Water Pollution Series No. 67

A COMPREHENSIVE PROGRAM FOR WATER POLLUTION CONTROL

for the

GREEN BAY WESTERN SHORE DRAINAGE BASIN

A COMPREHENSIVE WATER POLLUTION CONTROL PROGRAM

for the

REEN BAY WESTERN SHORE DRAINAGE BASIN

eveloped in Cooperation with the State Water Pollution Control Agencies
of
MICHIGAN AND WISCONSIN

1954

Adopted by

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Public Health Service

FOREWORD

Our country's development over the past 50 years has been marked by tremendous progress in many fields. It has made possible great gains in the health, comfort, and well-being of the people. But it has not been without cost. Part of the cost has been the damage to the Nation's water resources that has resulted from wastes discharged to the streams by our growing cities and industries. All water uses have been affected--public water supplies, recreation, agriculture, industry, fish and aquatic life.

In enacting the Federal Water Pollution Control Act in 1948, the Congress declared that "water pollution has become a matter of grave concern in many areas and its damaging effects on the public health and nstional resources are a matter of definite Federal concern as a menace to national welfare. Abatement must be undertaken in order to control it."

The Public Health Service, as part of its responsibilities under this Act, is required to prepare or adopt, in cooperation with other Federal agencies, State and interstate water pollution control agencies, and municipalities and industries, comprehensive programs for the abatement of pollution.

This report contains the comprehensive water pollution control program for the Green Bay Western Shore Drainage Basin as developed in cooperation with the Michigan Water Resources Commission and the Wisconsin Committee on Water Pollution. The program is sound and gives full consideration to the several present uses and to the reasonably anticipated future uses of the waters of this basin. It provides an equitable balance in the pollution control requirements for various private and public groups concerned.

I am pleased, therefore, in my capacity as Surgeon General of the Public Health Service, to adopt this program for the Green Bay Western Shore Drainage Basin as a comprehensive program which fully meets the requirements of the Federal Water Pollution Control Act.

This program is based on beneficial water uses and related conditions that prevailed on January 1, 1954. Comprehensive programs for pollution control must necessarily be flexible. They must allow for growth, development, and changing conditions. Any significant changes affecting water quality, such as stream flow, water use, industrial development, population, etc., may require changes in the pollution control program.

Obviously the mere adoption of this program will not, in itself, reduce pollution or improve the usefulness of the waters in this basin. It does provide to the citizens of the area and to the city officials and industrial leaders, farmers, fishermen, conservationists, and others an objective plan based on good engineering practice, and reflecting sound economics. It is a plan which the public can support, and must support, if progress is to be made in the abatement of pollution.

Certain additional considerations beyond the mere acceptance of a plan are essential to its successful execution. The citizens of the areas affected must see that sufficient resources are provided to the State water pollution control agencies concerned to enable them to make the technical investigations to aid those responsible for constructing pollution abatement works.

We must recognize, too, that in order to be fully effective the plans and programs of one State must be geared closely to thoae of adjoining States, since State boundaries are no barrier to pollution traveling in interstate streams. Above all, no program of this nature can progress beyond the report stage if its meaning and purpose are not made clear and understandable to the citizens of the area. In the final analysis, they are the ones who will pay, directly or indirectly, for the pollution abatement works that are needed.

It is my hope that this program for the Green Bay Western Shore Drainage Basin will be carried through to completion so that the area may enjoy all the benefits that clean water can provide, in health and recreational opportunities for the people, and in sound growth of industry and agriculture.

Leonard A. Scheele

Leonard A. Scheele
Surgeon General

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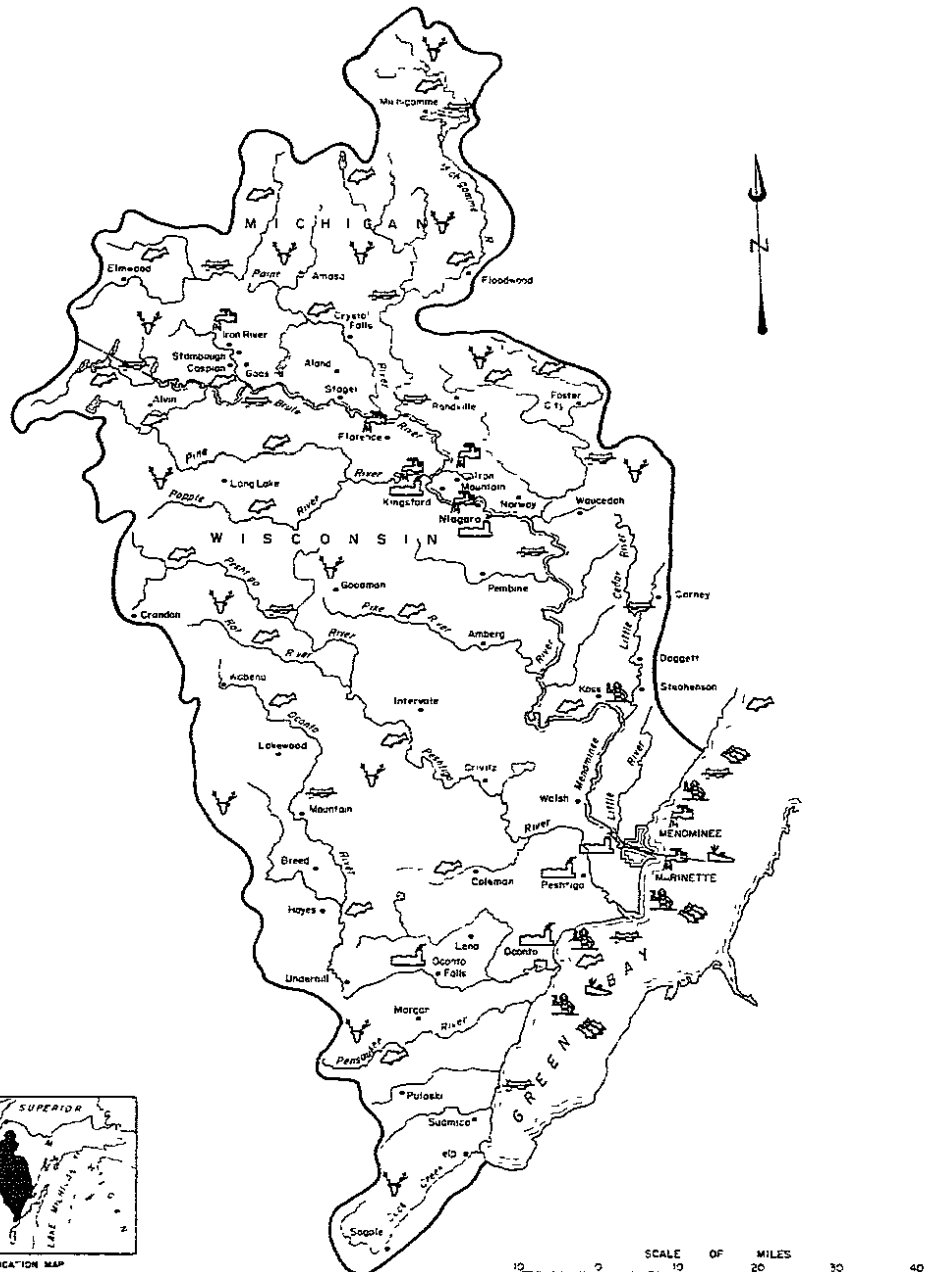
INTRODUCTION

The Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress in June 1948, requires the Surgeon General of the Public Health Service to cooperate with other Federal agencies, with State and interstate water pollution control agencies, and with municipalities and industries in the preparation or adoption of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof, and improving the sanitary condition of surface and underground waters.

This report, prepared in cooperation with the water pollution control agencies of Michigan and Wisconsin, sets forth a water pollution control program for the Green Bay Western Shore Drainage Basin. This program, which is based on data available as of January 1, 1954, was developed after a thorough consideration of the existing and potential uses of the water resources in the basin; the pollution entering the waters and the resulting damages; the benefits which may result from pollution prevention and abatement; and the prevention measures now in effect, as well as those which are needed.

The Michigan Water Resources Commission and the Wisconsin Committee on Water Pollution cooperated in the preparation of this report. Acknowledgment is made to the Corps of Engineers, Department of the Army; Soil Conservation Service and Forest Service, Department of Agriculture; Bureau of Census, Department of Commerce; Bureau of Mines, Fish and Wildlife Service, and Geological Survey, Department of Interior; and the Federal Power Commission for their review of the report and the information obtained from their published reports.



LOCATION MAP

- DOMESTIC WATER SUPPLY
- INDUSTRIAL WATER SUPPLY
- LIVESTOCK
- COMMERCIAL FISHING
- GAME FISHING
- WILDLIFE
- BATHING WATER
- OTHER RECREATION
- NAVIGATION

GREEN BAY WESTERN SHORE
DRAINAGE BASIN

EXISTING PRIMARY WATER USES

DEPARTMENT OF HEALTH EDUCATION AND WELFARE
Public Health Service

MAP NO 1

COMPREHENSIVE WATER POLLUTION CONTROL PROGRAM
for the
GREEN BAY WESTERN SHORE DRAINAGE BASIN

General Characteristics and Economic Development

The Green Bay Western Shore Drainage Basin lies west of the upper portion of Lake Michigan and includes all drainage to the western shore of Green Bay between the northern edge of the city of Green Bay, Wisconsin, and a point on Green Bay about 12 miles north of Menominee, Michigan. Three major river systems, the Menominee, Oconto, and Peshtigo, together with a number of smaller streams, drain the 6,800 square miles of the basin, 62 percent of which lies in Wisconsin and 38 percent in Michigan. The Menominee and one of its tributaries, the Brule, form the boundary between Michigan and Wisconsin from a point on the Brule southwest of Stambaugh, Michigan, to the mouth of the Menominee.

The topography of the basin is characterized by many high ridges which give variety to the landscape. The three main rivers rise in a high plateau, containing many lakes and swamps, which extends over most of the basin. They drop with steep gradients to a narrow plain, generally less than 10 miles, which parallels the western shore of Green Bay. Leaving the plain, the streams cross a ridged lowland area with steep stream gradients and hilly terrain to discharge into Green Bay. Low flows on the streams in this basin generally occur during late summer or early fall and again in the winter months. Critical flows on many of the tributary streams are very low, approaching or reaching zero flows at times.

Climate of the basin is of a continental type with Lake Michigan and Lake Superior exerting a moderating marine influence on the areas immediately adjacent to them. Monthly mean temperatures vary from 15° F. to 68° F. with slightly lower temperatures in the northern part and somewhat higher temperatures in the south. About 65 percent of the annual 30 inches of precipitation falls during the warmest six months of the year. The southern portion of the basin receives about 50 inches of snowfall each year while the northern portion gets an average snowfall of about 100 inches. Ice covers the streams 3 to 4 months of the year and is the major contributing factor to the critical low flows experienced in the winter.

This basin, with its many lakes, streams and scenic areas, is a part of one of the Nation's best recreational areas. It furnishes excellent hunting, fishing and vacationing facilities which provide considerable income to the area. Commercial fisheries operating from harbors in the basin harvest approximately 3 million pounds of fish annually from the Great Lakes. There is some agricultural activity, but farm production generally meets only the needs of local communities except in the areas within shipping distance of the few plants processing farm products. The outstanding industry in the basin is the manufacture of pulp, paper, and allied products, utilizing the timber resources of the area. Lumbering and iron mining are also important industries, although

they are declining in economic importance due to the depletion of the raw materials necessary to their operation.

The 1950 census of the basin is estimated to be 152,000, with 59 percent of the people living in Wisconsin and 41 percent in Michigan. The basin is rural, with an average population density of 22 persons per square mile; it contains only 15 municipalities with populations in excess of 1,000.

Water Use and Water Quality Objectives

The basin's waters are used for municipal, domestic, and industrial supplies; fish and wildlife propagation; recreation; water power; disposal of wastes; and to a minor extent for stockwatering and navigation.

Approximately 50,000 people, one-third of the basin's population, are served by surface water supplies, and a large number of households, camps, and others also depend upon surface water for their domestic supply. All but one of the communities with a population of 2,500 or more rely upon surface waters to supply their needs. The quality of finished water for municipal supply depends, to a considerable degree, upon the quality of the raw water used. The quality of the water used for households, camps and other individual domestic supplies is the quality found at the source of supply, as such users seldom treat the water before use. Therefore, source water quality objectives are among the factors considered when determining the treatment requirements for pollution sources upstream. In determining the suitability of water sources for municipal and domestic supplies, State health and water pollution control officials use Public Health Bulletin 296, "Manual of Recommended Water Sanitation Practice," as a guide.

The major industries of the basin use surface waters as their source of supply. Water quality requirements for these industrial supplies vary, and no specific criteria can be adopted as each case must be considered separately in light of the specific needs of the industry under consideration. Of general concern, however, are the organic and biological constituents, toxic and taste and odor producing substances, and properties of corrosion, encrustation, and slime formation.

Streams and lakes receive heavy recreational use, including sports fishing, swimming, camping, and boating. There are numerous recreational developments, swimming areas, and State parks in the basin where camping, swimming, boating, and other recreational facilities are available.

Quality objectives for the bacteriological quality of bathing waters recommended by the Joint Committee on Bathing Places (Joint Study of the American Public Health Association and Conference of State Sanitary Engineers, covered in a report entitled "Recommended Practice for Design, Equipment, and Operation of Swimming Pools and Other Public Bathing Places," 1949), together with the criteria adopted by the Great Lakes Board of Engineers and with sanitary surveys, are employed in the administration of the basin's pollution control programs as related to bathing waters. Although quality objectives for

water used for non-swimming recreation do not set forth as high a bacteriological criterion, the same basic fundamentals are used by the States in their program concerning those uses.

Commercial fishing is an important water use, and the basin's waters, particularly those in the lake regions, also serve as wildlife habitats.

The general criteria advocated by the U. S. Fish and Wildlife Service calling for a balanced aquatic habitat and limiting concentrations of pollutional substances are used by authorities in this basin for fishing waters.

Because of ample flow, favorable river gradients and the topography of the surrounding land, the streams of this basin are highly suitable for the development of water power. There are 28 hydroelectric projects in the basin with a combined installed capacity of nearly 140,000 kilowatts. Navigation is confined to Green Bay and the lower reaches of Oconto and Menominee Rivers. Stockwatering is a water use in the basin, but agriculture is of minor significance to the economy of the area. Quite importantly, the basin's waters also serve as final outlets for the wastes of its communities and industries.

Sources and Effect of Pollution

There are 24 sewered communities and 42 separate industrial waste outlets in the basin, which discharge a pollution load to the watercourses that has a combined population equivalent of more than 845,000.

Over half of the basin's people reside in the communities that have sewerage systems, and 74,500 of them are served by municipal sewers. Twelve communities are discharging treated, partially treated, and untreated sewage with a population equivalent of 25,690, while 12 other communities are discharging an undetermined amount of sewage to the basin's waters.

Industrial wastes with a combined population equivalent of 820,000 are discharged through separate outlets by 20 industries; four paper mills account for 774,550 of this amount. Included in the above 20 are seasonal industries, such as the sugar beet mill at Menominee and canning plants at other locations.

The eight communities which do not provide treatment for their wastes have a sewered population of 33,100, which is approximately 45 percent of the total sewered population of the basin. Four of the 17 existing municipal sewage treatment plants are considered to have inadequate capacity to handle their present load which totals about 2,200, while five plants are not being operated satisfactorily. Twenty-six of the industries provide some degree of treatment for their wastes, but nine of these do not have adequate capacity to handle the present waste load. Four of the pulp and paper mills have inadequate capacity and are the major contributors of organic pollution in this basin.

Pollution has damaged water uses in certain areas of the basin. Most of this damage has been the result of depleted dissolved oxygen or high coliform bacterial counts in the waters. In the mining area, the damages have, in

general, been due to the turbidity caused by the oxidation of the iron in the mine wastes and the deposition of mine waste solids on stream beds. Fishing and recreational water uses have been most commonly damaged by pollution because depleted oxygen, high bacterial counts, excessive turbidities and bottom deposits all affect these uses.

Fish killings were reported on the Menominee River near Iron Mountain in three separate years. Slime growths and accumulations on gill nets, at the mouth of the Oconto River, cause suspension of gill-net fishing by midsummer each year, according to commercial fishermen who also report the disintegration of all but nylon nets in the polluted sections of the Oconto River and adjacent Green Bay waters. The "Black Water Ribbon" of the Oconto entering the bay is reported to drive fish away and requires the moving of net sets whenever the discolored water shifts over them. The Iron River is practically devoid of fish below the city of Iron River, Michigan, while it is an excellent trout stream above the city.

One farmer is reported to have had to fence off the Oconto River and provide another source of water for his stock because his milk would not be accepted as long as his cattle had access to the river.

Many sections of the streams in the Michigan portion of the basin have been condemned in the past for recreational purposes by the Michigan State Health Department because of bacterial pollution. The streams involved include the Menominee and Paint Rivers. The beaches on Green Bay at Menominee, Michigan, were listed as unsafe for swimming for years until treatment facilities were provided for the sewage entering the bay at that point.

From a public health standpoint, pollution in this basin has generally resulted in hazardous conditions rather than actual damage. The high coliform concentrations found in sections of some of the streams--MPN counts of 1,000,000 and over--indicate the probability of the presence of pathogenic organisms which could cause serious illness under certain conditions. High coliform bacterial counts have been found in the waters of the Menominee River, especially in the Iron Mountain-Norway region. High concentrations have also been found in short sections of the Iron and Brule Rivers and of many of the tributary streams below the discharge from municipal sewerage systems. For the most part these pollutional damages have been localized, but in a few instances the pollution damage is spread over fairly long reaches of the streams.

Progress in Pollution Abatement

The water pollution control agencies of the States are actively working on the pollution problem and are using existing authority in a judicious and effective manner. They work cooperatively with municipalities and industries in solving pollution problems and enforcing existing statutes. Their activities have resulted in sewage treatment being provided by 16 of the basin's 24 sewered communities. The existing sewage treatment plants serve 55 percent of the basin's total sewered population. Twenty-six of the 42 industries that

have separate outlets to the basin's streams have facilities providing some degree of treatment for their wastes.

The water pollution control laws of the States in this basin are adequate to abate existing pollution and to prevent or control new or increased sources of pollution, and the States' activities are directed toward this end. The State water pollution control efforts have been quite successful, but in order for the State agencies to continue their effective and active program, they must be furnished with adequate appropriations to attract and hold sufficient qualified personnel to carry on their activities.

Pollution abatement and control is advancing in this basin. At the present time, four industrial waste treatment plants are under construction; five municipalities have sewage treatment plant plans approved; and two municipalities and three industries are actively preparing plans for needed facilities.

Pollution Prevention Measures Required

Excellent work has been done on the control of pollution within recent years, but to adequately control or prevent all damaging pollution, there are still a number of projects that must be constructed. Analysis of available data which show stream characteristics, the amount of wastes discharged to the watercourses, present water quality in the streams, and existing water uses in relation to generally accepted water quality objectives, has enabled the determination of treatment requirements for the major sources of pollution in the basin. These requirements consist of eight new sewage treatment plants--seven for systems without treatment, serving 30,460 people, and one for a system serving 1,000 people where the existing plant is no longer satisfactory. Also needed are enlargements or additions at two existing plants now serving 550 people. It is estimated that the construction of these facilities will cost approximately $2,000,000. This cost estimate does not include such items as sewers, interceptors, land, right-of-way, etc., which will vary with each project and with local conditions. There are nine new industrial waste treatment facilities needed at industries that do not now have treatment facilities, and one existing plant needs to be replaced if adequate treatment is to be obtained. In addition, eight existing industrial waste treatment plants require enlargement or additions in order to reduce to an acceptable level the industrial pollution load they now discharge to the streams of the basin. Many of these needed facilities will be small, but some of them will, no doubt, involve considerable construction. No satisfactory estimate of the cost of the industrial waste treatment facilities is possible since the nature of the wastes and possible in-plant improvements will vary widely, even within identical industrial groups.

The determination of the total pollution load from all municipalities and industries would require securing additional data. This is not warranted since the data now available are sufficient for the continuation of the comprehensive program and the elimination of many of the pollutional problems that now exist.

Water Pollution Control Program

The needed corrective measures discussed herein and listed below are based upon studies and investigations made by the responsible water pollution control agencies in the States concerned, and are part of the pollution abatement programs now being carried out by these agencies. The pollution prevention and control measures recommended are intended to restore, preserve, and protect all reasonable water uses including those now existing and those which may materialize in the immediate foreseeable future. These remedial measures were arrived at only after a thorough consideration of all water uses in the basin and are considered to be reasonable and adequate.

The corrective measures listed below are flexible and are intended to reflect the needs for the present situation as it now exists; however, changes in stream characteristics, pollutional load, or water uses may require revisions in the indicated required treatment at some future date.

The essential elements of the program as developed in cooperation with the States concerned consist of the following:

1. Provide the following improvements:

Name and Location	Improvements Needed	Remarks
Brookside, Wis.		
Brookside Cheese Fct.	Additions to existing treatment plant	
Duck Creek, Wis.		
Stokely Foods, Inc.	New treatment plant	
Florence, Wis.	New treatment plant	
Gillett, Wis.	Replacement of existing treatment plant	
Gillett Canning Co.	New treatment plant	Under construction
Hintz, Wis.		
Lindsy Brook Cheese Fct.	New treatment plant	
Iron Mountain, Mich.	New treatment plant	Abatement ordered by 6-1-54 Plans approved for joint plant with Kingsford, Mich.
Iron River, Mich.	New treatment plant	Abatement ordered by 6-1-55 Plans approved for joint plant with Stambaugh, Mich.

Name and Location	Improvement Needed	Remarks
Kingsford, Mich.	New treatment plant	See Iron Mountain, Mich.
Krakow, Wis.		
Brzezinski Bros. Cheese Fct.	New treatment plant	
Kunesch, Wis.		
Kunesch Cheese Fct.	Additions to existing treatment plant	
Lena, Wis.	Additions to existing treatment plant	
Little Suamico, Wis.		
Little Suamico Cheese Fct.	New treatment plant	
Wroblewski Pickle Co.	New treatment plant	
Marinette, Wis.		
Ansul Chemical Co.	Chemical recovery facilities	Under construction
M&M Light & Traction Co.	Additions to existing treatment plant	Converting to natural gas will eliminate waste
Niagara, Wis.	New treatment plant	Plans approved
Kimberly-Clark Pulp & Paper Mill	Enlargement of and additions to existing treatment plant	Active planning
Norway, Mich.	New treatment plant	Abatement ordered by 6-1-54 Preliminary planning
Oconto Falls, Wis.		
Falls Paper & Power Co.	Enlargement of and additions to existing treatment plant	Active planning
Oneida, Wis.		
Sacred Heart Seminary	Additions to existing treatment plant	
Peshtigo, Wis.		
Badger Paper Co.	Enlargement of and additions to existing treatment plant	Active planning
Porterfield, Wis.		
Riverside Cheese Fct.	Waste reduction program	

Name and Location	Improvement Needed	Remarks
Pulaski, Wis.		
Pulaski Canning Co.	New treatment plant	
Sobieski, Wis.		
Elmwood Cheese Fct.	Enlargement of existing treatment plant	
Spruce, Wis.		
Spruce Cheese Fct.	New treatment plant	
Stambaugh, Mich.	New treatment plant	See Iron River, Mich.
Cannon Mine	New treatment plant	Under construction
Wausaukee, Wis.		
Wausaukee Cheese Fct.	Waste reduction program	
Zachow, Wis.		
Graf Creamery	Additions to existing treatment plant	

2. Operate all existing and future waste treatment works at a uniformly efficient and high level in order to obtain maximum benefits from these facilities and permit their most effective utilization.

3. Continue the policy of requiring adequate treatment of wastes from new sources and from expanded use of existing facilities, in order to preclude new pollution problems.

PHYSICAL DESCRIPTION

The Green Bay Western Shore Drainage Basin lies west of Green Bay of Lake Michigan and is drained by the Menominee, Oconto, and Peshtigo Rivers, and several smaller rivers and streams. The basin contains an area of 6,800 square miles with 62 percent in Wisconsin and the balance in Michigan.

The Menominee River, the most northerly of the basin's rivers, drains about two-thirds of the basin area. It is formed by the junction of the Brule and Michigamme Rivers near Florence, Wisconsin, and flows southeasterly for 104 miles to discharge into Green Bay between Marinette, Wisconsin, and Menominee, Michigan. The Brule and Menominee Rivers form the boundary between Michigan and Wisconsin from a point southwest of Stambaugh, Michigan, to the mouth of the Menominee. The Menominee River falls about 700 feet from its headwaters to Lake Michigan as it gathers the waters from its major tributaries which are the Pike, Pine, Brule, Michigamme, Iron, Paint, Sturgeon, and Little Cedar Rivers.

The Oconto River, draining about 1,000 square miles, rises in the southern part of Forest County, Wisconsin, and flows southeasterly 87 miles before discharging into Green Bay at Oconto, Wisconsin. It originates at an elevation of 1,530 feet above sea level and has a total fall of about 945 feet, two-thirds of which occurs in the first 35 miles.

The remaining area of the basin is drained by the Peshtigo, Pensaukee, Suamico and Little Suamico Rivers, and Duck Creek, all of which discharge directly into Green Bay.

The topography of the basin is characterized by its hilly terrain, and the ridges give variety to the surface which is generally covered by glacial drift. The three main rivers rise in a section known as the Northern Highland, cross a narrow band of the Central Plains, and then flow through the Eastern Ridges and Lowlands. The Northern Highland is a high plateau, underlain with hard crystalline pre-Cambrian rocks, which extends over most of the basin. This region contains many lakes and swamps, and its rivers are fairly steep with relatively constant slopes except at rapids. The Central Plain is a narrow band, generally less than 10 miles wide, approximately parallel to the western shore of Green Bay. It is underlain with Cambrian sandstone, but is so narrow that the change in geological formation is not reflected in the slope of the streams. The Eastern Ridge and Lowland area is underlain with Lower Magnesia limestone and Trenton limestone. Stream gradients are steep and the terrain hilly with a few lakes and swamps.

The climate is of a continental type, but the large body of water in Green Bay and Lake Michigan has a moderating effect on a narrow band along the shore. Lake Superior, which is only 12 miles from the northern tip of the basin, exerts a marine influence on that portion of the basin. The winters are long and severe, with ice covering the streams three to four months each year. Average January temperatures vary from 11.2° F. in the northern part of the basin to 19.0° F. in the southern part. Corresponding average July temperatures range from 65.8° F. to 71.1° F. The headwaters area has only

100 days free of killing frost, while that near Green Bay has an average of 140 days. Precipitation is estimated to average about 30 inches per year with local variations up to 2 inches. Approximately 65 percent of this annual precipitation falls during the warmest six months of the year. Average annual snowfall varies from about 50 inches in the southern portion to about 100 inches in the northern area.

Stream flows in the basin are moderated to some extent by the many lakes and marshes in the headwaters area, while the hydroelectric power dams partially regulate flows in their respective areas. The mines in the Iron River watershed discharge considerable quantities of ground water and mine drainage water to that river, and the Way Reservoir affects the discharge of the Michigamme River. Minimum flows occur in early fall and again during January and February.

STREAM FLOW DATA AT VARIOUS LOCATIONS IN THE GREEN BAY WESTERN SHORE DRAINAGE BASIN*

River and Gaging Station	Drainage area in sq. mi.	River Discharge in Cubic Feet Per Second				
		Years of Record	Average	Maximum	Minimum	Average During Driest Month
MENOMINEE RIVER						
Koss, Mich.	3,790	38	3,146	23,200	162	731
Iron Mountain, Mich.	1,790	37	1,785	16,700	154	641
BRULE RIVER						
Florence, Wis.	380	8	329	2,480	155	179
PAINT RIVER						
Crystal Falls, Mich.	616	7	546	7,400	81	163
PINE RIVER						
Florence, Wis.	543	28	423	4,380	0	80
PIKE RIVER						
Amberg, Wis.	253	37	224	2,730	26	78
OCONTO RIVER						
Gillett, Wis.	678	38	581	8,400	93	158
PESHTIGO RIVER						
Crivitz, Wis.	571	27	494	3,860	0	97

*Data used in this table secured from Geological Survey Water-Supply Papers Part IV - St. Lawrence River Basin.

ECONOMIC DEVELOPMENT

This basin, with its many lakes, streams and scenic areas, is a natural recreation ground that is rapidly being developed into an important hunting, fishing and vacation area. There are about 100 resorts and public swimming sites and 19 State-owned public fishing sites in the Michigan portion of the basin. Recreational facilities are equally well-established in the Wisconsin portion of the basin, especially along tributary headwaters where trout fishing is unexcelled. The Menominee River area is noted throughout the Nation as a sportsman's paradise.

The development of potential recreation facilities, accompanied by the profitable tourist business, has become a primary factor in the economy of the basin. However, additional expansion of the tourist trade is being hampered to some extent by difficulty of access to parts of the basin and polluted waters in some of the developed sections.

The 1950 population of the basin is estimated to be 152,000 with 59 percent residing in Wisconsin and 41 percent in Michigan. The basin is basically rural, only 15 municipalities having populations in excess of 1,000. Marinette, Wisconsin, with a population of 14,198, and Menominee, Michigan, with a population of 11,151, are the two largest cities in the basin. The basin as a whole had a population decrease of 5 percent between 1940 and 1950; its average population density of 22 persons per square mile is about the same as it was in 1930.

The average effective buying income for the basin was approximately $1,015 in 1950, and ranged from $1,557 in Villa County, Wisconsin, to $657 in Florence County, Wisconsin, as compared to the national average of $1,311 for the same year.

Historically speaking, the two outstanding industries of the basin are iron mining and lumbering. Although these two industries are still operating, they are declining in economic importance due to the depletion of the raw materials necessary to their operation. The principal industrial development, especially from a pollutional standpoint, is the pulp and paper mills located on the Menominee, Peshtigo and Oconto Rivers. Industries based on the processing of farm products are operating in several areas with dairy products plants predominating.

The agriculture of the region is of minor economic importance because the basin, formerly an important timber producing area, is now mainly submarginal cut-over land. The soils over most of the area are not especially suitable for extensive agricultural pursuits, and farming is further limited because the area is a relatively long distance from major markets. Large farms are, in general, confined to areas within economical shipping distance of the industries processing farm products. Farms with small acreages are located throughout the basin, but they furnish little more than enough to sustain the occupants. Some dairying occurs, but dairy herds are small and milk production generally meets only the needs of local communities and milk processing plants.

Navigation is limited to Green Bay and the lower reaches of the Menominee and Oconto Rivers. General vessel traffic moved 524,144 tons in 1952, while car-ferry traffic moved 173,559 tons. Coal receipts of 370,729 tons made up about 71 percent of the 523,795 tons of incoming freight, while lumber and miscellaneous products accounted for all of the outgoing freight which amounted to 349 tons.

Commercial fisheries operating out of the Menominee and Oconto Harbors are of economic importance to the basin. A total catch of approximately 3 million pounds of fish is taken from the Great Lakes annually by these fisheries.

USES OF WATER RESOURCES

Important uses of the basin's waters include domestic and industrial supply, fishing, wildlife, bathing and other recreation, navigation, and final disposal of wastes. The primary use in some areas is industrial and domestic supply, but the predominant use throughout the basin is for sport and commercial fishing, hunting and recreation. Navigation is limited to the Green Bay and adjacent waters.

Municipal water supply is a very important water use in this basin, as all but one of the municipalities with a population of 2,500 or more secure their water from surface supplies. Florence, Wisconsin, and Iron Mountain, Michigan, obtain all of their domestic water supply from inland lakes, while Norway and Iron River, Michigan, draw their supply from wells with emergency connections to surface waters. Kingsford, Michigan, obtains its domestic supply from the Iron Mountain system, and Menominee, Michigan, and Marinette, Wisconsin, go to Green Bay for their supply. A large number of households, camps and others also depend upon surface water for their individual domestic supply.

Source water quality objectives are among the factors considered in determining treatment requirements for pollution sources upstream of municipal and domestic supplies. In appraising the suitability of water sources for such supplies, State health and waterworks officials use Public Health Bulletin 296, "Manual of Recommended Water Sanitation Practice," as a guide.

The quantity of surface water used by industry for cooling or process purposes, with or without treatment, is not known. However, nearly all of the major industrial development in the basin, with the exception of mining, has been along the main streams and larger tributaries, indicating the necessity of large quantities of good water. Because of the diversity of uses, quality requirements for industrial supplies vary widely and no general water criteria have been adopted as each case must be considered separately. Of general concern, however, are the organic and biological constituents, temperature, toxic substances, and properties of corrosion, encrustation and slime formation of the available waters.

The lakes, streams, and scenic areas within the basin provide fishing, hunting, swimming, skiing, skating, boating and other forms of recreation. The lakes and larger streams contain northern and walleyed pike, smallmouth bass, perch and pickerel. Temperatures and dissolved oxygen content of the waters in the majority of the smaller streams are suitable for trout, and many streams, such as the Brule, have a national reputation as trout water.

Hunting is popular in the western and northern sections of the basin. Florence and Forest Counties, Wisconsin, are outstanding in this regard, while Baraga, Dickinson, Iron, and Marquette Counties are reported to rank with the best in the State of Michigan. Consistently, year after year, the deer kill in the Michigan counties of the basin is the highest in that State, with between 8,000 and 10,000 deer being taken out of that area in 1947. Small game birds are also abundant in this area. While hunting is not a direct water use,

it depends upon the game attracted to the area by the water available for its use and convenience, and hunting camps and lodges are generally located where an ample supply of good water is available for domestic use as well as for aesthetic enjoyment.

The waters in the Great Lakes portion of the basin support a substantial commercial fishing industry. In 1952, fishermen operating out of Menominee Harbor caught 2,470,000 pounds of fish, while those basing at Oconto Harbor brought in 400,000 pounds.

Water quality objectives for fishing waters vary with the type of aquatic life to be protected. The general objectives advocated by the U. S. Fish and Wildlife Service calling for a balanced aquatic life habitat and limiting concentrations of pollutional substances are usually used by authorities in this basin. Consequently, toxic and oxygen consuming wastes and wastes responsible for sludge beds, silt and other deposits which tend to blanket the stream bottom and destroy the biological life necessary to the existence of fish are not considered desirable.

The many streams and lakes are popular with vacationists and boating advocates. The beaches of Green Bay and many of the lakes and streams are extensively patronized by swimmers during the summer season. Winter brings skiing enthusiasts to Iron Mountain, Michigan, for the annual ski meets, while the rest of the region offers excellent winter sport including skating, tobogganing, and ice fishing.

Contamination of bathing waters by sewage, especially that of recent origin, is objectionable, as water for recreational use should be free from floating solids, sludge banks, odors, and discoloration. Quality objectives for the bacteriological quality of bathing waters recommended by the Joint Committee on Bathing Places (Joint Study by the American Public Health Association and Conference of State Sanitary Engineers, covered in a report entitled "Recommended Practice for Design, Equipment, and Operation of Swimming Pools and Other Public Bathing Places," 1949), together with the criteria adopted by the Great Lakes Board of Engineers and with sanitary surveys, are employed in the administration of pollution control programs as related to bathing waters of this basin. Under the Joint Committee interpretation, various classifications of waters are defined as based on the number of coliform organisms per 100 milliliters of water. Other indices of quality, as enterococci, are receiving increasing attention; however, sanitary surveys are employed in pollution control programs as related to bathing waters. Although quality objectives for water used for non-swimming recreation do not set forth as high a bacteriological criterion, the same basic fundamentals are used by the States in their programs.

Ample flow, favorable river gradients, and the topography of the surrounding land, make the streams of this basin very suitable for the development of water power, and 28 hydraulic power sites are located within the basin. These are shown in the following table:

River	Number Plants	Installation Kilowatts
Menominee	10	57,785
Brule	1	5,335
Paint	2	600
Michigamme	5	46,040
Pine	1	3,200
Sturgeon	1	800
Peshtigo	6	22,724
Oconto	2	2,440
		138,924

Navigation is confined to Green Bay, the lower two miles of the Oconto River and the lower two and one-half miles of the Menominee River. In 1952, there was a general vessel tonnage shipped and received of 524,144 and a car-ferry traffic tonnage shipped and received of 173,559. The car-ferry traffic included a total of 9,101 railroad cars inbound and outbound, and a total of 716 automobiles with accompanying passengers.

Stockwatering is not a major water use because of the limited agricultural development. However, this use is very important to certain areas of the basin as surface water is the only available water in many places.

All of these water uses are considered essential for the economy, health and welfare of the people of the basin, and conservation of the water resources is necessary for the continued development of the area. Treatment of the wastes discharged to the watercourse will be necessary to achieve pertinent water quality objectives and to maintain the streams and lakes in a suitable condition for the indicated water uses.

POLLUTION CONTRIBUTED TO WATER RESOURCES

The sources of untreated, partially treated, and treated wastes which are discharged into the surface waters of the basin are tabulated in the appendices and summarized in Table A below. There are 24 municipalities in the basin which have sewerage systems and these serve an estimated total population of about 75,000. On the basis of population served, these municipal sources may be grouped as follows: three cities serving more than 10,000 each; five serving 2,500 to 10,000; nine serving between 1,000 and 2,500; five between 500 and 1,000; and two serving about 500.

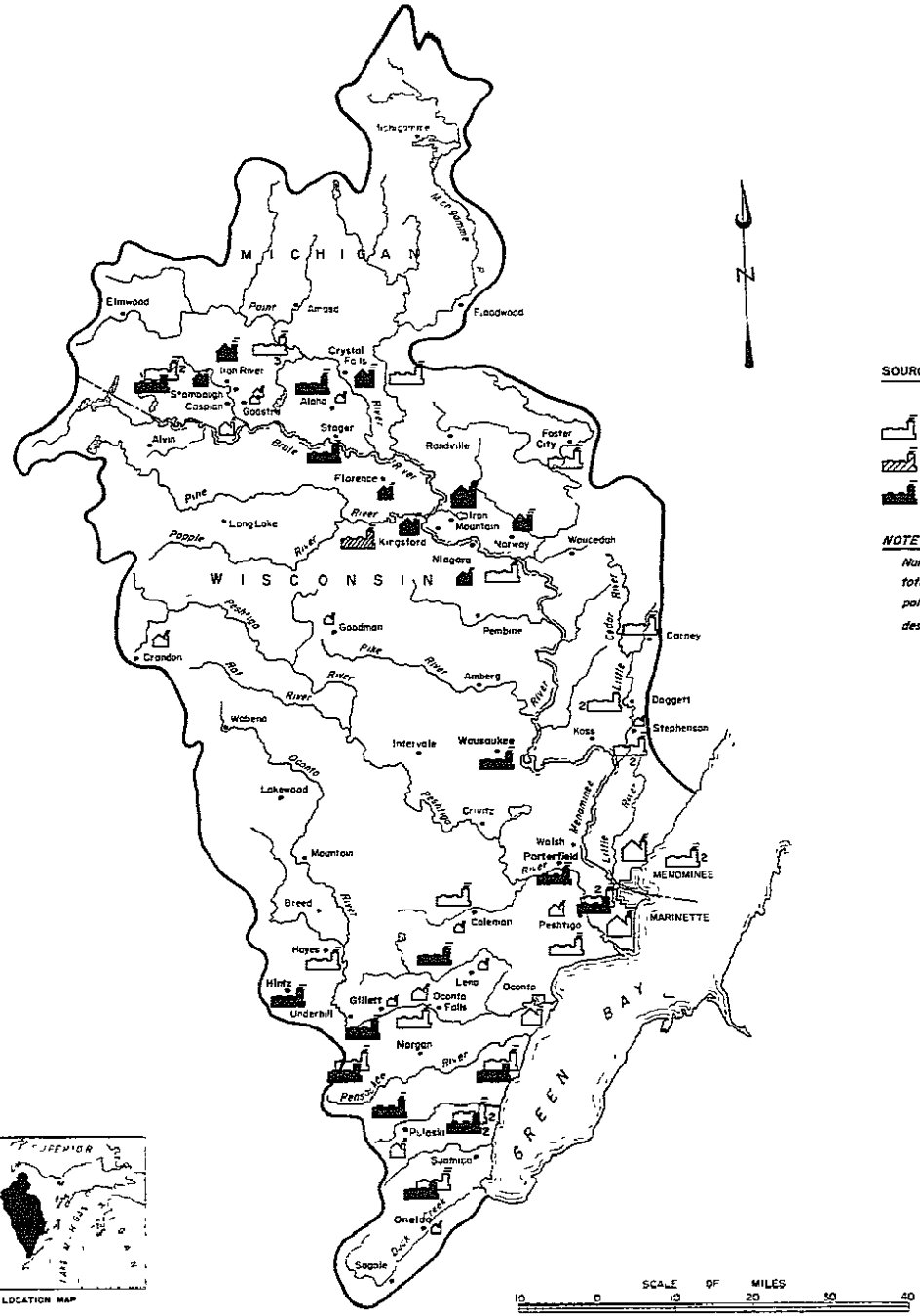
TABLE A
SEWERED MUNICIPALITIES*

Municipalities*	Number	Population Served by Sewerage System	Amount of Pollution Discharged to Watercourse (In terms of Equivalent Number of People)
Having data on pollution load discharged to watercourse	12	29,770	25,690
Having population data available (Data on pollution load to watercourse incomplete or not available)	12	44,790	Not applicable
TOTAL	24	74,560	xxx xxx

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse and industrial wastes discharged into municipal sewerage systems.

Eleven municipalities have 12 sewage treatment plants that are providing satisfactory treatment for the sewage from about 55 percent of the basin's sewered population. Four treatment plants, serving a little more than 5 percent of the sewered population, do not have adequate capacity to produce a satisfactory effluent, and the adequacy of one plant has not been determined. The other eight municipalities that have sewer systems do not provide treatment facilities, but discharge untreated sewage directly into the basin's waters.

The communities of Iron River and Stambaugh, Michigan, are discharging raw sewage into the Iron River. Drainage water discharged from the mines of the area adds pollution of an inorganic type, discoloring the water and forming



SOURCES OF INDUSTRIAL POLLUTION

- WITH TREATMENT
- TREATMENT UNDETERMINED
- WITHOUT TREATMENT

NOTE

Numbers Appearing by symbols indicate total number of industrial sources of pollution in the area in the category designated

SOURCES OF MUNICIPAL POLLUTION

POPULATION SERVED BY SEWERS

- 1-1,000
- 1,001-2,500
- 2,501-10,000
- 10,001 AND OVER

- WITH TREATMENT
- WITHOUT TREATMENT

GREEN BAY WESTERN SHORE
DRAINAGE BASIN

MUNICIPAL AND INDUSTRIAL SOURCES OF POLLUTION AND EXISTING TREATMENT FACILITIES

DEPARTMENT OF HEALTH EDUCATION AND WELFARE
Public Health Service

MAP NO 2

bottom deposits. The Menominee River, between Iron Mountain and Norway, Michigan, is receiving severe pollution from four municipalities and from the Kimberly-Clark Pulp and Paper Mill located at Niagara, Wisconsin. The discharge from the treatment plant at Marinette, Wisconsin, causes some pollution near the mouth of the Menominee River during the periods when the city is not chlorinating the plant effluent. The capacity of Marinette's plant is considered to be satisfactory for the protection of the present water uses in the area provided the effluent is chlorinated before discharge. The Marinette Paper Company at Marinette, Wisconsin, provides treatment for part of its waste, but it is still discharging considerable amounts of organic material. The Superior Sugar Company at Menominee, Michigan, operates seasonally and provides treatment for its waste, which is sufficient to comply with restrictions established by the Water Resources Commission.

The Peshtigo River receives large amounts of pollutional materials from the Badger Paper Mill at Peshtigo, Wisconsin, while the Oconto River receives a heavy pollution load from the Falls Paper and Power Company Mill at Oconto Falls, Wisconsin. Wastes discharged from a number of the smaller municipalities and industries introduce localized pollution in some sections of tributary streams.

As shown in Table B, 42 industries in the basin have separate outlets and discharge wastes directly to the watercourses. The amount of pollution discharged by 20 of the 33 industries producing organic wastes has been determined to have an oxygen-consuming potential equivalent to the sewage from 819,980 people.

TABLE B
SEPARATE INDUSTRIAL* OUTLETS

Industries*	Number	Amount of Pollution Discharged to Watercourse (In Terms of Equivalent Number of People)
Producing Organic Wastes	20**	819,980
Producing Organic Wastes	13	Not known
Producing Inorganic Wastes	13	Not applicable
TOTAL	42	xxx xxx

*Industries having separate outlets discharging wastes directly to watercourse and not through municipal sewerage systems.

**Includes four industries which produce both organic and inorganic wastes.

Comparison of the amount of pollution discharged to the basin's waters by municipalities and by industries shows that industry in this basin produces and discharges far more pollutional material than the municipalities. While organic industrial waste possesses dissolved-oxygen-consuming properties similar to untreated or insufficiently treated sanitary sewage, sanitary sewage also contains bacteria of intestinal origin which serve to create a public health hazard for persons coming in contact with waters receiving such sewage.

Four pulp and paper mills discharge wastes which have a combined biochemical oxygen demand population equivalent of about 775,000--over ten times as much as from the entire sewered population of the basin. Waste water pumped from mines is another significant industrial waste. This waste, entering the Iron River and a portion of the Brule River below the mouth of the Iron River, converts the clear streams into red turbid watercourses, and blankets the bottom with deposited inorganic material.

DAMAGES TO WATER RESOURCES FROM POLLUTION

Most of the basin's streams and lakes receive no polluting material, while the amount of such material that others receive does not exceed their pollution assimilation capacity consistent with present water uses. However, excessive pollution has damaged water uses in certain areas of the basin. The amount of damage varies with the degree of pollution and depends upon the extent to which the major existing water uses have been affected or potential future water uses discouraged by the unsatisfactory water quality resulting from the pollution.

Water use damage results from bacterial pollution, deoxygenation by organic materials, toxicity, increased hardness, or the presence of solids, turbidity, color, odor, or taste producing substances. Most of the damages that have occurred within the basin have been the result of depleted dissolved oxygen or high bacterial counts in the waters. In the mining areas, however, the damages have, in general, been due to the turbidity which is caused by the oxidation of the iron in the mine wastes and solids which blanket the stream beds. Fishing and recreational water uses have been the one most commonly damaged by pollution as depleted oxygen, high bacterial counts, bottom deposits and excessive turbidities all affect these uses.

Fish killings were reported on the Menominee River near Iron Mountain in 1943, 1944, and 1948. Complaints have also been received from commercial fishermen who report such heavy slime growths and accumulations on gill nets, at the mouth of the Oconto River, that they cause the suspension of gill-net fishing by midsummer each year. Commercial fishermen also report the disintegration of all but nylon nets in the polluted sections of the Oconto River and adjacent Green Bay waters. The "Black Water Ribbon," created by dark colored water of the Oconto entering the bay, is reported to drive fish away to the extent that whenever the black water shifts to the net sets, they must be pulled up and moved to clear water. Death of fish held in live racks at the mouth of Oconto River has also been reported as due to pollution. One farmer had his milk rejected bacause his cattle had access to the Oconto River below the source of pollution, and he was forced to spend money to fence off the

river and provide another water source for his herd before he could restore his market.

The Iron River is a clear, unpolluted trout stream above the city of Iron River, Michigan; however, from that city to the mouth of the river, the stream is practically devoid of fish because of the lack of fish food. The turbidity caused by the wastes in the river prevents light from penetrating to the bottom and retards plant growth, which, in turn, prevents the establishment of the stream bottom animals necessary to the maintenance of fish life.

Many sections of the streams in the Michigan portion of the basin have been listed as unsafe for recreational purposes by the Michigan State Health Department because of bacterial pollution. In years past, it was also found necessary to list the Green Bay beaches at Menominee as unsafe for swimming. The installation and operation of waste treatment facilities at the source of pollution in the Menominee area has corrected the situation, and swimming is again enjoyed at these beaches. Streams on which the State has had to list sections as unsafe for recreational purposes include the Menominee and Paint Rivers.

From a public health standpoint, pollution in this basin has generally resulted in hazardous conditions rather than actual damage. The high coliform concentrations (B Coli index of 1,000,000 per 100 ml. and over) found in sections of some of the streams indicate the probability of the presence of pathogenic organisms which could cause serious illness under certain conditions. High coliform bacterial counts have been found in water samples taken from the Menominee River, especially in the Iron Mountain-Norway region. High concentrations have also been found in the Iron and Brule Rivers and in many of the tributary streams of the basin just below the discharge from municipal sewerage systems.

An example of bacterial pollution hazard is found at Norway, Michigan, where untreated sewage is discharged into a small creek which flows past the fairgrounds, past a cemetery and then into the Menominee River. The cemetery uses the creek water for irrigation and it is quite possible for a person to drink this polluted water from one of the hydrants without realizing his danger. Some farmers along this polluted creek have had to abandon their original wells and expend considerable sums of money to construct new wells at some distance from the creek to get water which is not contaminated. They have also registered complaints of obnoxious odors during low flow periods. The damage, in a monetary sense, may be relatively small but the potential danger to the health of the public cannot be ignored.

When pollution damages are being considered, the loss through reduction of property values should not be overlooked. The condition of the available water is an important factor when locating a home, camp, or recreational development on or near waterfront property. There is little doubt that property values have suffered some loss due to pollution in the basin, especially along those streams and beaches that have had to be declared unsafe for recreational and swimming purposes.

BENEFITS RESULTING FROM POLLUTION PREVENTION AND ABATEMENT

The existing sewage and waste treatment facilities now operating in the basin have been of great value in preventing damage to the water resources and in correcting some of the damage that had developed. Man, of course, cannot live in an environment and maintain it in its virgin state. However, the damage to this environment can be kept consistent with its uses by proper disposal and treatment of waste materials. If municipalities and industries continue to pollute their water resources with untreated wastes, they will eventually realize a loss that could have been prevented but which can be corrected only through the expenditure of considerable money and effort.

The water resources of this basin have not been damaged beyond recovery, but there are some areas where correction of polluted conditions is necessary and desirable to restore the affected waters to their most useful condition. By abating existing pollution, the damaged water uses can be restored, and, by preventing additional pollution, future water uses can be preserved. This can be illustrated by benefits that were derived from the installation of pollution abatement measures at Menominee and Marinette. Pollution became so excessive that it became necessary to list the Green Bay beaches in this area as unsafe for swimming. After corrective measures were taken at the sources of pollution, the water quality improved and it is again safe to use these beaches for swimming as well as other recreational purposes.

The benefits to be derived from the provision of clean water for recreation in an area so well adapted to this use are self-evident. The provision of adequate treatment of wastes is required in the interest of aesthetics as well as for reducing the threat of water-borne disease. Effective pollution prevention measures will improve water quality and provide a safer environment for swimming, boating and fishing in those areas where bacterial pollution is not greater than that considered safe or desirable for these water uses.

Effective pollution prevention measures in those areas where surface water is used for public water supplies will reduce the heavy load on the water treatment plants of the communities that must rely upon such waters as their source of supply.

Availability of good quality water is a requisite to development of many industries and a major factor in locating industrial plants. This is of economic importance to the basin in maintaining existing industry and in attracting additional industry to the area.

Pollution control measures are necessary to assure continued and increased benefits from both commercial and sports fishing. Abatement of pollution will aid in promoting wider development of water uses, and prevention of future pollution will assure continued use. Wider development of the water resources for recreational use will attract additional revenues to the area from vacationists and sportsmen but only if there are clean waters available for their enjoyment.

POLLUTION PREVENTION MEASURES IN EFFECT

Approximately 50% of the total basin population resides in the 24 communities that are served by sewerage systems. Sixteen of these communities, with a total combined sewered population of 41,460, have also provided sewage treatment facilities in seven primary treatment plants and ten secondary sewage treatment plants.

TABLE C
EXISTING MUNICIPAL* TREATMENT FACILITIES

Degree of Treatment Provided	Number of Municipalities	Number of Plants	Population Served
Primary	6	7	25,750
Secondary	10	10	15,710
No Treatment	8	--	33,100

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers, and industrial wastes discharged into municipal sewerage systems.

As shown in Table D, the food processing industry has the largest number of industrial establishments that are discharging wastes directly into the watercourses. However, the paper and allied industry is, by far, the most important in this basin from a pollution standpoint. All five of the pulp and paper mills have provided treatment facilities and 15 of the food processing plants are treating their wastes. A total of 26 industrial plants in the basin are now providing some type of treatment for their wastes, but, in some cases, only the weaker wastes are being treated. The 26 industrial waste treatment plants include 20 with primary or equivalent type of facilities, two that are providing a higher degree of treatment and four which provide only a minor degree of treatment.

TABLE D
EXISTING INDUSTRIAL* TREATMENT FACILITIES

Type of Industry	Number of Plants	Number of Industrial Plants Having: Treatment Facilities	No Treatment Facilities	Undetermined Facilities
Food and Kindred Products	26	15	11	0
Chemical and Allied Products	2	0	1	1
Coal Products	1	1	0	0
Paper and Allied Products	5	5**	0	0
Mine Drainage	8	5	3	0
TOTAL	42	26	15	1

*Industries having separate outlets and discharging wastes directly to watercourse.

**The four pulp and paper plants have reduced fiber losses through the installation of save-alls, but do not provide treatment for the strong chemical wastes from their pulp mills.

A study of the adequacy of treatment facilities shows that twelve of the 17 sewage treatment plants have satisfactory capacity to handle the present load, while four do not have sufficient capacity. However, these four overloaded plants serve less than 10 percent of the basin's sewered population. All but seven of the municipalities that have sewage treatment plants are operating them in a satisfactory manner.

TABLE E
ADEQUACY OF EXISTING TREATMENT FACILITIES

Existing Treatment Facilities	Number	Adequacy with Relation to: Capacity: Satisfactory	Capacity: Unsatisfactory	Capacity: Undetermined	Operation: Satisfactory	Operation: Unsatisfactory	Operation: Undetermined
Municipal	17	12	4	1	10	5	2
Industrial	26	14	9	3	18	5	3

The majority of the industries that have provided waste treatment facilities are operating them in a satisfactory manner and are obtaining maximum efficiency out of the available facilities. However, about one-third of the industrial waste treatment plants do not have sufficient capacity or proper facilities to provide the degree of treatment necessary for the protection of the waters into which the wastes are discharged.

The first treatment plant in the basin was constructed at Caspian, Michigan, in 1926. Menominee and Stephenson, Michigan, placed their waste treatment plants in operation during 1937 and 1939, respectively, and Crandon, Wisconsin, completed its plant in 1943. Progress following the war, when construction materials became available, is indicated by Table F. Plants were completed at Goodman and Pulaski, Wisconsin, in 1948, and at Lena and Coleman, Wisconsin, in 1949. Peshtigo and Oconto Falls, Wisconsin, completed their plants in 1952 while Oconto, Wisconsin, placed its plant in operation in 1953.

TABLE F
PROGRESS IN POLLUTION ABATEMENT

	Municipal		Industrial	
Year	Plants Completed	Design Population	Plants Completed	Amount of waste treated (in terms of equivalent number of people)
1947	0	--	1	--
1948	2	2,590	1	--
1949	2	4,370	1	1,500
1950	0	--	1	--
1951	0	--	2	9,800
1952	2	3,600*	1	92,000
1953	1	5,700*	6	--

*Population served by sewerage system.

The Virgil-Spies mines installed waste treatment facilities in 1947 and the Superior Sugar Co. at Menominee started operation of a waste treatment plant in 1948. Additional facilities were added to this plant in 1952. The Whitehouse Milk Co. at Stephenson, Michigan, completed a waste treatment plant in 1949 and the Coleman Canning Co. at Coleman, Wisconsin, began discharging its waste to an irrigation field in 1951. The Marinette Paper Co. at Marinette, Wisconsin, and the Badger Paper Mills at Peshtigo,

Wisconsin, started hauling a portion of their waste sulphite liquor to lagoons and dumps in 1950 and 1951, respectively.

In Wisconsin, the Ansul Chemical Co. of Marinette, the Gillett Canning Co. of Gillett, and Hayes Dairy Coop. at Hayes placed waste treatment facilities in operation in 1953. Pollution abatement progress in Michigan during 1953 included the installation of waste treatment facilities at the Marathon Corporation of Menominee, the transfer of mining operations at the Buck and Baltic mine to the Berkshire shaft where a settling pond was installed, and the diversion of water from the Book mine at Alpha through an old water-filled pit which serves as an adequate settling basin. In addition, settling ponds at the Hiawatha and Homer mines were nearing completion.

Approximately 45% of the watershed area in Wisconsin and 55% of the watershed area in Michigan is now organized in Soil Conservation Districts. The Soil Conservation Service, working through these districts, provides technical assistance to the farmers in installing conservation practices, such as contour farming, contour strip cropping, waterway improvements and improved rotations. All of these practices definitely tend to reduce the sediment loads of the streams in the watershed, thereby reducing the cost of treating public water supplies, damage to fish life, silting of reservoirs and stream channels, and damage to agricultural lands.

The water pollution control laws of the States are adequate to abate existing pollution and to prevent or control new or increased sources of pollution. The water pollution control agencies have been given sufficient legal authority to carry on their programs and have used this authority judiciously and effectively in carrying out their work. The following brief analysis presents the salient features of water pollution control legislation of the States of the basin.

In Wisconsin the primary responsibility for the water pollution control program has been vested in the Committee on Water Pollution. The State Board of Health also has comprehensive water pollution control functions. The 1927 Wisconsin State legislature created the Committee on Water Pollution and designated its powers and duties. This legislation, called the State Water Pollution Control Act, was last revised in 1949.

The Committee on Water Pollution has authority to make studies and investigations, conduct scientific experiments and research, hold hearings, issue orders, enter into agreements with other States and with the Federal Government, and obtain enforcement of orders through court action. The Committee on Water Pollution consists of the State Chief Engineer, and a member or other representative of the Public Service Commission designated by the Commission, a conservation commissioner or an employee designated by the Conservation Commission, the State health officer or a member of the Board of Health designated by the Board, and the State sanitary engineer or other engineer appointed by the State Board of Health.

The Michigan Water Resources Commission has the general over-all authority relating to the control of pollution of any waters of the State. The Department of Conservation and the State Health Department also have related water pollution control functions.

The Water Resources Commission consists of the Director of Conservation, the Commissioner of Health, the Highway Commissioner, the Director of Agriculture, and three other members appointed by the Governor to represent industry, municipalities, and conservation interests. The Commission has the power to establish pollution standards for State waters in relation to their public use; to make rules and regulations; to make determinations of existing and possible future pollution; and to issue orders to secure correction of such pollution. It has the power to hold hearings and to enforce its regulations and orders; to make surveys, studies and investigations; and to cooperate and negotiate with other governments, governmental units and agencies in matters concerning the water resources of the State.

The Michigan Department of Conservation has the duty to prevent and guard against the pollution of lakes and streams for protection of fish within the State and to enforce all laws provided for that purpose; and the Department of Health has the authority to make and enforce rules and regulations governing the method of conducting and operating sewerage systems, to review plans and specifications for such systems, and to issue permits for their construction. It also has the duty to inspect sewerage systems and, if they are found inadequate, it may order such alterations as are deemed necessary.

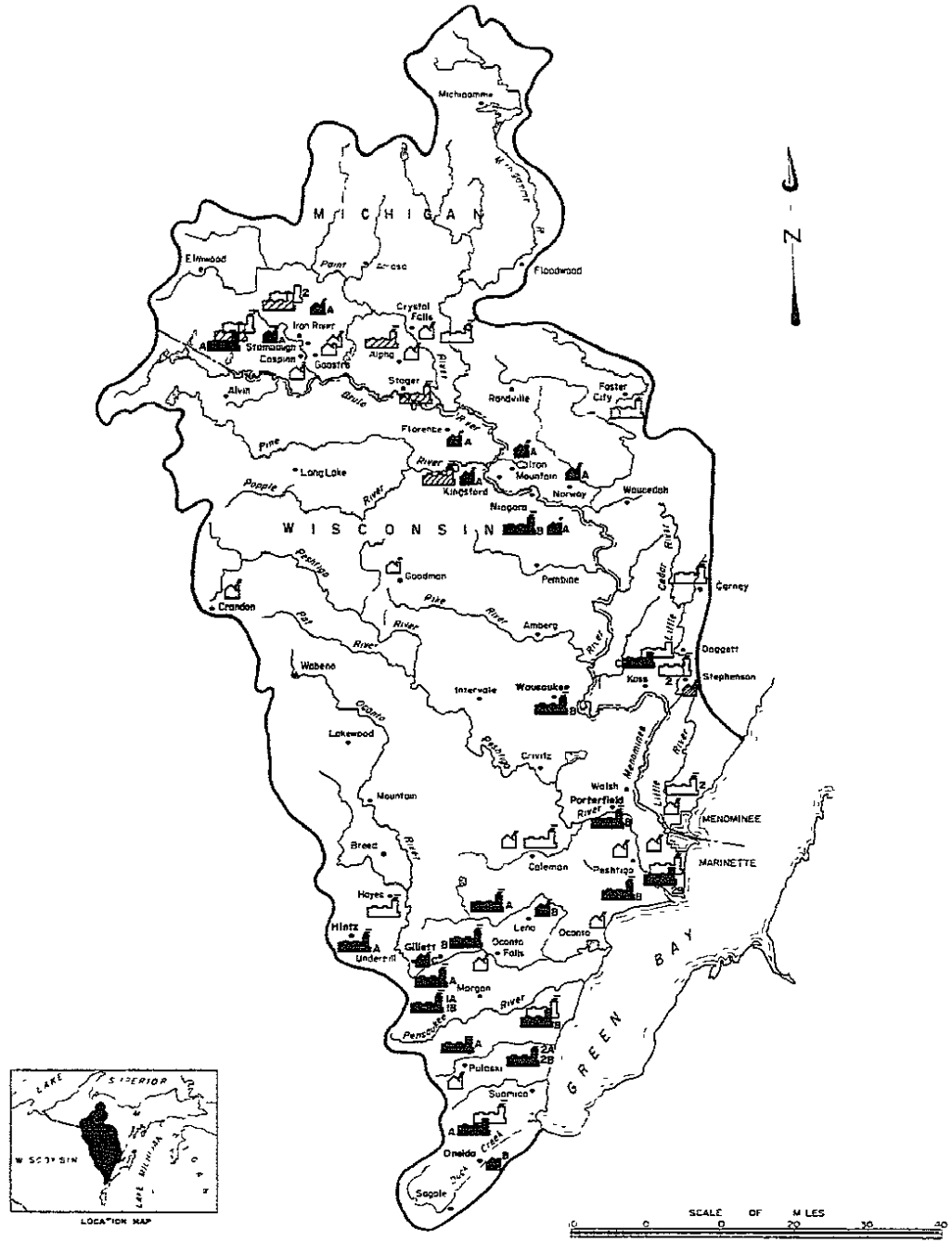
POLLUTION PREVENTION MEASURES REQUIRED

To obtain the maximum utilization of the water resources of the Green Bay Western Shore Drainage Basin, sewage and industrial wastes discharged to the streams must be treated to insure that water of suitable quality is available for all water uses. In view of the importance of industry and recreation to the economy of the region, the surface waters available for these uses should be maintained at a quality level that will stimulate their greatest development.

Water quality objectives pertinent to this basin have been discussed in the section of this report entitled "Uses of Water Resources." The type and design of each individual sewage or waste treatment plant depends upon several variable factors that can be determined only after an engineering survey of local conditions. The exact amount and type of wastes discharged are not known for some of the smaller problems in the basin, but preliminary studies and estimates are sufficient to set forth the abatement needs, and a local engineering survey will determine the exact type and degree of treatment needed. To insure that treatment facilities will satisfactorily protect water uses and to safeguard the taxpayer's investment, the Wisconsin Committee on Water Pollution and the Michigan State Health Department require the submission of plans for approval before construction is undertaken.

The degree of treatment required is influenced by the amount of dilution water available during periods of critical low flow and the water uses to be protected. Two separate and distinct critical stream flow periods occur in this region; the first during late summer and early fall, the second during midwinter. Increasing water temperatures reduce the capacity of the stream to absorb and hold oxygen during low flow periods which occur in hot weather, while at the same time, the high temperatures accelerate the rate of biological activity with a corresponding increase in the amount of oxygen required. During the winter low flow period, heavy and prolonged ice cover prevents or diminishes reaeration of the stream water, and biological activities, while progressing at a slower rate than in warm weather, must be wholly supported by oxygen contained in the receiving waters prior to the discharge of pollution. Thus where the quantity of waste discharge is large, as in areas where industry is concentrated, undesirable stream conditions are accentuated during low flow periods. At those points where stream flows may become critical, a high degree of treatment is essential to keep residual pollution loading within the stream's capacity for assimilation during such critical periods.

The preventive and corrective pollution control measures needed have been determined from results of stream surveys and other readily available data of the State agencies concerned. Construction of these needed facilities at an early date will restore, preserve, and protect existing water uses and those uses which may materialize in the immediate foreseeable future. These control measures were determined only after a thorough consideration of all water uses and are considered to be reasonable and adequate. The corrective measures are intended to be flexible and to reflect the needs of the existing



LOCATION MAP

MUNICIPAL INDUSTRIAL

NO POLLUTION ABATEMENT NEEDS

POLLUTION ABATEMENT NEEDS UNDETERMINED

POLLUTION ABATEMENT NEEDED

POLLUTION ABATEMENT NEEDS INDICATED BY LETTERS APPEARING BY "POLLUTION ABATEMENT NEEDED" SYMBOLS, AS FOLLOWS

A NEW TREATMENT PLANT OR OTHER POLLUTION CONTROL MEASURES

B ENLARGEMENTS OR ADDITIONS TO EXISTING PLANT

C REPLACE EXISTING PLANT

NOTE-

Numbers next to symbols or code letters represent number of pollution abatement need in the category designated

GREEN BAY WESTERN SHORE

DRAINAGE BASIN

MUNICIPAL AND INDUSTRIAL POLLUTION ABATEMENT NEEDS

DEPARTMENT OF HEALTH EDUCATION AND WELFARE

Public Health Service

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situation; however, changes in stream characteristics, pollution load, or water uses may require revisions in the indicated treatment needs at some future date.

Considerable progress has been made in providing municipal and industrial waste treatment facilities, but additional plant construction, replacement, and expansion are still needed before all waters of the basin are adequately protected from the effects of municipal and industrial pollution. There is also a need for improved operation at some of the existing treatment plants, as failure to operate these waste treatment works at or near maximum efficiency means that clean streams are not obtained as estimated, and funds spent in anticipation of clean streams are being wasted.

Pollution prevention measures required to control and abate the damaging effects of polluting material in the streams of the basin are described herein. Pollution control programs should be dynamic and flexible because they must change to meet changing conditions. However, since the population of this basin has been relatively stable for the past 20 years and there is no apparent expansion of industry within the region at present, it is reasonable to expect that, when the presently needed facilities are completed, the streams of the basin can be maintained in good condition as long as the treatment facilities are maintained and operated properly.

Seven municipalities are in need of new sewage treatment plants to serve a total population of 30,460 as shown in Table G, while one community needs to replace its existing plant with a new one. Plans have been prepared and approved for a joint plant to serve Iron River and Stambaugh, Michigan, which have been ordered to abate pollution by June 1, 1955. Iron Mountain and Kingsford, Michigan, have been ordered to abate pollution by June 1, 1954, and have obtained approval of plans for a joint plant. Niagara, Wisconsin, has plans approved for its proposed new plant. When these three sewage treatment plants are constructed, they will reduce the amount of untreated sewage being discharged into the basin waters by a population equivalent of 25,430. Norway, Michigan, which also needs a new plant and has been ordered to abate its pollution by June 1, 1954, is planning to meet its obligation. Only two communities, with a total combined population of 3,940, are not treating or planning to treat their waste at present.

TABLE G
REQUIREMENTS FOR MUNICIPAL AND INDUSTRIAL
WASTE TREATMENT PLANTS

Requirements	Municipal		Industrial
	Number of Plants	Population Served by Facilities	Plants Needed
New Plant	7	30,460	9
Enlargement or Additions to Existing Plant	2	550	8*
Replace Plant	1	1,000	1
Waste Reduction Program	0	--	2
Chemical Recovery Unit	0	--	1
No Project Required	14	41,930	16
Undetermined	1	620	5

*Includes three plants for treatment of pulp mill wastes at mills which now have treatment for paper mill wastes.

In addition, two communities need to enlarge or add to their existing plants. It is estimated that the construction of the needed municipal facilities will cost about $2,000,000.

Crystal Falls, Michigan, a municipality of about 2,600, discharges untreated sewage into the Paint River, tributary to the Brule River, but is not listed as needing treatment facilities. A public hearing was held May 26, 1950. Effect of pollution resulting from Crystal Falls' waste at that time was determined to be insufficient to warrant issuance of abatement orders.

Nine new industrial waste treatment plants are required in the basin, and eight industries need to enlarge or make additions to their existing plants. The most important of these are the facilities needed to treat the waste from the pulp departments of the pulp and paper mills at Niagara, Peshtigo and Oconto Falls, Wisconsin. Eight mines are known to discharge inorganic wastes to the Iron and Paint Rivers and Armstrong Creek, and treatment by settling is being provided by five of them. One chemical industry is reducing its pollution problem through the installation of recovery equipment which will prevent the loss of materials that now cause trouble. The M & M Light and Traction Company is planning to convert to natural gas and place their existing gas plant on a standby basis, thus eliminating the need for treatment facilities.

TABLE H
STATUS OF TREATMENT WORKS PROJECTS TO ABATE POLLUTION
JANUARY 1, 1954

Status of Project	Number	
	Municipal	Industrial
Plans Under Preparation	2	3
Final Plans Approved	3*	0
Under Construction	0	4
Status Undetermined	2	2

*Two of these plants are to serve two communities each.

The pollution abatement program is moving ahead in this basin with four industrial waste treatment plants now under construction and three municipalities with final plans for their proposed treatment plants approved and ready for construction. In addition, two municipalities and three industries are actively engaged in preparing plans for the facilities that are needed to abate the pollution caused by their wastes.

Intensification of State water pollution control educational programs is important to long-range planning and good administration by water pollution control agencies. The undesirable effects of pollution on public health and water conservation must be presented to the public if its support of water pollution control measures is to be expected. Responsible officials of both municipalities and industries should become acquainted with expected treatment needs so that the needed improvements can be planned for well ahead of the time when these needs become an actuality and before damage to the waters has occurred.

APPENDIX I

BASIC DATA ON SOURCES OF MUNICIPAL* POLLUTION

GREEN BAY WESTERN SHORE DRAINAGE BASIN

Name and Location	Miles Above Stream Mouth	Population Served by Sewers	Waste Treatment Provided	Adequacy of Treatment Facilities		P.E. (B.O.D.) Discharged to Water-course	Treatment Needs	Current Status of Municipal Action
				Capy.	Opr.			
MENOMINEE RIVER:								
Iron Mountain, Mich.		11,080	None	--	--		New plant)	Plans approved for joint
Kingsford, Mich.		5,770	None	--	--		New plant)	plant
Niagara, Wis.	83.9	2,000	None	--	--	2,000	New plant	Plans approved
Norway, Mich.		3,730	None	--	--	--	New plant	Active planning
Menominee, Mich.		10,200	Primary	Sat.	Sat.		None	
Marinette, Wis.	1.4	12,500	Primary	Sat.	Sat.	12,000	None	
IRON RIVER:								
Iron River, Mich.		4,500	None	--	--	6,500	New plant)	Plans approved for joint
Stambaugh, Mich.		2,080	None	--	--	1,600	New plant)	plant
Caspian, Mich.		1,800	Primary	Undet.	Undet.		None	
Gaastra, Mich.								
Plant "A"		330	Primary	Sat.	Sat.		None	
Plant "B"		340	Primary	Sat.	Sat.		None	

*Includes incorporated and unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

Name and Location	Miles Above Stream Mouth	Population Served by Sewers	Waste Treatment Provided	Adequacy of Treatment Facilities		P.E. (B.O.D.) Discharged to Watercourse	Treatment Needs	Current Status of Municipal Action
				Capy.	Opr.			
ARMSTRONG CREEK:								
Alpha, Mich.		500	Primary	Sat.	Sat.		None	
PAINT RIVER:								
Crystal Falls, Mich.		2,640	None	--	--		None**	
BRULE RIVER:								
Florence, Wis.	3.5	1,300	None	--	--	1,300	New plant	Inactive
PIKE RIVER:								
Goodman, Wis.	43.2	760	Secondary	Sat.	Sat.	20	None	
LITTLE CEDAR RIVER:								
Stephenson, Mich.		620	Secondary	Unsat.	Unsat.		Undet.	Active planning
PESHTIGO RIVER:								
Peshtigo, Wis.	10.0	1,700	Secondary	Sat.	Sat.	930	None	
S. BRANCH PESHTIGO RIVER:								
Crandon, Wis.	9.1	2,000	Secondary	Sat.	Unsat.		None	
LITTLE PESHTIGO RIVER:								
Coleman, Wis.	11.0	560	Secondary	Sat.	Sat.	120	None	

**Public hearing was held 5/26/50 -- pollution injury determined at that time, insufficient to warrant issuance of pollution abatement orders.

Name and Location	Miles Above Stream Mouth	Population Served by Sewers	Waste Treatment Provided	Adequacy of Treatment Facilities		P.E. (B.O.D.) Discharged to Water-course	Treatment Needs	Current Status of Municipal Action
				Capy.	Opr.			
OCONTO RIVER:								
Gillett, Wis.	25.8	1,000	Secondary	Unsat.	Unsat.	300	Replace plant	Undetermined
Oconto Falls, Wis.	19.5	1,900	Secondary	Sat.	Undet.	250	None	
Oconto, Wis.	1.3	5,700	Secondary	Sat.	Sat.		None	
LITTLE RIVER:								
Lena, Wis.	11.5	470	Secondary	Unsat.	Unsat.	420	Additions	Inactive
LITTLE SUAMICO RIVER:								
Pulaski, Wis.	19.1	1,000	Secondary	Sat.	Sat.	250		None
DUCK CREEK:								
Oneida, Wis. Sacred Heart Seminary	16.1	80	Primary	Unsat.	Unsat.		Additions	Inactive

APPENDIX II

BASIC DATA ON SOURCES OF INDUSTRIAL* POLLUTION

GREEN BAY WESTERN SHORE DRAINAGE BASIN

Name and Location	Miles Above Stream Mouth	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Water-course	Pollution Abatement Needs	Current Status of Industrial Action
				Degree	Adequacy of				
					Capy.	Opr.			
MENOMINEE RIVER:									
Kingsford, Mich. Kingsford Chemical Pt.		Chemical	Organic	Undet.	--	--		Undet.	
Niagara, Wis. Kimberly-Clark Pulp and Paper Mill	85.1	Paper	Organic and inorganic	Minor	Unsat.	Sat.	242,500	Enlargement and additions	Active planning
Marinette, Wis. Marinette Paper Co.	2.9	Paper	Organic and inorganic	Primary	Sat.	Sat.	117,200	None	
M & M Light and Traction Co.	1.4	Coal products	Organic	Minor	Unsat.	Sat.		Additions or waste reduction	Converting to natural gas with no waste
Ansul Chemical Co.	1.2	Chemical	Inorganic	None	--	--		Chemical recovery facilities	Under construction

*Industries having separate outlets and discharging wastes directly to the watercourses.

Name and Location	Miles Above Stream Mouth	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Water-course	Pollution Abatement Needs	Current Status of Industrial Action
				Degree	Adequacy of				
					Capy.	Opr.			
MENOMINEE RIVER (Contd.):									
Menominee, Mich.									
Superior Sugar Co.		Food	Organic	Primary	Sat.	Sat.	29,000	None	
Marathon Corp.		Paper	Organic	Primary	Sat.	Sat.		None	
IRON RIVER:									
Iron River, Mich.									
Homer-Mickler-Cadiff Mines		Mining	Inorganic	Primary	Undet.	Undet.		Undet.	
Sherwood Mines		Mining	Inorganic	Primary	Sat.	Sat.		None	
Virgil-Spies Mine		Mining	Inorganic	Primary	Undet.	Undet.		None	
Stambaugh Twp., Mich.									
Berkshire Mines		Mining	Inorganic	Primary	Sat.	Sat.		None	
Hiawatha Mines		Mining	Inorganic	Primary	Undet.	Undet.		Undet.	
Cannon Mine		Mining	Inorganic	None	--	--		New plant	Under construction
ARMSTRONG CREEK:									
Alpha, Mich.									
Book Mine		Mining	Inorganic	None	--	--		Undet.	
PAINT RIVER:									
Crystal Falls, Mich:									
Crystal Dairy Prod. Co.		Food	Organic	Primary	Sat.	Sat.		None	
Stager, Mich.									
Tobin Mine		Mining	Inorganic	None	--	--		Undet.	

Name and Location	Miles Above Stream Mouth	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Water-course	Pollution Abatement Needs	Current Status of Industrial Action
				Degree	Adequacy of				
					Capy.	Opr.			
E. BRANCH STURGEON RIVER:									
Foster City, Mich.									
Riverside Coop. Cheese Pt.		Food	Organic	Primary	Sat.	Sat.		None	
WAUSAUKEE RIVER:									
Wausaukee, Wis.									
Wausaukee Cheese Fct.	4.1	Food	Organic	None	--	--	325	Waste reduction program	Undet.
LITTLE CEDAR RIVER:									
Carney, Mich.									
Carney Cheese Co.		Food	Organic	Primary	Sat.	Sat.		None	
Daggett, Mich.									
Daggett Cheese Co.		Food	Organic	Primary	Unsat.	Unsat.		Replacement	Inactive
Cloverleaf Cheese Co.		Food	Organic	Primary	Sat.	Sat.		None	
Stephenson, Mich.									
Palestine Cheese Co.		Food	Organic	Primary	Sat.	Sat.		None	
Whitehouse Milk Co.		Food	Organic	Secondary	Sat.	Sat.	180	None	
PESHTIGO RIVER:									
Porterfield, Wis.									
Riverside Cheese Fct.	27.5	Food	Organic	None	--	--	325	Waste reduction program	Undet.

Name and Location	Miles Above Stream Mouth	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Water-course	Pollution Abatement Needs	Current Status of Industrial Action
				Degree	Adequacy of				
					Capy.	Opr.			
PESHTIGO RIVER (Contd.):									
Peshtigo, Wis.									
Badger Paper Co.	10.4	Paper	Organic and inorganic	Minor	Unsat.	Sat.	104,650	Enlargement and additions	Active planning
LITTLE PESHTIGO RIVER:									
Coleman, Wis.									
Coleman Canning Co.	11.0	Food	Organic	Primary	Sat.	Sat.		None	
OCONTO RIVER:									
Oconto Falls, Wis.									
Falls Paper and Power Co.	19.7	Paper	Organic and inorganic	Minor	Unsat.	Sat.	310,200	Enlargement and additions	Active planning
S. BRANCH OCONTO RIVER-HAYES BROOK:									
Hayes, Wis.									
Hayes Dairy Coop.	2.2	Food	Organic	Primary	Sat.	Sat.		None	
LINZY BROOK:									
Hintz, Wis.									
Linzy Brook Cheese Fct.	1.9	Food	Organic	None	--	--	270	New plant	Inactive

Name and Location	Miles Above Stream Mouth	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Water-course	Pollution Abatement Needs	Current Status of Industrial Action
				Degree	Adequacy of				
					Capy.	Opr.			
CHRISTY BROOK:									
Gillett, Wis.									
Gillett Canning Co.	2.4	Food	Organic	None	--	--	12,000	New plant	Irrigation equip. being installed
LITTLE RIVER:									
Spruce, Wis.									
Spruce Cheese Fct.	7.8	Food	Organic	None	--	--	230	New plant	Inactive
PENSAUKEE RIVER:									
Zachow, Wis.									
Graf Creamery	32.5	Food	Organic	Primary	Unsat.	Unsat.	200	Additions	Inactive
Krakow, Wis.									
Brzezinski Bros. Cheese Fct.	26.9	Food	Organic	None	--	--	360	New plant	Inactive
Abrams, Wis.									
Riverside Cheese Fct.	14.1	Food	Organic	None	--	--	180	None	
Brookside, Wis.									
Brookside Cheese Fct.	7.0	Food	Organic	Primary	Unsat.	Unsat.	280	Additions	Inactive
LITTLE SUAMICO RIVER:									
Pulaski, Wis.									
Pulaski Canning Co.	19.0	Food	Organic	None	--	--		New plant	Inactive

Name and Location	Miles Above Stream Mouth	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Water-course	Pollution Abatement Needs	Current Status of Industrial Action
				Degree	Adequacy of				
					Capy.	Opr.			
LITTLE SUAMICO RIVER (Contd.):									
Sobieski, Wis.									
Elmwood Cheese Fct.	5.5	Food	Organic	Secondary	Unsat.	Unsat.	250	Enlargement	Inactive
Little Suamico, Wis.									
Wroblewski Pickle Co.	2.1	Food	Organic	None	--	--		New plant	Inactive
Little Suamico Cheese Fct.	2.0	Food	Organic	None	--	--	240	New plant	Inactive
SUAMICO RIVER:									
Kunesch, Wis.									
Kunesch Cheese Fct.	14.0	Food	Organic	Primary	Unsat.	Unsat.	330	Additions	Inactive
Flintville, Wis.									
Flintville Cheese Fct.	8.8	Food	Organic	Primary	Sat.	Sat.	280	None	
DUCK CREEK:									
Duck Creek, Wis.									
Stokely Foods, Inc.	2.6	Food	Organic	None	--	--	980	New plant	Inactive

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