitoring program efforts are needed to assess the potential problems associated with agricultural practices in the Grand River Basin. There is a lack of reliable information concerning land use practices and the quantities of pesticides and fertilizers applied within the Basin. Reliable data concerning application rates on a yearly basis in each county would be very helpful in identifying potential water quality problem areas.

Dredging

The practice of dredging to maintain adequate navigation depths is recognized as necessary. However, the subsequent disposal of dredgings, particularly those containing residues of municipal and industrial wastes, can create or increase water quality problems. The present practice of off-shore disposal of dredgings in Lake Michigan is not considered consistent with the goal of water quality management in Lake Michigan. Alternative schemes for disposal of dredgings should be devised and evaluated by all Federal, State and local agencies concerned. Appropriate action to eliminate this direct waste input to Lake Michigan should be initiated as soon as practicable.

Thermal Discharges

Where practicable thermal discharges should be reduced where other water uses are adversely affected. As discussed in Chapter 6 the area below Lansing is particularly significant from this standpoint. In the planning of new installations requiring large amounts of cooling water the quality requirements of the receiving streams should be a prime factor in determining the location of such installations.

Flow Regulation

The need for streamflow regulation for water quality control at two critical reaches in the Grand River, below Jackson and Lansing, were discussed at the close of Chapter 6. In both reaches it appears that streamflow regulation would be required to further improve water quality, even after the provision of high degrees of waste treatment efficiency. However, streamflow regulation cannot be considered for a quality improvement measure until an adequately high degree of treatment is provided for municipal and industrial wastes.

State Water Pollution Control Program

The Federal Water Pollution Control Act recognizes the primary responsibility of the States in the control and prevention of water pollution. The effectiveness of a State program, however, is dependent upon

adequate funds and personnel with which to accomplish this mission.

The State of Michigan has achieved commendable success in the control of water pollution with the staff and funds available. However, even though much has been accomplished by the State in controlling conditions, much remains yet to be done. In 1964, the Public Administration Service prepared a survey report for the Public Health Service concerning the budgeting and staffing of State programs(24). This report, containing suggested guidelines for use in evaluating the adequacy of State water pollution control programs, may be of assistance to the State of Michigan in terms of evaluating the present water pollution control efforts.

In view of the water pollution control problems still existing in the Basin consideration should be given to an accelerated program to match the needs for clean water for all legitimate uses. An accelerated State water pollution control program utilizing fully the resources and programs of the Federal Water Pollution Control Administration will ensure the earliest possible accomplishment of our common goal - more effective use of our water resources.

CHAPTER 8

PROGRAM IMPLEMENTATION

The implementation of the Comprehensive Water Pollution Control Program for the Lake Michigan Basin will involve the combined efforts of the water pollution control agencies at all levels of government. Specific recommendations for implementing the Lake Michigan Program, and for coordinating the subbasin programs will be contained in the Summary Report for Lake Michigan, which will be the final report in the Lake Michigan series. The recommendations contained in the Summary Report will in no way conflict with recommendations contained in the Grand River Basin water pollution control program, nor will it interfere in any way with any steps taken to implement those recommendations.

Accordingly it is recommended that the Michigan Water Resources Commission consider the Comprehensive Water Pollution Control Program contained herein as the basis for improvement of the quality of the waters in the Grand River Basin. The Federal Water Pollution Control Administration will cooperate with and assist the Commission to the fullest extent of its resources and personnel in each action taken to achieve objectives consistent with the Program.

CHAPTER 9

BENEFITS

Implementation of the recommendations contained in this report will result in substantial improvement in the quality of the waters of the Grand River Basin and the adjacent waters of Lake Michigan. The program objectives, however, are more specific and have been developed to provide water of satisfactory quality for both present and planned uses as shown on Table 3-1. Accomplishment of Program objectives will result in both tangible and intagible benefits to the people of the Grand River Basin in particular, and to the people of Michigan and the Nation as a whole. As the waters of Lake Michigan serve many States and are of National importance, all will share in the benefits resulting from the enhancement and protection of these waters for both present and future needs.

Residents of the Basin will benefit from the assurance of a safer, more palatable water supplied to their homes, business establishments, industries, schools and public buildings. Owners of property adjacent to and near bodies of water will derive increased esthetic enjoyment and enhanced property values from the elimination of ugliness and unsightly conditions resulting from water pollution, including nuisance algal blooms stimulated by over-fertilization.

Michigan residents and visitors from out-of-state who use the area streams and lakes for swimming, water skiing, boating and other water-oriented sports will be protected against infectious diseases which can be spread as a result of water pollution. The sports fishermen will find additional fishing areas to challenge his skill, and improved fishing as a benefit of enhanced water quality.

As a return on their investment in improved water quality, industry will share in the benefits through assurance of consistency in the quality of process water it needs for many of its products and other water uses.

In addition to these immediate and direct benefits resulting from the control of pollution, the preservation and protection of the quality of the waters of Lake Michigan and the Great Lakes is an important benefit which is essential to the Nation's continued growth and prosperity. This immense fresh water resource, the greatest in the world, is beginning to show the effects of man's carelessness. Lake Erie provides a clear demonstration that size is no protection against pollution and that man has the capability of destroying the usefulness of even a major water resource.

The Calumet, Milwaukee and Green Bay areas of Lake Michigan are already affected adversely by pollution. Should the Lake as a whole reach critical levels of nutrients or other persistent contaminants, it would require many decades before remedial measures could result in restoration of satisfactory water quality. An action program based upon the recommendations contained in this report is essential for protection of an invaluable water resource, Lake Michigan.

Where is info from BCR showing need for Recreation areas -

BIBLIOGRAPHY

1. Surface Water Records of Michigan, 1964. U. S. Department of the Interior, Geological Survey District Office, Lansing, Michigan.

2. Drought Flow of Michigan Streams. University of Michigan, School of Public Health, Department of Environmental Health, Ann Arbor, Michigan, 1960 and 1964. Supplement.

3. Climatological Data, Michigan Annual Summary, 1964. U. S. Department of Commerce, Weather Bureau, Asheville, N. C. (1965).

4. U.S. Census of Manufactures: 1947, 1954, 1958 1963. U.S. Department of Commerce, Bureau of the Census, U. S. Government Printing Office, Washington,D. C. (1949, 1957, 1961, 1965).

5. Water Quality Criteria. Appendix No. 8, Lake Michigan Basin Report, U. S. Department of the Interior, FWPCA, Great Lakes-Illinois River Basins Project, Chicago, Illinois (to be published).

6. Water Oriented Outdoor Recreation Lake Michigan Basin. U. S. Department of the Interior, Bureau of Outdoor Recreation, Lake Central Region, Ann Arbor, Michigan (June 1965).

7. Water Resource Conditions and Uses in the Upper Grand River Basin. Michigan Water Resources Commission, Lansing, Michigan(1961).

8. Michigan Summary of Irrigation. Michigan Water Resources Commission, Lansing, Michigan (1958).

9. United States Census of Agriculture 1959, Michigan Counties. U.S. Department of Commerce, Bureau of the Census (1961).

10. Grand River Basin Data Book. U.S. Army Engineer District Detroit Corps of Engineers, Detroit, Michigan.

11. Planning Status Report, Water Resource Appraisals for Hydroelectric Licensing, Grand River Basin, Michigan. Federal Power Commission, Bureau of Power, Washington D.C. (1965).

12. Water Resources Development in Michigan. U.S. Army Engineer Division, North Central Chicago, Illinois (January 1963).

BIBLIOGRAPHY (CON'T)

13. Oxygen Relationships of Grand River, Lansing to Grand Ledge, 1960 Survey. Michigan Water Resources Commission Lansing, Michigan (May 1962).

14. 1962 Inventory of Community Sewerage Facilities Lake Michigan Basin. U.S. Department of the Interior FWPCA, Great Lakes-Illinois River Basins Project Chicago, Illinois (Unpublished).

15. 1963 Inventory of Industrial Waste Sources Lake Michigan Basin. U.S. Department of the Interior, FWPCA, Great Lakes-Illinois River Basins Project, Chicago Illinois (Unpublished).

16. Pollutional Effects of Stormwater and Overflows from Combined Sewer Systems. Public Health Service Publication No. 1246. U.S. Government Printing Office Washington, D. C. (November 1964).

17. Municipal Waste Facilities 1962 Inventory. Public Health Service Publication No. 1065, Vol. 5. U.S. Government Printing Office Washington, D. C. (1963).

18. Runoff as a Source of Phosphate in the Waters of Streams and Lakes. Preliminary Report Prepared by H. Hall U. S. Department of Health Education and Welfare FWPCA, GLIRB Project, Chicago Illinois (February 1965).

19. Pesticides and Water Pollution, James B. Coulter. Presented at the Fall Public Education Meeting of the Interstate Commission on the Potomac River Basin held at Martinsburg, West Virginia (September 24 1964).

20. Discharge of Vessel Wastes in Fresh Water Rivers and Lakes-The Great Lakes and Connecting Waters. Public Health Service Interstate Quarantine Regulation, Federal Register (September 16, 1960).

21. Chemistry for Sanitary Engineers. C. N. Sawyer McGraw-Hill Book Co. Inc., New York, N. Y. (1960).

22. Public Health Service Drinking Water Standards: 1962. Public Health Service Publication No. 956. U. S. Government Printing Office, Washington D. C. (1962).

23. Storm Water Control Looks Like Costliest Pollution Fight Yet. Engineering News Record New York N. Y. (March 31 1966).

24. Staffing and Budgetary Guidelines for State Water Pollution Control Agencies. Public Administration Service, Chicago, Illinois (1964).

DEPARTMENT, [illegible]
Library, [illegible]
1 North [illegible]
Chicago, [illegible]